GREEN VOLT

Technical Appendix 5.2

Unexploded Ordnance Survey Specifications

Offshore EIA Report: Volume 2

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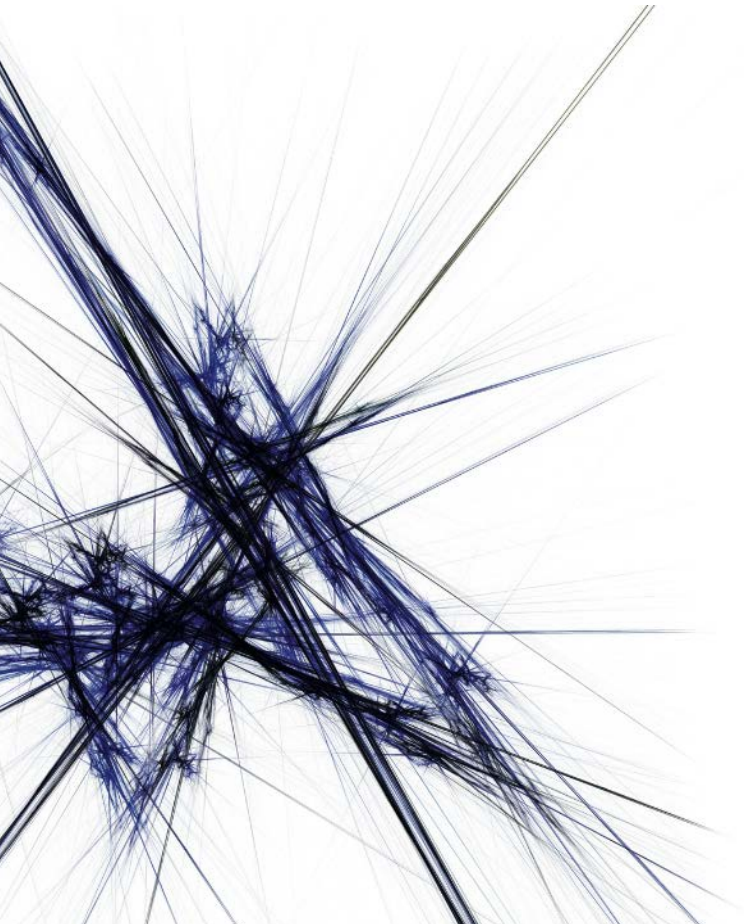
UXO Survey Acquisition, Processing and Survey Verification Test (SVT) Procedures

FLOTATION ENERGY

Project: *Green Volt OWF*

Meeting the requirements of the UK's Construction Industry Research and Information Association's Risk Management Framework:

"Assessment and Management of the Unexploded Ordnance Risk in the Marine Environment"



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Abbreviations

AAA	Anti-Aircraft Artillery
ALARP	As Low As Reasonably Practicable
CIRIA	Construction Industry Research and Information Association
DGPS	Differential Global Positioning System
ECR	Export Cable Route
GNSS	Global Navigation Satellite System
HE	High Explosive
HSE	Health Safety and Environment
IAC	Inter Array Cable
IHO	International Hydrographic Organisation
kg	Kilogram
kHz	Kilohertz
LAT	Lowest Astronomical Tide
LMA/LMB	Luftmine A/B
MAG	Magnetometer
MBES	Multibeam Echosounder
m	metres
NEQ	Net Explosive Quantity
nT	Nanotesla
OWF	Offshore Wind Farm
pUXO	Potential Unexploded Ordnance
QA	Quality Assessment
QC	Quality Control
ROTV	Remotely Operated Towed Vehicle
RPL	Route Position List
RTK	Real-time Kinematic
SSS	Sidescan Sonar
SVT	Survey Verification Test
TVG	Transverse Gradiometer
USBL	Ultra-short Baseline
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
WGS	World Geodetic System
WTG	Wind Turbine Generator

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1 Introduction

References:

A CIRIA C574_Assessment and Management of UXO Risk in the Marine Environment, dated February 2016;
B 9691_UXOTARA_Green Volt OWF_Flotation Energy_V2.0, dated 1st June 2022;
C 9691_UXORMS_Green Volt OWF_Flotation Energy_V2.0, dated 1st June 2022.

1.1 Geophysical Unexploded Ordnance (UXO) Survey

This document has been prepared by 6 Alpha Associates Ltd, (*hereafter referred to as 6 Alpha*), for and on behalf of *Flotation Energy, (hereafter referred to as the Client),* and it defines the expected calibrations, data acquisition and processing workflow, and quality/performance output to be achieved by the survey contractor whilst acquiring and processing geophysical unexploded ordnance (UXO) survey data for the *Green Volt Offshore Wind Farm (OWF)* project.

Furthermore, this document outlines the Survey Verification Test, (SVT), procedures to be undertaken prior to commencement of survey operations in accordance with the Construction Industry Research and Information Association, (CIRIA), best practice guide, (*Reference A*), in order to sufficiently prove correct functionality of the survey sensors and to determine positional accuracy of the survey spreads on-board each vessel.

The resulting outputs defined in this specification are expected to be used to manage the UXO risks to the cable installation methodologies, in accordance with industry "best practice", as detailed in the CIRIA best practice guide (*Reference A*).

1.2 Constraints and Limitations

The following constraints and limitations apply to the performance specification:

- Its employment is restricted to the desk study (*Reference B*) and risk management strategy (*Reference C*) that support it, which has been undertaken and provided by 6 Alpha;
- It considers the employment of Multibeam Echosounder (MBES), Sidescan Sonar (SSS), and Magnetometer (MAG) data, only.

1.3 Aims and Objectives

Aim; to define and to describe a performance specification for geophysical UXO survey data processing in order to guide, enable and quality control, third-party geophysical UXO survey data processing activities.

Objectives; to describe:

- UXO threat targets and the selection of the minimum size of UXO threat for selection;
- The anticipated survey data inputs;
- The overarching processing and expected workflow steps.

1.4 Threat Sources

The threat items likely to be present on site are outlined within the 6 Alpha threat and risk assessment, (*Reference B*), and the minimum threat items are outlined as follows:

- Water depths shallower than 10m below LAT (Lowest Astronomical Tide);
    - 3.7" Artillery Projectile – 0.93kg NEQ, ~11.6kg ferrous mass;
- Water depths between 10-26m below LAT;
    - SC-50 HE Bomb – 25kg NEQ, ~25kg ferrous mass.
- Water depths between 26-40m below LAT;
    - SC-250 HE Bomb – 130kg NEQ, ~126kg ferrous mass.
- Water depths deeper than 40m below LAT;
    - Mark XVII/XX Mine – 227kg NEQ, ~68kg ferrous mass.

The minimum size threat item detectable using practicable methods, is an SC-50, (50 kg), German aerially delivered HE Bomb; equating to approximately 25kg detectable ferrous metal. Other larger items of UXO will also be concurrently detected.

2 UXO Survey Acquisition Methodology

2.1 Geophysical UXO Survey

A geophysical UXO survey is to be performed by an experienced Survey Contractor, utilising a magnetometer array consisting of at least two or more caesium vapour magnetometers with a sensitivity of <0.004nT / $\sqrt{Hz}_{\text{rms}}$, sidescan sonar (SSS) with a minimum operating frequency of not less than 600kHz and high resolution multibeam echosounder (MBES). 6 Alpha recommend that a survey corridor width of not less than 50m is surveyed centred on the planned inter-array and export cable Route Position Lists (RPL's). The Client should advise the area to be surveyed around the intended Wind Turbine Generator (WTG) locations based on the installation methodology. Survey personnel in key positions of responsibility are to have not less than 5 years of geophysical survey experience and demonstrable experience of performing surveys for UXO detection.

2.1.1 Multibeam Echosounder (MBES) Survey

In addition to a magnetometer and SSS survey, a high resolution MBES survey would be useful in order to corroborate surface contacts identified with SSS and to further inform 6 Alpha about seabed morphology in relation to the potential for UXO migration, movement, and burial. It is therefore recommended that MBES is hull-mounted to the survey vessel in order to enable concurrent MBES data capture as the magnetometer and SSS survey work is undertaken.

2.1.2 Sidescan Sonar (SSS) Survey

In addition to a magnetometer survey, a high resolution SSS survey is to be undertaken to detect low ferrous content UXO that may be located upon on the surface of the seabed, such as LMA/LMB mines. The high-resolution images that result from this element of the survey will be used to identify the locations, sizes and shapes of those items that might be associated with such UXO, (and other large masses). The operating range and survey swath generated by the SSS system will be significantly larger than the detection range of the magnetometers, so line spacing will be determined based on magnetometer line spacing. All towed survey equipment is to be tracked and positioned using acoustic positioning.

2.1.3 Magnetometer (MAG) Survey

For the magnetometer survey, the line spacing, magnetometer configuration and survey specification will be designed in such a way as to be capable of detecting a minimum threat item with a ferrous mass of

25kg, equivalent to that contained in a German SC-50 HE bomb. The detection of smaller UXO ferrous masses such as artillery projectiles (AAA), although beneficial, is deemed to be beyond the necessary level to reduce the UXO risk to As Low As Reasonably Practicable (ALARP), **subject to water depths onsite, vessel stand-off applied, diver involvement and proximity, and locally identified threat items.** (The risk of encountering and initiating such small Net Explosive Quantity (NEQ) items needs be within the capacity of project stakeholders to tolerate it). Should any of the above conditions change throughout the course of project planning, a further survey specification to identify smaller NEQ items will be required.

Survey line spacing will be subject to the number and type of magnetometers in the gradiometer array as well as their lateral separation and flying altitude. For this survey, the acquired magnetometer coverage will be calculated using a dynamic coverage method. Dynamic coverage for each total field magnetometer will be calculated based on a maximum 6m detection range generating approximately a 1nT response from a 25kg ferrous mass UXO, in water depths less than 26m, and 8m detection range generating approximately a 1nT response from a 68kg ferrous mass UXO, in water depths greater than 26m. The aim will be to a target burial depth of 2m below the seabed and assuming a statistical mode background noise of 0nT. Further details of the calculation for dynamic coverage is presented in Section 3.7.

Magnetometer specification parameters will not be amended following the results of a Survey Verification Test (SVT), which has been designed as *inter alia* an equipment wet-test and survey positional accuracy test. All towed survey equipment is to be tracked and positioned using acoustic positioning.

2.2 Survey Verification Test (SVT)

The Survey Contractor will be required to perform a Survey Verification Test (SVT) towards the beginning of the survey in order to wet-test and validate their survey equipment, USBL positioning, data acquisition methodology and to prove the subsequent data processing technique, as well as delivering the survey crew an opportunity to identify any technical issues or other problems that might otherwise compromise subsequent survey performance or data quality.

2.3 Permitting and Authorisation

It is the Client's responsibility for obtaining all relevant permits, licence consents as well as any other authorisations that may be necessary to perform survey operations within the specified survey areas and corridor(s). However, the Survey Contractor should notify the Client which permits will be required in a timely manner.

2.4 Equipment Specification

2.4.1 Magnetometer Specification

The following minimum specifications are required for all magnetometer survey options:

- Two or more total field caesium vapour magnetometers are to be deployed in a transverse configuration;
- Magnetometers may be individually soft towed or preferably, frame mounted;
- Magnetometers will be flown with a maximum towing altitude of 4.0m above the seabed for a 25kg ferrous mass, or 6.0m above the seabed for a 68kg ferrous mass. Where magnetometers are arranged vertically, care must be taken to ensure the top sensor adheres to this altitude requirement;
- In water depths shallower than 26m below LAT; at a target altitude of 3.5m, theoretical maximum lateral sensor separations are approximately 4.7m to provide 100% dynamic coverage, in order to detect a minimum of 25kg ferrous mass buried up to 2m below seabed;
- In water depths of greater than 26m below LAT; at a target altitude of 5m, theoretical maximum lateral sensor separations are approximately 7.7m to provide 100% dynamic coverage, in order to detect a minimum of 68kg ferrous mass buried up to 2m below seabed;
- *6 Alpha* recommend the use of a Remotely Operated Towed Vehicle (ROTV) in the offshore environment, and a fixed-frame Transverse Gradiometer (TVG) in the nearshore environment, to carry the magnetometers, maintain a steady altitude above seabed and actively track the seabed to ensure high quality of data and line keeping. An industry standard system, such as the EIVA Katria Scanfish could be used, for example. The below specifications should be applied whether a single or dual Scanfish/TVG solution is employed;
- *6 Alpha* further recommend designing the survey and vessel line plans to ensure sensor spacing is consistent across adjacent lines during survey operations. Regular sensor spacing produces consistent, high-quality data from which to model pUXO, which in turn reduces false positives and provides higher confidence during pUXO analysis. Furthermore, this also provides contingency and sufficient overlap to reduce vessel infill work, which can add unexpected time to the project schedule, and further uncertainty into the data interpretation. Nonetheless, vessel or survey line spacing can be increased up to where the distance between the outer sensors of adjacent lines is 6.2m, in water depths shallower than 26m below LAT assuming the use of a TVG, and 12.2m in water depths greater than 26m below LAT assuming the use of the EIVA Katria

Scanfish, however, this will increase the likelihood of survey infills.

- Nominally, considering the TVG and EIVA Katria Scanfish with a sensor spacing of 1.5m, the recommended configurations are provided in Figure 2.1 and 2.2 along with Table 2.1 and 2.2 below:

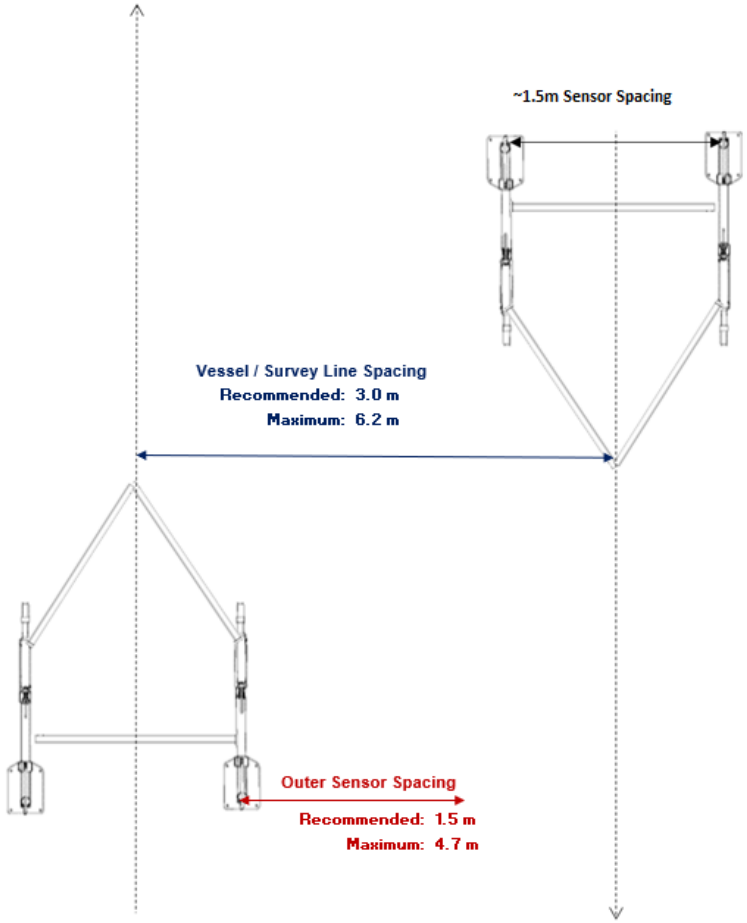

Figure 2.1: Example Survey Line Plan and Sensor Layout **for water depths shallower than 26m below LAT.**

TVG Frame with 2 x G-882 sensors, approx. 1.5m lateral spacing		
Configuration	**Unit**	**100 % Coverage**
Target Survey Flying Altitude:	m	3.50
Vessel / Survey or TVG (dual) Line Spacing, (recommended):	m	3.00
Vessel / Survey or TVG (dual) Line Spacing, (maximum):	m	6.20
Separation between outer sensors on adjacent lines, (recommended):	m	1.50
Separation between outer sensors on adjacent lines, (maximum):	m	4.70

Table 2.1: Recommended specification for a TVG Frame with 2 x G-882 sensors with approx. 1.5m lateral separation **for water depths shallower than 26m below LAT.**

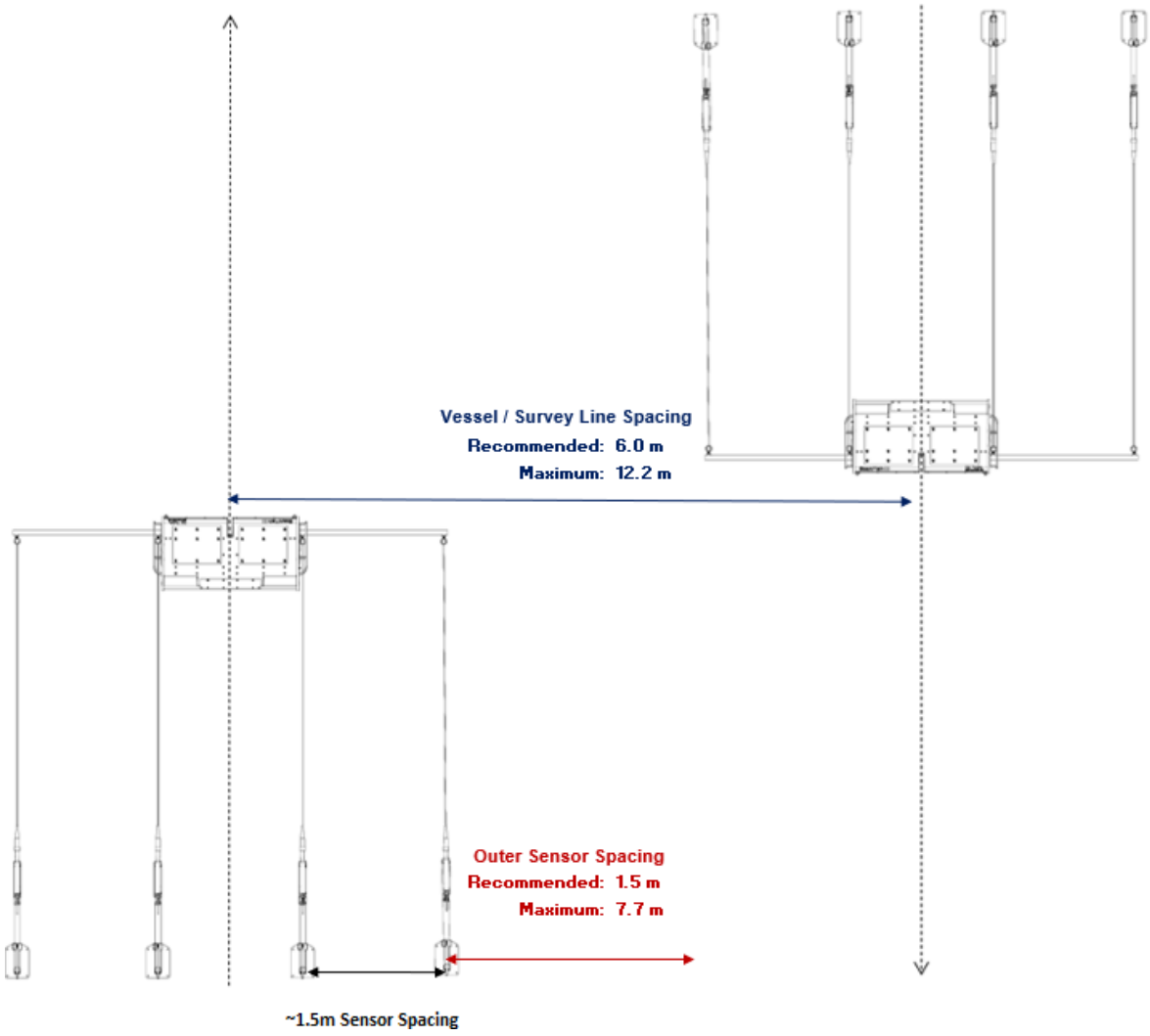

Figure 2.2: Example Survey Line Plan and Sensor Layout **for water depths greater than 26m below LAT.**

EIVA Katria Scanfish Frame with 4 x G-882 sensors, approx. 1.50m lateral spacing		
Configuration	**Unit**	**100 % Coverage**
Target Survey Flying Altitude:	m	5.00
Vessel / Survey or Scanfish (dual) Line Spacing, (recommended):	m	6.00
Vessel / Survey or Scanfish (dual) Line Spacing, (maximum):	m	12.20
Separation between outer sensors on adjacent lines, (recommended):	m	1.50
Separation between outer sensors on adjacent lines, (maximum):	m	7.70

Table 2.2: Recommended specification for an EIVA Katria Scanfish Frame with 4 x G-882 sensors with approx. 1.50m lateral separation **for water depths deeper than 26m below LAT.**

Other Magnetometer Specifications:

- The minimum sampling rate for the survey will be 10Hz or 0.1s sample rate;
- A magnetometer operating range of 20,000 to 100,000 nanotesla (nT), and a minimum counter sensitivity of <0.004nT / $\sqrt{Hz}_{\text{rms}}$. The magnetometers are to have a heading accuracy of less than 1nT over the entire 360° spin and tumble as well as an absolute accuracy of less than 3nT throughout range;
- A Motion Reference Unit (MRU) is to be fitted to the towed frame and a maximum roll and pitch angle of 15° shall not be exceeded for an ROTV or TVG frame deployed system;
- Magnetometers are to be able to operate within the full range of water depths and each individual magnetometer sensor is to be fitted with a depth sensor and altimeter, of which both are to be demonstrated to be correctly calibrated during mobilisation;
- Positioning of the magnetometers will be by Ultra Short Baseline (USBL) Positioning System. The USBL beacon shall be positioned at such a distance from the magnetometer(s) that it does not cause any magnetic interference;
- The use of estimated layback based upon tow cable length/angle is generally unacceptable, but a relaxation of this element of the specification may be delivered due to operational limitations e.g., where USBL in shallow water causes positional difficulties;
- The magnetometers shall be mounted and towed at a distance from the survey vessel which is sufficient to minimise magnetic interference. This distance is normally expected to be at least three times the length of the vessel;
- Deck cabling shall also be arranged to minimise magnetic noise;
- Equipment is to be approved to meet International Hydrographic Organisation (IHO) survey specifications and proven using a UXO Survey Verification Test (SVT);
- The magnetometer survey is to be subject to independent QA/QC by Client's Representative and/or UXO Consultant.

2.4.2 *Sidescan Sonar Specifications*

The following minimum representative specification is required for the SSS survey:

- SSS survey is to run at a minimum frequency of 600 kHz, at a range no larger than 50m;
- 200% data coverage is to be achieved, and lines planned to cover the nadir between adjacent lines;
- The range setting should be appropriate to the vessel line spacing and not be needlessly excessive. It is recommended to be operated at 25m if run concurrently with the magnetometer sensors whilst retaining coverage requirements;
- Fully redundant vessel positioning to be provided with navigation and survey suite. Accuracy is to be commensurate with Real Time Kinematic (RTK) DGPS or equivalent;
- The SSS is to be towed, independent of all other sensors deployed (i.e., a combined SSS/MBES systems such as the Edgetech 6205 system is not to be utilised). Other independent sensors (i.e. MAG, MBES, SBP) may be run concurrently;
- Acoustic positioning of all towed bodies integrated into the survey suite is required;
- The use of estimated layback based upon tow cable length/angle is generally unacceptable, but a relaxation of this element of the specification may be delivered due to operational limitations e.g., where USBL in shallow water causes positional difficulties;
- The underwater accuracy of detected targets is to be demonstrated to be approximately +/- 2.5m or better;
- Isometrically corrected SSS mosaics with surface contact lists and imagery shall be created. Ideally this is to be undertaken in or near real time as the survey proceeds with data delivery to the UXO consultant, not later than 24 hours after its acquisition;
- Equipment is to be approved to meet IHO survey specifications and proven using a UXO SVT;
- The SSS survey is to be subject to independent QA/QC by Client's Representative and/or UXO Consultant.

2.4.3 *MBES Specifications*

The following minimum specification is required for the multi-beam echo sounder:

- Operating frequency of 400kHz or more;
- Sampling rate of 30Hz or more;

- A minimum resolution to the end of swath of 0.15m;
- Statistical analysis of the MBES data should be undertaken with repeated sampling of a single point throughout the survey period and be used to verify the results of the MBES for any gross measurement errors;
- Water column sound velocities should be determined at the start and end of the survey and at appropriate intervals during the survey;
- Equipment is to be approved to meet IHO survey specifications and proven using a UXO SVT;
- The MBES survey is to be subject to independent QA/QC by Client's Representative and/or UXO Consultant.

2.4.4 Vessel and Positioning Specification

The vessel(s) specification(s) is/are to be described in detail by the Survey Contractor however, the following conditions must be met:

- The survey is to be subject to independent Quality Assessment (QA) / Quality Control (QC) by the Client's Representative;
- The survey vessel(s) is/are to have sufficient draft to suit water depths and to access the low water mark, if and as required;
- Vessel(s) are to be equipped to carry the UXO Consultants Geophysicists, Survey Contractors crew and a Client Representative, (unless e.g., the near shore vessel is so small that its capacity restricts their on-board presence), and all of the survey equipment specified;
- The vessel(s) are to be equipped with primary and secondary GNSS positioning systems (the Survey Contractor is to supply specifications). Real Time Kinematic (RTK) positioning is the preferred primary system;
- The GNSS positioning systems shall be used in combination with digital compass and motion sensor information. It is to be recorded and used for sensor positioning and navigational purposes;
- A USBL positioning system is to be deployed with the magnetometer and SSS survey equipment, to increase positional accuracy. Leniency may be given due to operational limitations e.g., with USBL in shallow waters subject to a formal discussion and review with the UXO consultant;
- The vessel will be capable of maintaining a steady survey speed of 4.0-4.5 knots throughout a survey line;

- Vessel line keeping is to be within +/-2m either side of the centreline. This constraint is expected to reduce the risk of gaps appearing in the data which will subsequently require infill, which is to be undertaken at the Survey Contractor's cost. However, it is anticipated, with the tidal conditions on site, that the vessel may have to steer a course offline to maintain the magnetometer array and other underwater survey equipment, on the line;
- Vessel(s) to have tidal height system (the Survey Contactor is to supply specifications) in order to acquire real-time data to reduce recorded water depths to the projected vertical datum (LAT);
- Equipment is to be approved to meet IHO survey standards and is to be proven using a Survey Verification Test (SVT) which will also act as an acceptance test;
- The Vessel(s) will be of sufficient size to accommodate the necessary equipment and facilitate the safe deployment and operation of underwater equipment to accomplish the survey;
- The Vessel(s) will be of sufficient size to safely deliver and recover UXO surrogates for the purposes of the SVT. Where smaller (near-shore) survey vessels may be employed, UXO surrogates may have to be emplaced and recovered by a separate vessel, which the Survey Contractor is to provide.

2.5 Spares Provision

To minimise equipment downtime, the Survey Contractor shall provide a full range of spares and a high degree of redundancy for all and any underwater equipment, in order to ensure minimal disruption to SVT and data acquisition operations.

2.6 Survey Units of Measurement

The following will apply:

- Geodetic Datum and Projection
  - All coordinate positions must be referenced to datum and projection: WGS84, UTM Zone 30N;
  - All positions must have an origin point and Easting and Northing shown with units provided.
- Vertical Datum
  - All bathymetric data must be vessel draft and tidally corrected stating port of tidal correction;
  - All bathymetric depths must be referenced to LAT;

- Depths must be presented in metric.

- Units of Measurement
  - Unless otherwise stated, all units must be metric;
  - All linear measurements shall be in metres (m), to one decimal place;
  - All elevation measurements must be in metres (m), to two decimal places;
  - All time measurements must be referred to Coordinated Universal Time (UTC);
  - All weight measurements must be in kilograms (kg);
  - All magnetic data shall be presented in nanotesla (nT).

2.7 Calibrations and Qualification Tests

2.7.1 Calibration Certificates

All equipment and instruments necessary for completion of the work shall be calibrated by an institution accepted by the Client. The calibration certificate shall:

- Clearly identify the instrument;
- Show date of calibration;
- Present the calibration results;
- Not be older than specified in the Survey Contractor's quality assurance system;
- Be included in the Survey Contractor's documentation of quality.

2.7.2 Calibration of Instruments

Survey instruments are to be calibrated as follows:

Pre-deployment Checks

Checks shall be performed on each instrument before mobilisation/deployment to ensure that all the sensors and processing equipment specified herein are functioning correctly and that they are performing within the manufacturers' specifications.

If the performance of any sensor is found to be unsatisfactory and outside of the manufacturer's specification, then the Survey Contractor shall discount it entirely. The Survey Contractor will undertake a full calibration of the sensor or instrument in order to obtain new calibration curves

and/or equations that shall be applied to the gathered data or replace the faulty equipment prior to the survey starting.

Instruments shall be calibrated to a national standard. The Survey Contractor is to specify which standard is/has been applied. Instrument calibration checks shall be undertaken in the presence of the Client's Representative.

Performance Checks

Performance checks shall also be carried out, where practicable, on each instrument during deployment and particularly by monitoring data quality. Any instrument not performing within specification shall be replaced at the Survey Contractor's cost and any missing data shall be reacquired as appropriate with the prior approval of the Client's Representative and at the Survey Contractor's cost.

If any instrument malfunctions during the acquisition period, discussions shall be held with the client's Representative in order to establish any requirements for additional calibrations and any corrections that shall be applied to the gathered data or the need to reacquire data, which shall be carried at the Survey Contractor's cost.

USBL Calibration

A USBL calibration is required on site prior to the commencement of the geophysical survey. A previous calibration may be accepted subject to verification and agreement with the Client. The Contractor's proposal is to include a description of how all installation and sound velocity calibrations will be conducted. Full account of calibration and final calibration parameters are to be included in the final survey report.

MBES Calibration

A standard patch test calibration should be conducted prior to commencement of the geophysical survey. A previous patch test may be accepted subject to verification and agreement with the Client. The calibration corrects for the misalignment between the vessel's motion reference unit and the mounting angles of the MBES head. The test should account for roll error, pitch and heading (yaw). A latency check is also to be undertaken.

Contractor's proposal is to include details of the calibration process and a description of how all installation and sound velocity calibrations will be conducted. The correction values applied, and full details of the calibration process carried out are to be included.

Magnetometer Calibrations

Magnetometers are generally factory calibrated and cannot be altered. The optimum sensor orientation is to be checked prior to survey to ensure it is within the active zone for the location and orientation of the main survey lines. A 'spanner check' shall be used to demonstrate correct numbering of sensors.

The magnetometer altimeters shall be calibrated using a bar check method or similar to determine scale and bias values to be applied to the data. Digital altimeters do not require scale and bias values but must still be verified in the same manner. Calibration certificates from previous projects, or the manufacturer are not acceptable as a replacement for this verification.

Measurements of the magnetometer array and offset diagrams are to be provided prior to the SVT, indicating:

- X, Y and Z offsets from USBL beacon to the magnetometer sensor;
- X, Y and Z offsets from the magnetometer sensors to the altimeter, if not housed within the nosecone;
- Confirmation of the convention of X, Y, Z offsets on the vessel reference frame, and the polarity convention/direction of roll, pitch and heave measurements provided;
- Numbering of magnetometer sensors with reference to the output data string;
- Photos of the set-up on deck, where possible.

Furthermore, it shall be confirmed by the contractor to which node the navigation and motion information are referenced to in the data export format.

The magnetometers are to be towed at a distance of approximately 3 times vessel length to ensure that there is minimum interference generated by the vessel's electromagnetic field.

All data is to be corrected for temporal variations in the earth's magnetic field, such as diurnal variations and magnetic storms. The value of the earth's magnetic field vector at the survey location shall be applied such that anomalies are properly identified and extracted.

A sea trial of the magnetometers and their functionality is to be undertaken prior to the commencement of the survey and is to be witnessed and endorsed in writing by the Client's Representative.

Side Scan Sonar Calibrations

A rub test is to be carried out prior to the SSS being deployed. The SSS system is to be tested during the

SVT and the results are to be recorded in the final survey report.

Full UXO Sensor Spread Calibration

A test line of at least 200m in length must be undertaken, running all sensors concurrently, as planned for the UXO survey component of the works, to demonstrate data can be collected simultaneously and interference free.

Should a parametric sub-bottom profiler, in particular, be employed at the same time as the UXO spread, this shall be demonstrated to not interfere with the MBES data collection or USBL positioning system.

2.8 Navigational Accuracy

Navigation checks shall be completed prior to leaving harbour. The procedures to be followed in event of navigational non-compliance shall be logged in the daily report and the Client Representative advised on site. The Survey Contractor is required to supply Vessel offset diagrams showing the positions of all instruments deployed in the Operations Report for each vessel. Each iteration of the survey instrument configuration and layback-corrected vessel track plots are also to be supplied as part of the Operations Report. Layback-corrected survey track plots must be provided for each sensor/instrument as part of the Survey Report. Towed equipment positioning error shall be within ±1m, with altitude/depth values within ±0.1m.

All calibration corrections, adjustments, offsets, and changes to positioning data shall be recorded and displayed during the execution of the survey. The application and nature of any data smoothing shall be indicated.

A health check calibration (to a surveyed-in point) shall be performed at mobilisation and demobilisation.

2.9 RTK DGPS System

RTK DGPS shall be used for positioning control. Its use should follow the Guidelines for GNSS Positioning in the Oil and Gas Industry, published by the International Association of Oil & Gas Producers (IOGP) and IMCA (2021), in particular the recommendations on quality monitoring and acceptance criteria, namely:

- Real time pseudo-range correction updates shall be received at least every 5 seconds. Correction data must be received from at least two reference stations and multi-station position comparison must be available;
- A 10 degree minimum mask angle shall apply;
- Satellite coverage shall have at least 5 satellites available with acceptable geometrical

constraints;

- Height aiding control may only be utilised with prior Client Representative's approval of method and relative weighting. In general, it should not be used.

Prior to deployment, receiver tests and calibrations shall be carried out at a point with known coordinates, to verify the normal operation of the receiver. Data relating to these checks must be available on each vessel. Full back-up of all operational equipment will be required.

3 Magnetometer Processing Methodology

3.1 Magnetic Survey Data

The processing of the geophysical UXO survey magnetic data will be undertaken using the recognised, industry leading, magnetic data processing software package, *Seequent's Oasis montaj*. Initial data processing will be undertaken on-board, and subsequent further pUXO analysis undertaken by *6 Alpha*.

The magnetic survey data will be acquired in accordance with aforementioned geophysical UXO Survey specifications in Section 2, outlining the survey equipment requirements to be employed during the survey.

The basic outline of the processing procedure is as follows:

1. Undertake QC on the data to ensure that the Navigation (X, Y and Z components), Mag value (nanotesla (nT) reading) and axial variance (pitch, roll and yaw components, where applicable) are workable and cleaned;
2. Calculate survey dynamic coverage and issue any areas to be infilled where necessary;
3. Identify anomalies which "model" as potential UXO (pUXO).

The key parameters to consider are:

- 25kg ferrous mass detectable threat – 6m maximum detection range;
- 68kg ferrous mass detectable threat – 8m maximum detection range;
- Target magnetometer altitude - 3m, but not higher than 4m in water depths shallower than 26m below LAT and 5m, not higher than 6m in water depths deeper than 26m below LAT;
- Maximum expected depth of cable burial - 2m.

3.2 Raw Data Export

The magnetic data will be required to be exported by the survey contractor in ASCII (.txt or .csv) format compatible with the processing software. The minimum requirements are as follows:

- Each magnetometer or gradiometer sensor readings will need to be exported as an individual ASCII file or be combined into a single file for import into the processing software;
- As a minimum, the export shall include: Unique Line Name / Identifier, Date, Time (HH:MM:SS), Easting (m), Northing (m), Altitude (Corrected for scale and bias[1] (m)), Magnetic Total Field Value (nT), Depth[2] (m), Signal Strength/Quality, Roll[2] (º), Pitch[2] (º), Heading[2] (º), Layback (m), Vessel Easting (m) and Vessel Northing (m);

1 - Analogue altimeters only. Digital altimeters require no calibration but must still be verified with an alongside check.

2 - Where compatible sensors are installed, e.g., on a Remotely Operated Towed Vehicle (ROTV).

3.3 Data Quality Control (QC)

Data QC steps are to be undertaken to assess the quality of the survey data and where necessary to remove, by "cleaning" and "de-spiking", any unrepresentative artefacts in the data. It is important not to *over smooth* the data as this will make it unrepresentative and will make target modelling less accurate.

3.4 Navigation

Depending on the sample frequency of the USBL beacon, positional data may be less frequent than the 10Hz mag sample rate. If this occurs, a range of the data processing software tools and filters are to be appropriately applied in order to best fit the data. Options include but are not limited to:

- Removal of duplicate position values;
- Interpolating across gaps under a certain fiducial limit and ensuring the maximum gap to interpolate does not exceed the maximum tolerable gap distance defined in the specification;
- Removing any navigational jumps in the Easting and Northing channels.

The latter can be dealt with using the following techniques but need to be adapted based on the data quality provided:

- Manually removing noticeably large jumps in the Easting/Northing channels;
- Use a rolling statistics filter on the Eastings and Northing channels to smooth the data;
- If the navigation is so poor that it is difficult to determine what is real and what is not, it may be easier to re-run the line, or portions thereof. In such circumstances, the line is to be rejected

(deselect/remove from project), the survey contractor is to be notified, and the processing log is to be updated with justification for the line rejection.

3.5 Altitude

The following altitude actions are to be taken:

- Manual removal of altimeter reading spikes;
- Once all spikes have been removed, a low intensity filter should be applied through the data to smooth the readings and give a more realistic indication of sensor height;
- Interpolation can be applied, but the altitude is not to be interpolated over significant distances;
- Finally, any altitude readings found to be outside of the specification, (i.e., larger than 4m in water depths shallower than 26m below LAT, and 6m in water depths greater than 26m below LAT), are to be removed, and this will be used as the final altitude channel.

3.6 Magnetic Reading

The magnetic reading channel generally requires less filtering. The following actions are to be taken:

- Manual removal of magnetometer/gradiometer reading spikes;
- Review of data for rhythmic noise caused by environmental factors or interference from the survey vessel, (or other vessels in the vicinity), that may influence the calculated magnetic residual profile and potentially mask pUXO;
- If noise exceeds suitable thresholds, the affected lines will need to be rejected and the processing log updated accordingly. In some instances, replacement of survey sensors/changes in configuration may be required.

3.7 Dynamic Coverage

The survey contractor will produce onboard and receive updated daily coverage plots from 6 Alpha subsequent to further analysis, to identify areas of poor coverage. The dynamic coverage calculation will account for the detection range of the minimum detectable threat in different water depths, (that is, a ferrous mass of 25kg in water depths shallower than 26m, and 68kg in water depths deeper than 26m), to 2m depth of burial. The radius of dynamic coverage will be determined from the sensor position, and as follows:

$$Dynamic\ Coverage = \sqrt{Detection\ Range^2 - (Altitude + 2)^2}$$

N.B. – The survey contactor will need to be informed of any whole lines which have been deselected/rejected from consideration the project and they will not be included in the coverage plot.

Dynamic coverage can be applied within Oasis montaj, with the results exported in GeoTIFF format, at a suitably small cell size to ensure accurate enough representation of the coverage. Alternatively, a GIS-based solution can be used to generate an ESRI Shapefile polygon of the dynamic coverage.

Full dynamic coverage is required throughout the survey corridor or extents, except gaps which are smaller than the project gap tolerance. *6 Alpha* have defined this nominally as an area no larger than 3.0m in the along-track direction **and** 1.0m in the across-track direction.

3.8 Creating a Magnetic Residual Channel

The following actions are to be taken:

- It is recommended that an altitude correction be performed on the data to normalise total field data/vertical gradient data collected at variable altitudes to a constant reference altitude;
- Any long wavelength background noise is to be removed with a non-linear filter and the residual total field is to be calculated.

3.9 Gridding

The follow actions are to be taken:

- Grid the total field/vertical gradient residual channel, and calculate a quasi-analytic signal (AS nT/m) grid;
- Both grids should possess a cell size suitable for target modelling and a blanking distance which does not exceed the extent of the magnetic survey dynamic coverage;
- The false colour scale needs to be appropriate so not misrepresent anomalies on the grids;
- These colour scales can be increased if the residual data is very noisy.

Gridding of the total field/vertical gradient and analytical signal data can be used to produce a GeoTIFF, or similar, and should be compared against the Route Position List (RPL) or survey corridor, to inform potential re-routing or additional survey work prior to pUXO analysis.

3.10 Targets Selection

The following actions are to be taken:

- Targets should be picked initially using an unbiased automated picking function such as the Blakely method. This should be performed on the Analytic Signal (AS) grid, using a grid value cut-

off determined by the quality of the data. Noisier data will require a slightly higher cut-off than clean data;

- With noisier data, it is important to make sure that low amplitude anomalies are not missed by being masked within the noise. If in doubt, a lower grid value cut-off value is to be chosen. Manually remove any false picks and manually add any remaining missed anomalies from the gridded data and profile;
- 6 Alpha will perform target modelling on the MAG data and discount any targets which, based on professional experience, are unlikely to represent the minimum UXO threat item or larger.

3.11 Exports

The following minimum requirements are to be supplied for the magnetic data:

- Raw data files, which have been exported directly from the data acquisition software;
- Processed Oasis montaj geodatabase;
- Target database including all initial offshore anomaly picks but also a final pUXO Master Target List which will be produced by 6 Alpha;
- GeoTIFF of AS grid for each survey data block;
- GeoTIFF of TF grid for each survey data block;
- GeoTIFF or ESRI Shapefile of Magnetic dynamic coverage of complete survey blocks;
- Processing log detailing any editing or survey line removal/rejection and justification.

4 MBES/SSS Processing Methodology

4.1 General

In addition to a magnetometer survey, a high resolution MBES/SSS survey is to be undertaken to detect low ferrous content UXO that may be located upon on the surface of the seabed, such as LMA/LMB mines, and to support the magnetometer data.

The processing of the geophysical UXO survey MBES/SSS data will be undertaken using a recognized, industry leading data processing software package, such as for example, *Teledyne CARIS* and *Chesapeake SonarWiz.*

The high-resolution images that result from this element of the survey will be used to identify the locations, sizes and shapes of those items that might be associated with such UXO, (and other large masses).

The survey contractor will be responsible for processing and target picking both the MBES and SSS data, but it is the responsibility of 6 Alpha to review the data and ensure coverage has been met and the data is suitable for the purpose of detecting UXO located on the seabed. The following requirements must be supplied for the MBES and SSS data:

- Gridded Processed MBES data for each survey block, exported at 0.1m[1] resolution, in ASCII XYZ format, z-encoded GeoTIFF and false colour, hill shaded GeoTIFF (RGB) formats;
- False colour GeoTIFFs of the SSS mosaics for each survey block exported at 0.1m[1] resolution;
- A contact list detailing a minimum of: Target ID, Easting[2] (m), Northing[2] (m), Dimensions[3] (Length, Width, Height), Classification, Confidence[4];
- Associated contact imagery from SSS waterfall view.

1 - 0.1m resolution is preferred but should this be unobtainable due to either vessel bandwidth, or hardware/software limitations, resolutions up to 0.3m can be provided. The Client Representative should be informed of any data limitations and inform 6 Alpha immediately should this be needed to be reviewed.

2 - Positions adjusted to MBES imagery, where visible in both datasets.

3 - Length of contacts shall be the longest dimension, and width measured perpendicular to length. Height is to be derived from the slant angle and range and calculated within the interpretation software.

4 - Confidence value and criteria to be defined by the survey contractor, at low/medium/high levels, or similar.

4.2 Contact Interpretation

The survey contractor will review the MBES and SSS data for significant contacts, selecting contacts larger than 0.25m in any dimension. All contacts above the threshold of 0.25m in any dimension are required to be picked. The survey contractor will not classify boulder fields in high density areas. 6 Alpha will review these listings, along with the magnetic data and discount any targets which, based on professional experience, are unlikely to represent the low ferrous UXO threat item.

5 Survey Verification Test Methodology

5.1 Introduction

In advance of any marine geophysical survey for unexploded ordnance (UXO), in line with CIRIA guidelines (*Reference A*), and ALARP (As Low As Reasonably Practicable) best practice for risk mitigation, a Survey Verification Test (SVT) is to be undertaken using a variety of UXO surrogates of known size, shape, and magnetic responses, in order to wet-test the survey contractor's equipment. The SVT is not designed to set, confirm, or alter survey specifications, nor are the surrogates that it employs designed to replicate magnetic responses associated with real UXO.

5.2 Aim

The aim of the SVT is not only to wet test and to prove that the survey instruments being employed work as expected, but also to provide site-specific reference data that will be used to inform and to guide the survey contractor's subsequent raw data capture and processing methodology, as well as to integrate at an early stage of the project, the involvement of the Clients Representative and 6 Alpha. Data capture, processing and flow are also expected to be validated, albeit tacitly.

5.3 SVT Objectives

The objectives of the SVT include but are not limited to:

- To survey the surrogate UXO items of known dimensions and magnetic responses, in a number of magnetometer/gradiometer configurations and altitudes. These configurations have been designed to replicate prospective survey methodologies which may be employed during the main survey. The surrogate items have been constructed to mimic the dimensions of their UXO equivalent. They are not designed to be physical look-alike, nor do they possess the same magnetic signature;
- To survey the surrogate items at three different sensor heights in order to observe and verify expected differences in magnetic response with varying altitude;
- To validate the geophysical UXO survey contractor's data collection and processing methods in general;
- To inform 6 Alpha's subsequent data flow methodology and anomaly selection criteria;

- To benchmark the SVT methodology with the survey protocols designed and employed for the main survey, to evaluate and establish survey confidence, repeatability and critically, to confirm that any requisite survey standards defined in the survey specification and/or scope of work are met with the executed survey equipment and methodology and verify the survey positional accuracy.

5.4 Logistics and Personnel

The SVT will be conducted by the geophysical UXO survey contractor, utilising the same survey vessel and equipment that will be employed subsequently during the main survey works for each section of the route. Should the survey campaign be split into subsections, (e.g., Nearshore and Offshore), a separate SVT will be required for each different survey setup or survey vessel to be used, in order to verify that all survey configurations work separately in their intended environments as expected. Similarly, should a significant change to the survey configuration be required midway through the survey, (such as one that may constitute a reduction in survey positional accuracy), it is recommended that another SVT be performed prior to recommencing the survey.

The practicalities of the SVT, (i.e., handling, launch and recovery of the surrogate item), will be the sole responsibility of the Geophysical Survey Contractor. Where it is beneficial and practicable to do so, multiple survey vessels may carry out their respective SVTs over the same deployment of surrogate items, but these should be recovered as soon as reasonably safe to do so.

6 Alpha will deliver the surrogate items to and from a specified harbour/port of disembarkation, as required by the client. Surrogate item approximate weights and dimensions are given in Section 5.7 of this document.

A protocol for Health, Safety, and the Environment (HSE) is to include a safe method for handling the surrogate items including their operational deployment and recovery, which will remain the responsibility of the Geophysical Survey Contractor.

5.5 SVT Location

The SVT is to be conducted on a representative area of the *Green Volt Offshore Wind Farm (OWF)* project. An area for the SVT is to be selected by the Geophysical Survey Contractor but approved by the Client's Representative and 6 Alpha.

It is recommended that the SVT for the project be undertaken in water depths close to the average encountered on site, provided the vessel can safely manoeuvre and carry out surrogate deployment, survey operations and recovery.

All survey instruments to be utilised for UXO determination should be employed during the SVT.

The following constraints and limitations are to apply to the SVT site:

- The area is to be subject to Multibeam Echosounder (MBES), Sidescan Sonar (SSS) and magnetometer (MAG) survey in advance, in order to establish that is it generally unobstructed and magnetically clean (i.e., free of significant anomalies);
- A magnetically clean and unobstructed area of seabed, not smaller than 100m long x 50m wide is to be selected in an area that is representative of the main survey environment, (either on or adjacent to the export cable route (ECR) / main inter-array cable (IAC) or infield area). In order to achieve this, an area larger than 100m long should be surveyed initially, so that if magnetic anomalies are discovered, then the finding and moving to relatively magnetically clean area might be more easily facilitated (and without the need to undertake more survey), into which the UXO surrogates can be deployed;
- The representative area chosen should be surveyed so that it is parallel to that element of the ECR/IAC area it is closest to, with UXO surrogates being deployed and surveyed in the same orientation as the main survey will be performed. These actions will help prove that the survey system employed is capable of operating in the anticipated environmental conditions on site;
- If objects are discovered (in advance of the emplacement of the surrogate UXO item) by MBES, SSS and/or MAG, they are to be accurately recorded in terms of their position and geophysical survey responses;
- Whilst the surrogate items are to be carefully emplaced in an unobstructed and magnetically clean area of the seabed, they are also to be sufficiently far from any existing anomalies/contacts, to ensure they are not confused with those items when subsequently surveyed themselves. Therefore, the surrogate items should not be placed within 20m of an existing contact, clump weight or another surrogate to ensure that respective surrogates can be seen as discrete anomalies and that they are not confused, or their geophysical signals mixed with, those that might be generated by seabed detritus;
- Further MBES must be collected post-deployment to determine as-found positions of the surrogate items and to plan subsequent SVT lines.

5.6 UXO Threats

The threat items likely to be present on site are outlined within the 6 Alpha threat and risk assessment, (*Reference B*), and the minimum threat items are outlined as follows:

- Water depths shallower than 10m below LAT;
    - 3.7" Artillery Projectile – 0.93kg NEQ, ~11.6kg ferrous mass.
- Water depths between 10-26m below LAT;
    - German SC-50 50kg HE Bomb – 25kg NEQ, ~25kg ferrous mass.
- Water depths between 26-40m below LAT;
    - German SC-250 50kg HE Bomb – 130kg NEQ, ~126kg ferrous mass.
- Water depths deeper than 40m below LAT;
    - Mark XVII/XX Mine– 227kg NEQ, ~68kg ferrous mass.

5.7 Surrogate UXO Item Selection

Although the site(s) may be contaminated with a wide variety of types UXO, a representative sample of threat spectrum UXO surrogate items is to be employed for SVT purposes. Although not all types of prospective items of UXO will be represented, (e.g., artillery projectiles might be removed as their risks may well be tolerated and the time and cost of their detection is likely to be onerous), it is generally accepted that the representative items employed will form a suitable test generic "benchmark" because their physical and magnetic responses are known, (where they are made from ferrous metal).

Therefore, one of each, or a close representative of the following generic types of surrogate item will be employed for the SVT:

- Circa. 250kg (500lbs) air delivered HE iron bomb;
- Circa. 50kg air delivered HE iron bomb;
- Circa. >500kg Allied/Axis Ground Mine.

It is expected that the following surrogate items will be supplied and delivered to the geophysical UXO survey contractor, as follows, and presented in *Figure 5.1* to *Figure 5.3*:

Figure 5.1 – Surrogate Circa. 50kg air delivered HE iron bomb.

Figure 5.2 – Surrogate Circa. 250kg air delivered HE iron bomb.

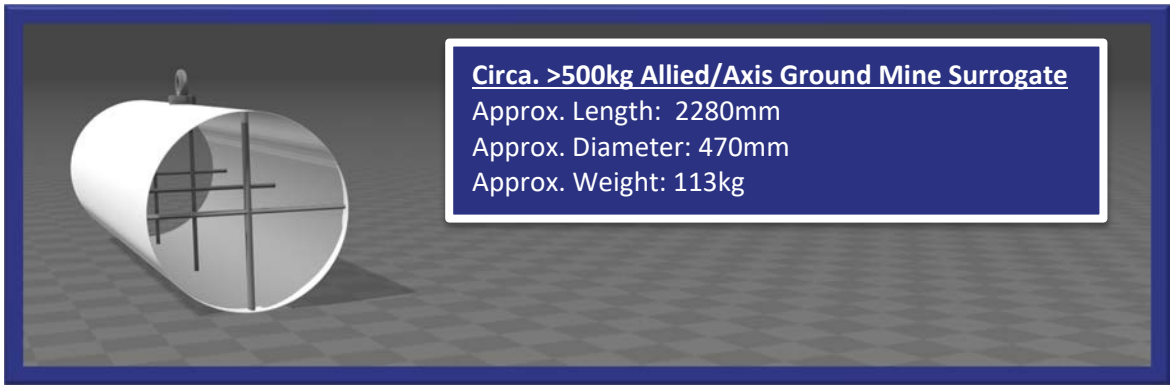

Figure 5.3 – Surrogate Circa. >500kg Allied/Axis Ground Mine.

5.8 Surrogate Item Deployment

The surrogate items are to be deployed in an area of seabed clear of existing "contacts" by not less than 20m in any direction, in order to ensure the surrogate item can be seen as a discrete anomaly. The items are to be lowered to the seabed, and their position and sequential order of lay recorded in a log, which will inform the contractors final report. Position of the surrogate items must be verified with MBES data to confirm the seabed positions and that no movement after deployment has occurred.

The method of deployment and design of the surrogate "mooring" is to be decided by the Client's geophysical UXO survey contractor. Suitable weighted, non-ferrous ropes, (such as a lead line), should be employed to connect the items together and weighted with a clump-weight and an offset recovery buoy. A minimum separation length of 20m must be employed between surrogates and clump weights so that magnetic fields (and subsequent responses) do not overlap.

Ferrous metal steel wire rope and or ferrous metal fastenings are not to be used as these will affect the magnetic signal response.

5.9 Surrogate Item Supply

For a number of reasons, it is impractical to use real WWII ordnance cases for the SVT. 6 Alpha will therefore supply surrogate UXO items. The general manufacturing methodology is to employ mild sheet steel (or aluminium) which can be rolled/fabricated into tubular form in order to represent the dimensions of the main body of each of the actual threat items. For the purpose of the survey there is no benefit in forming either the nose, ogive, or the tapered rear section of the bomb/mine.

A tubular body will represent each item, and will be open ended but, where it is necessary, with the cross-bracing at either end of the tube (in order to add structural integrity and act as secondary anchor points).

Surrogate items have where possible, dedicated and load tested lifting lugs/points and where such points have been attached to large items, load-test certificates will be supplied. Where there is no dedicated lifting point the geophysical UXO survey contractor may either tie a rope and/or attach a fastening eye at the end of each item to allow a shackle to be fixed, in order to aid item launch and recovery. However, the final position and size of this fastening eye will need to be clipped or otherwise attached once the contractor has confirmed the type of launch and recovery equipment to be employed for this SVT. For the purposes of electromagnetic integration, any shackles or fastenings used to aid deployment and recovery are to be made from non-ferrous metal.

5.10 Surrogate Item Return

The surrogate items are to be recovered at the end of the SVT and this is to be the specific responsibility of the geophysical UXO survey contractor. If the surrogates are not recovered, they may represent a hazard to subsequent installation activities, (or be mistaken for real UXO items). If the items are buoyed throughout the SVT, (as is recommended), it will enable their straightforward recovery. It the contractor chooses not to buoy the items, then they will need to be recovered by grapnel, (or other approved means), at the contractor's expense.

All items are to be recovered at the end of the SVT and returned to the port of embarkation for return to 6 Alpha at the earliest opportunity. Any items that may be lost or are otherwise not recovered will be subject to reasonable replacement and/or recovery charges.

5.11 Survey Configuration and Data Collection

The surrogate items are to be surveyed and associated data collected with the following survey configurations or as agreed with the Client's Representative and 6 Alpha:

- The survey configuration to be used for the main survey should be replicated for the SVT, (i.e., vessel line spacing, number of sensors, sensor separation, array configuration);
- The surrogate items should be surveyed in the orientation they are laid so that all surrogate items are passed over in one line (the orientation being consistent with the predominant RPL/survey line orientation, where possible);
- Passes with the magnetometer/gradiometer array should be performed at three different altitudes, nominally:
    - **6.0m (Nearshore), 8.0m (Offshore),** to represent the maximum altitude of the sensor (4.0m and 6.0m respectively), **plus** the maximum expected burial of UXO (2.0m);
    - **5.5m (Nearshore), 7.0m (Offshore),** to represent the target altitude for the main survey (3.5m and 5.0m respectively), **plus** the maximum expected burial of UXO (2.0m);
    - **3.5m (Nearshore), 5.0m (Offshore),** to represent the target altitude for the main survey (3.5m and 5.0m respectively), with UXO on the seabed.
- MBES and SSS data will also be collected for the SVT. Easting and Northings will be recorded for each surrogate item detected, in addition to, (and where achievable), length, width and height data for the surrogate contacts. This will allow the positional accuracy of the deployed surrogates to be cross-referenced between the MAG, MBES and SSS datasets collected;
- The number of required vessel track lines will be agreed between all parties on-board the vessel and they are to be expressly endorsed by the Client's Representative. However, the survey should not only aim to have "complete" coverage of the surrogate items, but also aim to capture (separately or concurrently) data from any existing seabed contacts;

- As a minimum, one centre line of magnetometer data will be collected in one direction, and a further four adjacent wing lines will be run, in reciprocal directions. This is to be repeated fully for each altitude pass. Additional survey lines may need to be run if the first pass deviates too far from the planned line and should be carried out in the same direction as the original 'missed' line.
- MBES/SSS data should be collected in reciprocal directions across both surrogate items.
- Navigation data smoothing (such as Kalman filtering) may be used within the data acquisition software but should not be used to smooth the raw navigation data beyond reasonable levels. Post-processing smoothing can be applied if necessary.

Figure 5.4 presents a typical SVT layout following these measures:

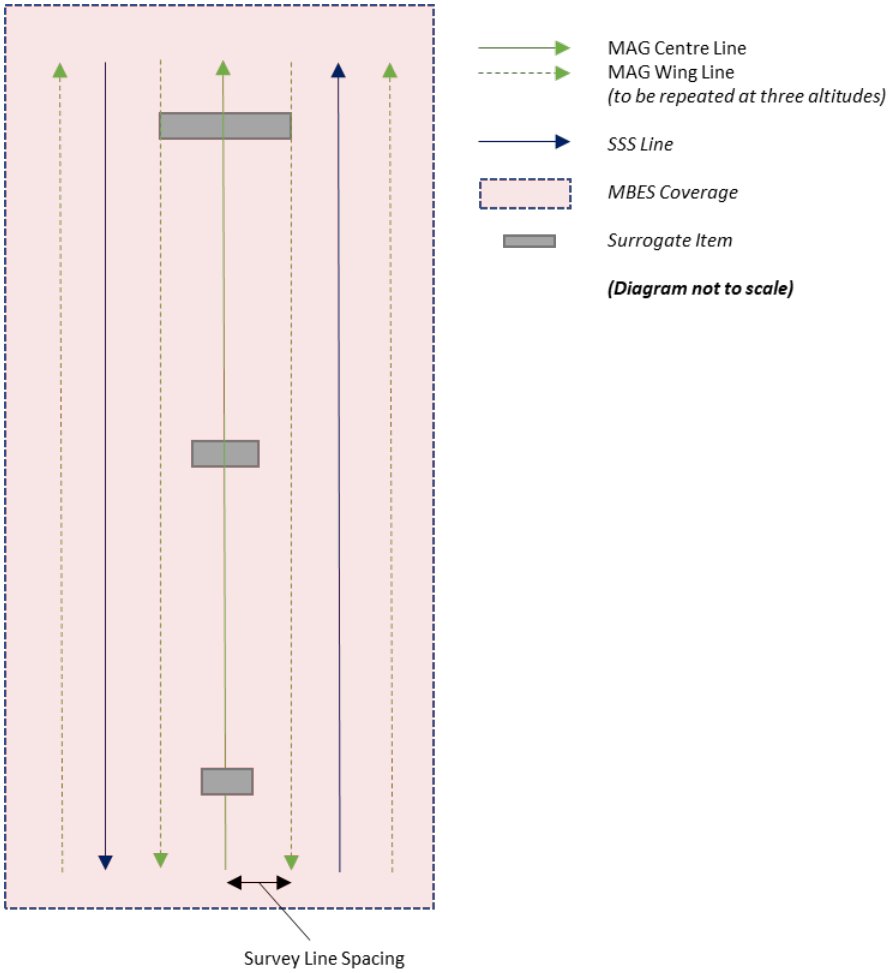

Figure 5.4: Example SVT Line Plan

5.12 Magnetometer/Gradiometer Data Processing and Interpretation

The raw magnetic data collected for the SVT is to be inspected for quality/gaps by the survey contractor, and by subsequent 6 Alpha review.

It is anticipated that the raw magnetic data will be processed as Total Field data, (or Vertical Gradient where applicable), using Oasis montaj software employing the UXO Marine Mag modules, (or similar). The raw data from all survey configurations is to be processed using the same filters, then gridded and finally presented to the same false colour scale.

Surrogate magnetic anomalies are to be picked from the processed magnetic analytic signal grid selected within the Oasis montaj project space and exported as an .xlsx or .csv file. The resultant spreadsheet is to display the following information, which can be distributed subsequently throughout the project team:

- Surrogate ID;
- Target Altitude pass (m);
- MAG Easting (m);
- MAG Northing (m);
- MBES Easting (m);
- MBES Northing (m);
- Analytical Signal Grid value (nT/m);
- Distance between MBES and MAG position.

5.13 SSS Data Processing and Interpretation

The raw sidescan sonar data collected for the SVT is to be inspected for quality by the survey contractor, and the positions of the surrogate items interpreted from each line.

Data shall be processed with gains to improve visuals on the surrogate item in the data, however no positional corrections to the MBES, nor any artificial heading rotation shall be used to improve positioning.

Surrogate items are to be picked from the processed SSS data and exported as an .xlsx or .csv file. The resultant spreadsheet is to display the following information, which can be distributed subsequently throughout the project team:

- Surrogate ID;
- SSS Easting (m);
- SSS Northing (m);
- MBES Easting (m);
- MBES Northing (m);
- Dimensions (m) [L x W x H]);
- Distance between MBES and SSS position.

5.14 Contractor Reporting

The Geophysical Survey Contractor is to provide a succinct SVT report or field memo. This is to be delivered within one day (24 hours) of the end of the SVT, such that acceptance may be determined, and the main part of the survey commenced as soon as possible after completion of the SVT.

This should include:

- An outline of the procedure undertaken;
- Images of the clearance area pre-deployment in the MBES, SSS and MAG data;
- Images of the surrogate items present in the MBES, SSS and MAG data at each altitude pass, overlain with target picks, where possible;
- An example magnetic profile from each altitude pass demonstrating background noise and altitude achieved, with the anomalies attributed to the surrogate items labelled, where possible;
- Tabulated results comparing the positions of the MAG targets and SSS contacts with the MBES positions for each surrogate item.

Raw survey data from the SVT should precede, or be sent with, the initial report/ field memo. Processed MBES and SSS georeferenced imagery should also be provided at a suitable resolution, (0.1m or better), to identify the surrogate items.

Vessel operations can continue, (with agreement from the onboard Client's Representative), whilst the SVT data is being reviewed, however, should the results from the SVT be deemed unacceptable the test may need to be repeated and/or initial data collection rejected for quality purposes.

A final report, or addition to the existing mobilisation and calibration report, is to be delivered within four days of the end of the SVT. The scheduling given here is an indicative and in outline.

It is considered likely in ideal circumstances, that with on-board decision making and express endorsement by the Client's Representative, then the survey is likely to proceed immediately on completion of the SVT and will not wait for the final SVT final report issue.

GREEN VOLT

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