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Marine Characterisation Research Project (MCRP)

MCRP-MARICO-DOC-0002_

Morlais_Hydrographic_Survey_Specification

Menter Môn

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MDZ HYDROGRAPHIC SURVEY SPECIFICATION

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ABBREVIATIONS

Abbreviation	Detail
BM	Benchmark
CD	Chart Datum
CHP	Civil Hydrography Programme
DGPS	Differential Global Positioning System
ETRS98	European Terrestrial Reference System 1989
FIG	Féderération Internationale des Géometres
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
IHO	International Hydrographic Organization
MBES	Multibeam Echosounder
MCA	Maritime & Coastguard Agency
MGN	Marine Guidance Note
OD	Ordnance Datum
RoS	Report of Survey
RTK	Real Time Kinematic
UKHO	United Kingdom Hydrographic Office
UTC	Universal Time Co-ordinated
UTM	Universal Transverse Mercator

1 INTRODUCTION

Following the successful consenting of the Morlais tidal Demonstration Zone (MDZ) in December 2021, Marine and Risk Consultants Ltd have been commissioned to prepare this navigation-focussed Hydrographic Survey Specification in support of the Navigation Monitoring Specification (NMS) required by the MDZ marine licence (ORML 1938) **(see Figure 1).**

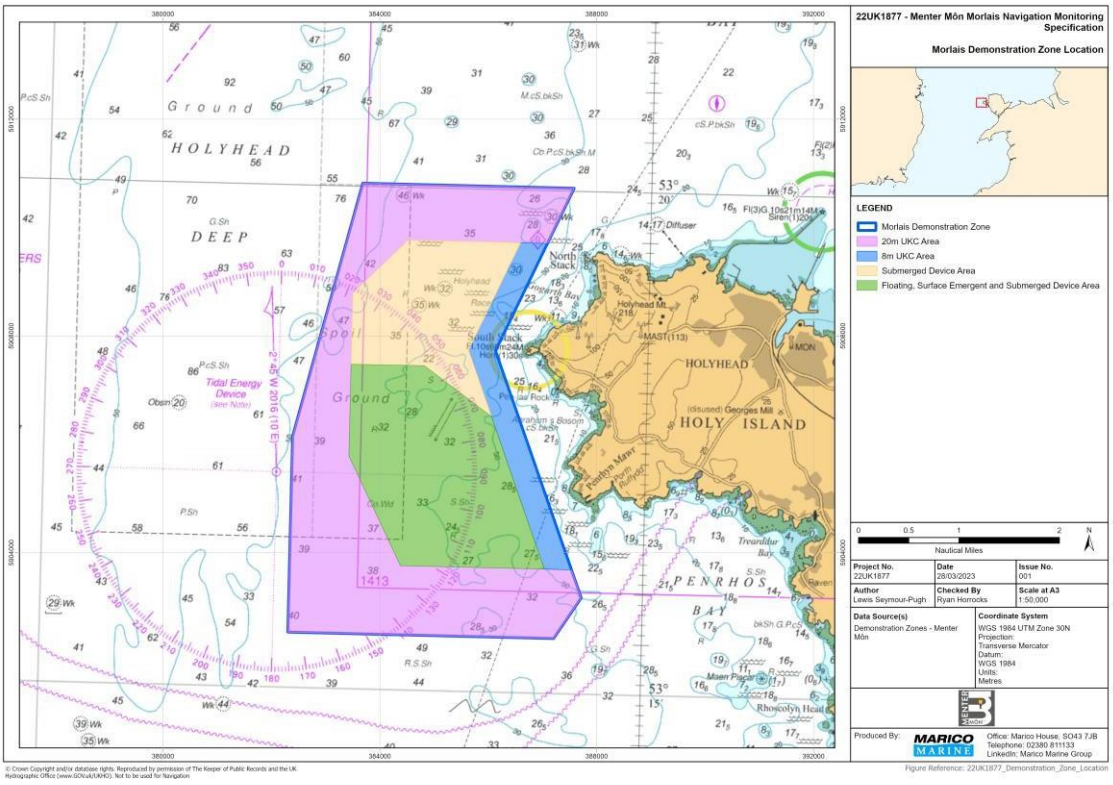

Figure 1: Location and zoning of the Morlais Demonstration Zone (as of June 2023)

Annex 4 of the MCA's Marine Guidance Note (MGN) 654 (M+F) - *Offshore Renewable Energy Installations (OREI) safety response, Guidance on UK Navigational Practice, Safety and Emergency Response* - contains the current UK guidance on conducting hydrographic surveys in support of safety of navigation within and around ORE installations.

1.1 SCOPE

All hydrographic surveys conducted to support development consent or ongoing licence conditions should provide full seafloor coverage that meets the requirements of IHO S44 Edition 6 Order 1a.

This document presents guidance in the form of a hydrographic survey specification to meet these international survey standards, ensuring that data gathered is of a suitable quality to be used for the update of nautical charts by the UK Hydrographic Office (UKHO). Furthermore, data collected to this standard will be suitable for a range of other engineering uses, following the ethos of 'gather once, use many times'. This has the potential to introduce survey cost savings for Menter Môn, if adopted as the common survey standard across the MDZ.

This specification is supplied for guidance only. Experienced survey contractors are likely to have their own survey specification and workflows to meet IHO standards. This specification is adapted from technical requirements developed by the UK's Maritime and Coastguard Agency; to map UK home waters under the auspices of the UK Civil Hydrography Programme.

1.1.1 Proposed Survey Programme

In order to establish a baseline, confirm safe navigable depth, monitor seabed mobility and to identify underwater hazards, detailed and accurate hydrographic surveys are required of active zones within the MDZ at the following stages:

- **Pre-construction**: the proposed generating assets area/zone and proposed cable route(s).
- **Post-construction**: deployed generating assets area/zone and cable route(s).
- **Post-decommissioning of all or part of the development**: the installed generating assets area and the cable route(s).

1.2 RELATED STANDARDS & PUBLICATIONS

- Standards for Hydrographic Surveys. Special Publication No. 44. Edition 6. International Hydrographic Organization.
- Civil Hydrography Programme Survey Specification, Maritime & Coastguard Agency.
- The Mariner's Handbook (NP100). United Kingdom Hydrographic Office.
- Admiralty Tidal Handbook NP122 No.2. United Kingdom Hydrographic Office.

2 SURVEY SPECIFICATION

2.1 PERSONNEL

2.1.1 Charge Surveyor

A Charge Surveyor (also termed as Party Chief or Surveyor in Charge) shall always have oversight during survey operations. The Charge Surveyor shall be a IHO/FIG Category A accredited hydrographic surveyor (or equivalent) and have a minimum of 5 years offshore surveying experience including surveying for nautical charting purposes. The Charge Surveyor shall have the authority and experience to make and implement operational decisions and will be available for Menter Môn's representative to contact in order to progress and modify the survey plan if necessary.

2.1.2 Survey Team

Survey teams shall include suitably qualified and experienced personnel capable of supporting all aspects of hydrographic survey in offshore areas for nautical charting purposes and office-based staff responsible for data compilation and quality assurance.

2.2 MULTIBEAM ECHOSOUNDER BATHYMETRY

2.2.1 Primary Depth Sensor

Depth will be measured throughout the survey area using a multibeam bathymetry system (MBES) capable of meeting all requirements stated below.

2.2.2 Uncertainty

Sounding uncertainty (in three dimensions) shall be in accordance with IHO Order 1A, as defined in IHO S44 Edition 6.

The Contractor shall provide a fully developed uncertainty model to Menter Môn prior to survey operations commencing. The model shall state all component uncertainties, as well as the combined Total Propagated Uncertainty (TPU).

2.2.3 Object Detection

For all parts of the survey area, the minimum size of object detected shall be:

- Cube with sides of 2m in depths < 40m
- Cube with sides of 10% of depth in depths >40m

2.2.4 Sounding Density

Each object is to be detected by at least 3 valid data points in the along-track direction and 3 valid data points in the across-track direction, forming a minimum 3x3 grid of 9 data points.

To monitor compliance with the Target Detection requirements for a given area, a minimum sounding density of 9 accepted soundings will be achieved in the following bin sizes:

- Bin with sides of 2m in depths < 40m
- Bin with sides of 10% of depth in depths >40m

2.2.5 Acoustic Coverage

Full seafloor coverage shall be achieved to the 2m depth contour where it is safe to do so.

2.2.6 Crosslines

A minimum of 4 bathymetric crosslines shall be run for each survey area, at approximately equal spacing, with an optimum of 4 crosslines for each survey block. These crosslines shall be approximately perpendicular to the typical mainline orientation in that block.

Crossline shall data should be cleaned as per 2.27.

2.2.7 Depth Data Precision

Soundings shall be logged to at least two decimal places of a metre and presented as depths below Chart Datum (CD).

2.2.8 Data Cleaning

All accepted soundings within the final bathymetric dataset shall fall within the IHO Order 1A uncertainty allowance. All systematic errors and obvious outliers shall be rejected from the bathymetric data. Data points falling within the Order 1a depth requirements but still numerically

distant from the main dataset will still be regarded as outliers and should be rejected, but not deleted, from the dataset.

2.3 TIDES AND REDUCTION OF SOUNDINGS

2.3.1 Reduction of Soundings to Chart Datum

Soundings are to be reduced to Chart Datum (CD) by using dual frequency carrier phase GNSS combined with the Ordnance Survey Active Networks i.e. Post Processed Kinematic (PPK) GNSS.

2.3.2 Establishment of Shore-Based and Offshore Tide Gauges

Coastal or offshore tidal stations may be required within the extents of the survey area. Supplementary tidal stations, and/or use of locally available permanently installed gauges, e.g. local Harbour Master, National Tidal and Sea Level Facility (NTSLF) or Regional Coastal Monitoring Programme tide gauges, may also be used.

Tidal heights will be measured throughout the survey period and for a minimum of 30 days using a temporary or permanent tide gauge capable of meeting all of the requirements stated below.

Automatic tide gauges (both onshore and offshore) should be capable of resolving water level measurement to ± 0.01m in height and ± 2 min in time.

Heights must be recorded to at least 2 decimal places of precision and at sample intervals no higher than 5-minute resolution.

Offshore (on non-vented) tide gauges shall be corrected for atmospheric pressure. Atmospheric pressure shall be recorded within 100km of the gauge location at a temporal resolution no greater than 6 hours.

2.3.3 Pole to Gauge Calibration

All temporary contractor-installed coastal tide gauges must be calibrated by reference to independent readings using a tide pole or 'top down air gap' measurements (e.g. by weighted tape measure from an appropriate reference mark which can be subsequently tied into the vertical control).

Readings are to be taken half-hourly as a minimum, with 10-minute interval readings taken for the duration of one hour before to one hour after high and low water. If observing at a location with a tide range more than 7m (or where the range is perceived to be changing rapidly) the

observations are to be taken every 10 minutes, and every 5 minutes for the duration of one hour before to one hour after high and low water. Automatic coastal tide gauges installed by the Contractor only require a minimum 13-hour period of manual observations.

When reading a pole in calm weather an accuracy of ± 0.03m should be attainable, with the time of each reading recorded to within ± 5 seconds of UTC; the same for a 'top down air gap' measurement technique.

2.4 POSITIONING

2.4.1 Survey Geodasy

Unless otherwise stated, each survey shall be rendered using the following geodetic parameters:

- Datum: ETRS89
- Spheroid: GRS '80
- Projection: UTM Grid Zone 30 North.

All rendered positions shall be quoted as geographical co-ordinates (i.e. in terms of Lat / Long) as degrees and decimal minutes.

2.4.2 Horizontal Accuracy

The Horizontal Accuracy of all depths and positions shall be in accordance with IHO S44 Order 1a (6th Edition).

2.4.3 Positioning

Soundings are to be positioned by using dual frequency carrier phase GNSS combined with the Ordnance Survey Active Networks i.e. Post Processed Kinematic (PPK) GNSS.

The Contractor will state methodologies for post-processed and real-time positioning within the report of survey.

2.5 SURVEY CONTROL

2.5.1 Establishment of Survey Control

Three-dimensional position of any existing or newly established survey control shall be determined by dual frequency carrier phase GNSS techniques, tied into the Ordnance Survey

Active Network. A minimum of six hours of observations are required per station. The six-hour observation period should be divided into two three-hour sessions. At the end of the first session the antenna should be physically moved away from the mark and then re-established over the mark before commencing the 2nd observation session. The height of the static GNSS antenna should be measured before each session and clearly recorded and reported. If the height measured is a slope distance from the edge of the antenna, this shall be appropriately corrected to obtain the true vertical offset. The static GNSS antenna shall be positioned directly over the control point using an optical plummet. The absolute uncertainty with respect to ETRS89 for any existing or newly established survey control shall not exceed 1cm in horizontal and 2 cm in vertical at the 95% confidence level.

Elevation masks should be selected appropriate for the surrounding site, but typically should be not less than 10°. The appropriate OD height and appropriate UTM coordinate for each station shall be computed. Where necessary, co-ordinate conversion shall be conducted using approved conversion programmes and an estimated final uncertainty stated.

2.5.2 Optical Levelling

To perform a redundant check on any control established and/or utilised, all control points shall be optically levelled from two pre-existing control points referred to the appropriate Ordnance Datum.

Levelling is to be conducted between the 2 control points established, the tide pole and any existing BM's in the vicinity of the survey area.

Levelling is to comprise a looped traverse – no inter-sights shall be taken. Levels should be read and recorded to a precision of 0.001m. Any levelling field records should also be supplied.

2.5.3 Station Marking & Documentation

All geodetic stations established during survey operations shall be described and photographed.

Descriptions of stations should include the coordinates and height of the station; a location description; a detailed description; list of other visible marks; visibility diagram and suitability for positioning fixing systems. Digital photographs, sketches, maps and/or chart extracts should be included to show views of the mark in situ and its immediate locality.

2.5.4 Vessel Dimensional Control

An appropriate dimensional control survey of each vessel to be utilised shall be conducted prior to commencement. Permanent and recoverable control points are to be established on each vessel utilised, coordinated to the vessel reference frame to within a tolerance ±0.01m relative (at the 95% confidence level) in X, Y and Z.

All sensors shall be established within the vessel reference frame within a tolerance ±0.02m relative (at the 95% confidence level) in X, Y and Z.

Where appropriate, the rotations of each sensor around the X, Y and Z axis shall be initially determined by the dimensional control survey to within ±0.2 degrees (at the 95% confidence level). These values may be later adjusted during the sonar patch test, if required. The centre of gravity (rotation) should also be estimated and its location within the vessel reference frame and method of establishment clearly stated in the report of survey.

A copy of the dimensional control report for each vessel shall be annexed to the report of survey.

2.6 CALIBRATION

2.6.1 Multibeam Bathymetry Calibration

A calibration of the multibeam bathymetry system and associated sensors (i.e. "patch test") shall be performed at the start of each survey season or after changing out or significantly reconfiguring any survey sensor (methodology shall be detailed in tender). Final post calibration repeatability shall be proven by means of the repeatability test detailed below.

2.6.2 Static Positioning Check

A static positioning check shall be performed at the start of each survey season or after changing out or significantly reconfiguring any survey sensor. The check shall monitor the three-dimensional position of either the primary GNSS antenna or another appropriate point within the vessel reference frame, for a period of no less than 30 minutes at a 1-minute resolution.

The report of survey should separately state the computed statistical reliability of both the horizontal position and the height measured. The positioning data to be compared will have been derived using the same procedures used to obtain all positions associated with the bathymetric data (i.e. post processed kinematic).

Any local survey control utilised in this procedure shall be compliant with the requirements stated in Survey Control section.

2.6.3 Multibeam Bathymetry Repeatability Test

A multibeam bathymetry repeatability test shall be performed following calibration at the start of each survey or after changing out or significantly reconfiguring any survey sensor. This test should be conducted after the static position check as stated in the Static Positioning Check section.

The test shall monitor the three-dimensional position of a clearly defined small but easily detectable feature on the seabed. The feature should be first surveyed near nadir from multiple directions – as a minimum from north, south, east and west. Secondly the feature should be boxed in, so that it appears in the outer beams on port for 2 lines, and the outer beams on starboard for 2 lines.

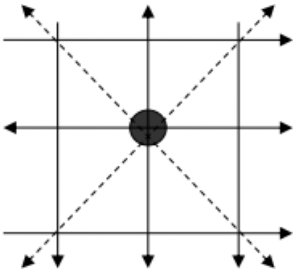

Figure 2: Illustration depicting survey lines required for an MBES Repeatability

The subsequent report should separately state the computed statistical reliability of both the horizontal position and the depth measured for the feature.

2.6.4 Vertical Offset Check

A vertical offset gross error check shall be performed at the start of each survey or after changing out or significantly reconfiguring any survey sensor (methodology shall be detailed in tender). The check shall compare the physical measurements of the distance from the primary and secondary GNSS antennas on the vessel to the seabed. This shall be performed in one location using a method entirely independent of the vessel's survey systems (e.g. level staff or leadline in a berth). These measurements shall be compared to data logged simultaneously in the same location using the vessel's survey system and software. The results should be compared and detailed in the report of survey.

2.6.5 Quality

The Contractor shall provide a real-time indication of the quality of the 3D position and received augmentation data.

2.6.6 Calibration Report

The Contractor shall provide Menter Môn within an agreed timeframe, a draft report or summary of details following completion of each multibeam bathymetry calibration, static positioning checks, multibeam bathymetry repeatability, dimensional control and vertical offset checks. The full detailed calibration report(s) shall be included within the report of survey.

2.7 GENERAL REQUIREMENTS

2.7.1 Hydrographic Notes

Reports of significant differences to depths for a given area, particularly to the controlling depth, and any newly discovered dangers to surface or sub-surface navigation, shall be passed within 24 hours to the UKHO using the 'Hydrographic Note' (H102) form.

2.7.2 Sound Speed

The Contractor shall observe sound speed profiles at an interval consistent with the proposed error budget.

2.7.3 Licences, Consents & Permissions

The Contractor shall be responsible for arranging all licences, consents and permissions for access and frequency clearance for all survey operations whether ashore or afloat.

2.7.4 Daily & Weekly Progress Reports

Daily Progress Reports (DPRs) shall detail, survey operational progress, % of total survey coverage, planned activities, toolbox meetings, safety drills, etc., weather downtime and any problems encountered.

DPRs shall be completed and e-mailed to Menter Môn on a daily basis.

A brief Weekly Progress Report (WPR) shall summarise survey operations, milestone and completion and delivery dates, and include graphics of latest data coverage. WPRS shall be completed and e-mailed to Menter Môn on a weekly basis.

2.7.5 Quality Control

Robust quality control procedures shall be provided and adhered to during processing of all data. A copy of these procedures shall be provided to Menter Môn prior to survey operations commencing.

3 DELIVERABLES

3.1 LABELLING OF RECORDS & DELIVERABLES

Each rendered item of digital data shall bear a depiction of the Menter Môn logo, together with:

Project Name:

MORLAIS DEMONSTRATION ZONE

Hydrographic Survey Title:

[SURVEY DESCRIPTION]*

Survey Dates:

[SURVEY DATES]*

* To be completed.

3.2 MULTIBEAM ECHOSOUNDER DELIVERABLES

For supply to Menter Môn:

- All data should be rendered in digital form, in one of the following formats: CARIS Project Directory or GSF (Generic Sensor Format).
- Spurious data should be cleaned from the final, delivered dataset. Digital data should have rejected soundings included but flagged as deleted. The method used in any data cleaning (e.g. Shoal or Median Biased) should be clearly stated.
- Digital data should be full density i.e. prior to any gridding, binning or tinning being applied.
- If gridded datasets have been created, then these should also be included.
- Report of Survey.

3.3 REPORT OF SURVEY

For supply to Menter Môn:

A report of survey shall be prepared for each hydrographic survey that describes how the data was gathered and processed, including:

- A list of equipment and software used and the personnel employed.

- How the echosounder transducer and positioning equipment were set up, calibrated and used, together with all sensor offsets.
- Details of the horizontal datum to which the positions are referenced.
- Details of how the tides were measured, tide gauge was levelled and how the depths were reduced to Chart Datum (CD).

3.4 TIDAL DATA

For supply to Menter Môn:

Tide gauge records, including raw tide heights and metadata, are to be submitted either in text file format (ASCII) or Microsoft Excel format (.xls). Metadata pertinent to the deployment must include:

- Position of instrument
- Depth of water at the deployment site
- Start/ End of deployment time and date
- Units in metres

3.5 RETENTION OF DATA

All raw and processed digital records shall be retained and maintained by the Contractor for a period of 3 years from the date of deliverables submission. On completion of this 3-year period, the Contractor may seek permission from Menter Môn to dispose of the data as they so wish.