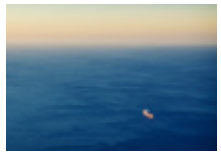
UK Hydrographic Office

Hydrographic Survey Specification (Seabed Mapping)

February 2022

ADMIRALTY
Maritime Data Solutions

Content



Part A
Introduction
P02

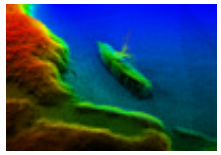
Part B
Personnel
P07

Part C
Quality, Health, Safety and Environment (QHSE)
P20

Part D
General Requirements
P116

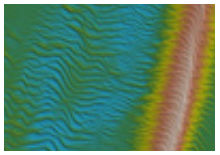
Part E
Positioning
P121

Part F
Tides
P141



Part G
Bathymetry
P152

Part H
Topography (lidar)
P169

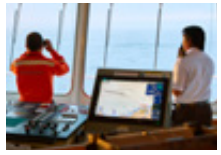


Part I
Seabed
P173

Part J
Aerial Photography (lidar)
P190

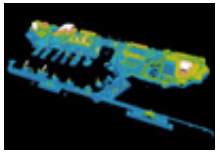
Part K
Vegetation Mapping
P194

Part L
Shoreline Mapping and Imagery
P199



Part M
Ancillary Observations
P202

Annex A
P207



Annex B
P209

Annex C
P212

How to use this interactive document

This interactive report has added links to make it easier and quicker to navigate to the content you need. It is compatible with both desktop computers and tablet or mobile devices. For best results, we recommend using the free software **Adobe Reader**.

You can navigate around this report from anywhere in the document, as well as selecting specific page and online links:

Contents panel
Click on the Contents titles on the left to go to that page.

Section tabs
Select the section tabs at the top of each page to go to the start of that section.

Buttons
Select the buttons at the top right of the menu bar:

back to this home page (contents) or

back or forward a page.

Underlined copy
Click on underlined text to jump to that page or web link.

Part A

Introduction

The UK Hydrographic Office 03
Scope 03
Use of this Specification 03
Assurance 04
Quality, Health, Safety and Environment – The Authorities Intent 04
Updates 04
Open Government Licence 05
Symbols & Abbreviated Terms 05

A1 The UK Hydrographic Office

The UK Hydrographic Office ("the Authority") is part of the Ministry of Defence and operates as a Trading Fund. It is responsible for satisfying the UK's Safety of Life at Sea (SOLAS) obligations with regards to the publishing and updating of nautical charts and publications. The Authority also provides other services for Mariners and the Royal Navy.

In accordance with the Equality Act 2010, in our capacity as a public body we have a statutory duty to eliminate unlawful discrimination, promote equality of opportunity and promote good relations between people from different groups.

Further to the above, and in accordance with the Modern Slavery Act 2015 we have a statutory duty to ensure that no person knowingly holds another person in slavery or servitude or requiring another person to perform forced or compulsory labour.

Participating Survey Companies (and their sub-contractors) ("the Contractor") will be expected to ensure that the service they provide promotes Equality between the Authority and its customers, does not directly or indirectly discriminate on the grounds of Equality in accordance with both the Act and the Duty. The Contractor will also ensure that they comply with the Modern Slavery Act.

A2 Scope

This specification is the main technical document for all surveys conducted on behalf of the Authority where traditionally acoustic or lidar systems would have been specified. Where possible it attempts to be equipment agnostic, to allow contractors the freedom to innovate and propose the most efficient and accurate methodology for completing the work to the required standards. It is however to be understood that in most cases the requirement in relation to current technology will lean heavily towards one methodology or other and as such does specify where the use of different systems carries with them different requirements. It will be supplemented by the Hydrographic Instruction for each specific project which will contain further instructions and requirements.

A3 Use of this Specification

This Hydrographic Survey Specification is written to detail the requirements of marine geospatial data collection, in shallow and deep water, using both Swath Bathymetry (manned and unmanned vessel) and lidar (manned and unmanned aircraft) techniques as appropriate.

Where the requirements are generic to both data collection techniques, a black typeface is used.

Where the requirements are unique to Acoustic Bathymetric techniques, a red typeface is used.

Where the requirements are unique to lidar techniques, a green typeface is used.

A4 Assurance

This specification builds on the IHO S44 standard and forms part of a total quality management system for hydrographic surveys that allows for the enhanced use of the resultant data in safety of navigation and other maritime geospatial products. Used alongside other quality assurance measures such as client representative visits, standardised reporting and data validation, it can assist in providing confidence to the contracting authority in the quality of the data provided.

A5 Quality, Health, Safety and Environment – The Authorities Intent

A well-run Quality, Health, Safety, Environment (QHSE) management system provides an effective means of protecting employees' health and safety, as well as the environment, and doing it in a cost-effective and well-planned manner. This in turn inevitably leads to sound operational outcomes and the rendering of high-quality data to the Authority whilst also ensuring zero harm.

An effective QHSE system is based on the understanding that all accidents are the result of human error and are preventable. Establishing effective QHSE management also results in overall better training and administration methods.

It is the Authority's intent to demonstrate an ongoing and determined commitment to improving QHSE at work throughout our organisation and by our Contractors and Sub-Contractors.

We will lead the global offshore survey industry by promoting and improving upon existing offshore industry QHSE best practice and meeting or exceeding the guidance of the UK Health and Safety Executive and other regulatory bodies. A full description of Project HSEQ requirements is at Section C.

The UK Government has set out a strategy for the UK to achieve Net Zero by 2050 and the UKHO has committed to being Carbon Neutral by 2026 as a first step to playing its part in the governments roadmap. We will look to ensure our supply chain is similarly engaged in moving towards Net Zero.

A6 Updates

The Authority retains the right to amend this specification at any time as new techniques and requirements become available.

Similarly, all Authority provided templates and instruction formats may be amended at any time to streamline the survey and validation process and provide more accurate metadata for data governance.

It will always be the Authorities intent to where possible ensure that such amends create efficiencies for both the Company and the Authority.

A7 Open Government Licence

A8 Symbols & Abbreviated Terms

Abbreviation	Term
AAR	After Action Review
ALARP	As Low as Reasonably Practicable
ASPRS	American Society for Photogrammetry and Remote Sensing
ASV	Autonomous Surface Vessel
ATC	Air Traffic Control
AUV	Autonomous Underwater Vehicle
BM	Benchmark
CAA	Civil Aviation Authority
CD	Chart Datum
ConOps	Concept of Operations
DimCon	Dimensional Control (Survey)
DPR (DOR)	Daily Progress Report (or Daily Operations Report)
EAP	Employee Assistance Program
EEZ	Exclusive Economic Zone
ERP	Emergency Response Plan
GNSS	Global Navigation Satellite System
HAZID/HIRA	Hazard Identification/Hazard Identification & Risk Assessment
HI	Hydrographic Instruction
HIRA	Hazard Identification & Risk Assessment
HOC	Hazard Observation Card (otherwise known as Safety Observation or STOP Cards)

A8 Symbols & Abbreviated Terms Continued

HSEMP	Health, Safety & Environment Management Plan
iaw	In accordance with
ICAO	International Civil Aviation Organisation
IHO	International Hydrographic Organisation
ITP	Inspection and Test Plan
ITQ	Invitation to Quote
JSA/JHA	Job Safety Analysis/Job Hazard Analysis
PC	Party Chief
PEP	Project Execution Plan
QHSE	Quality, Health, Safety and Environment
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (2013)
ROV	Remotely Operated Vehicle
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RPAS SOC	Remotely Piloted Aircraft System Safety Operating Case
RPS	Remote Pilot Station
S44	Special Publication No.44 – Standards for Hydrographic Surveys, edition 6 July 2020.
SfM	Structure from Motion
SIDS	Small Island Developing States
SWA	Stop Work Authority
SIMOPS	Simultaneous Operations
UK CAA	The UK Civil Aviation Authority
UKHO	The UK Hydrographic Office
WPR	Weekly Progress Report
IBSC	FIG/IHO/ICA International Board On Standards Of Competence For Hydrographic Surveyors And Nautical Cartographers
HPAS	Hydrographic Professional Accreditation Scheme

Part B

Personnel

Survey Team 08
Offshore Manager 08
Party Chief 09
Charge Surveyor 10
Online Surveyor 10
Combining roles of Charge Surveyor/Party Chief and Online Surveyor 11
Online Surveyors in Small Boats 11
Survey Engineer 12
Data Processor 12
Other Survey Specialists 12
Survey Team 13
Vessel Master 13
Marine Crew 14
Chef/Cook 14
Engine Driver/Engineer 14
Flight Team 14
Offshore Paramedic/EMT 15
Medical Certification 15
Safety Training Certification 16
First Aid & First Responder Training 17
Pilot Certification (Manned Aircraft) 18
Remote Pilot Certification (RPAS) 18
Certification of Client Representatives 19
Working Hours & Conditions 19
Remote Working 19

B1 Survey Team

The Contractor must provide the Authority with the position, names, qualifications, and experience of all the survey team sufficiently in advance of the personnel mobilising that substitutions can be proposed by the Contractor if required by the Authority. For immigration details see also (C15).

Any proposed changes to personnel must, once the initial list has been agreed, be passed to the Authority in sufficient time for approval to be sought. The Authorities decision on proposed changes is final.

Survey teams will include a balanced mix of the personnel identified below, with adequate experience both in charge of and in assisting with all aspects of surveys of complex coastal/offshore areas for nautical charting purposes, including office data compilation as well as fieldwork.

The requirement for a workable manning plan which allows the Charge Surveyor (and Party Chief if a different person) to perform his primary role, without working excessive hours, is emphasised.

B2 Offshore Manager

The Offshore Manager performs the role of the Project Manager, but locally from the field offices, (afloat or ashore) as opposed to remotely from the Contractor's main offices.

The requirement for an Offshore Manager is not normally envisaged but may be proposed in the Tender where Contractor considers that the reality of the local situation is such that the presence of an Offshore Manager on the ground in-country would help ensure the smooth conduct of operations in the face of potentially poor communications, challenging local logistics and culture and potentially considerable time zone differences between the Contractor main offices and the Survey Team. Exceptionally the requirement for an Offshore Manager may be stated in the HI although this will be limited to situations in which it is known that significant logistics issues will be encountered.

B3 Party Chief

The Party Chief is in overall charge of the conduct of survey operations. They are responsible for:

- Liaison with the Authority Client Representative or Project Manager
- The welfare of all project personnel including sub-contractors
- QHSE
- Logistics
- Running the daily routine
- Direction and completion of the work scope in accordance with the HI and Framework
- Adherence to Contractor policy and procedures
- The creation of field deliverables including the Mobilisation and Calibration Report and DPRs
- Completion of all QHSE related documentation and returns

The Party Chief may be from a hydrographic survey background and may also meet the requirements and fulfil the role of Charge Surveyor described below.

Appropriately experienced individuals from other offshore backgrounds may however be appropriate, including but not limited to Survey Engineers and Geophysicists. If this is to be the case, there must also be a designated Charge Surveyor present who meets the specific requirements stated below. The Party Chief must be on site during all survey operations.

B4 Charge Surveyor

The Charge Surveyor must be accredited to HPAS Level 1 or 0 (or equivalent) and/or degree level hydrographic surveying qualification from an IBSC Category A recognised course or equivalent (equivalency to be decided on a case-by-case basis) and have a minimum of 5 years' hydrographic surveying experience.

In the case of bathymetric surveys conducted using lidar, this must include at least 2 years working specifically with lidar.

The Charge Surveyor must have the authority and experience to make and implement operational decisions and will be available for the Authority to contact regularly to assess progress and modify the survey plan if necessary.

The Charge Surveyor's other duties and responsibilities must be arranged such that they do not interfere with the management of the contract and his/her primary Quality Control (QC), Leadership and Management responsibilities as Charge Surveyor (See also B11 & C8).

It would not normally be considered appropriate or possible in practice for the Charge Surveyor to additionally perform the role of Online Surveyor. If the Contractor's intention is for the Charge Surveyor to also fulfil the role of Online Surveyor, this is to be made clear in the tender documentation, together with an explanation of how they will in practice conduct a full working day as Online Surveyor and then fulfil their other duties, and not be in breach of working time regulations or Contractor Fitness for Work or Fatigue Management policies.

It is expected that the Charge Surveyor shall be onsite during all field operations, however if the company can prove that the data quality function can be achieved satisfactorily and a field manager is in place, the role may be conducted from another suitable venue. The primary role of the person must be to the project and other work must not be allowed to interfere with this.

B5 Online Surveyor

The online surveyor is responsible for data acquisition and real-time data QC. They coordinate survey operations during live operations and ensure, by maintaining the Online Survey Logbook, that an accurate narrative exists of how operations were conducted in practice.

For acoustic work, as a minimum, the Online Surveyor must be accredited to HPAS Level 2 or higher (or equivalent) and/or have completed an IBSC Category B recognised hydrographic survey course.

For lidar operations, the online operator is to have at least two years' experience in flying bathymetric lidar campaigns including experience in operating the proposed system.

B6 Combining roles of Charge Surveyor/Party Chief and Online Surveyor

It is highly undesirable for the Charge Surveyor to also perform the role of Online Surveyor. A tender which indicates that this is the manning intention will be scored accordingly. Experience repeatedly shows that when a surveyor is given the responsibilities of two people they will inevitably succumb to remote pressure, (perceived or otherwise), from the Contractor office and focus on achieving maximum data collection. i.e. they will revert to performing the role of Online Surveyor and will 'load shed' all the other critical elements of the QC, leadership and management role except for issuing the DPR. This is entirely predictable and defeats the intended purpose of the Charge Surveyor and his function as Field Manager; this workload is unavoidably to the detriment of their health and wellbeing, their management and leadership role, the overall conduct of the survey, adherence to the Survey Specification, data quality, the ability to recognise developing equipment/data problems which should be self-evident, attention to wider QHSE and his/her ability to oversee data processing and be to be available to communicate and develop survey operations as required with the Client Representative. This then has downstream impact on data quality, data cleaning and timely rendering of data to an acceptable standard.

A plan which amounts to having an Online Surveyor engaged in data collection for 12 hrs a day, leaving him to 'catch up' with his 'other duties' as Charge Surveyor in his supposed rest time (i.e. committing him to a routine of >14 hr days and eventual burn-out and under-performance in both roles) is unfair and not an acceptable plan as, fundamentally, it fails all reasonable QHSE considerations.

If, despite this advice, Contractor's intention is to 'dual-hat' the Charge Surveyor as the Online Surveyor, Company must demonstrate how the composition and duties of the rest of the survey team will allow the Charge Surveyor to first and foremost successfully perform his duties as such, whilst maintaining a moderate 12 hr working day and then additionally run the online data collection as a secondary duty.

B7 Online Surveyors in Small Boats

Some small boat survey operations are conducted on the basis of two personnel in the survey boat, namely the Coxswain and the Online Surveyor. Where this is the case the proposed Online Surveyor must be used to working in this environment. Additionally, they must have sufficient boat handling experience that, in the event of the Coxswain falling overboard, (or becoming incapacitated), they can safely handle the vessel to recover a conscious or unconscious person overboard and then safely return the vessel to a place of safety as designated in the Emergency Response Plan.

Formal boat handling qualifications are preferred but not specifically required for the Online Surveyor on small boats. The Online Surveyor should however be able to practically demonstrate, in the field, the safe and effective unaided recovery of an unconscious man overboard.

B8 Survey Engineer

The Survey Engineer is responsible for Systems and IT installation maintenance. He should have sufficient training and experience to be able to diagnose and repair any emergent faults in the survey spread.

In small boat operations the Survey Engineer may additionally be delegated responsibility by the Party Chief for logistics.

Whilst the Survey Engineer may support the Online Surveyor during the conduct of data collection, it would not normally be expected that the Survey Engineer would also be able to conduct the role of Online Surveyor unsupervised. If it is the intention for the Survey Engineer to also fulfil the role of Online Surveyor, particularly where they are the only 'surveyor' onboard, this is to be made clear in the tender documentation, together with an explanation of how his/her skills, knowledge and experience will allow him/her to meet the minimum requirements specified for the Online Surveyor.

B9 Data Processor

The Data Processor is responsible to the Charge Surveyor for the post-processing of acquired survey data and the generation of project deliverables.

As a minimum, the Data Processor must be accredited to HPAS Level 2 and/or have completed an IHO/FIG Category B accredited hydrographic survey course (or equivalent as agreed by the Authority).

If the proposed plan for project manning is to have a Party Chief who is not a Surveyor (and therefore cannot additionally perform the role of Charge Surveyor), it is an acceptable alternative for the Lead Data Processor to perform the role of Charge Surveyor. If this is to be the case, then the Lead Data Processor in their capacity as Charge Surveyor must be on site during all survey operations and be accredited/qualified and experienced as required at B4.

B10 Other Survey Specialists

Other survey specialists may be proposed by the Contractor during the Tender process. It is envisaged that these might include but not be limited to:

- Land surveyors for the conduct of geodetic work and levelling
- Metocean specialists for the installation of tide gauges and offshore oceanographic equipment
- Specialist operators or maintainers of unmanned autonomous vehicles, vessels, and drones
- ROV pilots and technicians

Where these additional personnel are proposed, CVs and relevant documentation must be provided to demonstrate their competency in the proposed role.

B11 Survey Team

The Contractor must provide the Authority with the position, names, qualifications, and experience of all the survey team sufficiently in advance of the personnel mobilising that substitutions can be proposed by the Contractor if required by the Authority. See also C15 - Immigration

Survey teams will include a balanced mix of the personnel identified above, with adequate experience both in charge of and in assisting with all aspects of lidar surveys of complex coastal/offshore areas for nautical charting purposes, including office data compilation as well as fieldwork.

The requirement for a workable manning plan which allows the Charge Surveyor to perform his primary role, without working excessive hours, is emphasised.

B12 Vessel Master

The Contractor must provide details of the proposed Vessel Master and his competency to safely operate the proposed survey vessel and safely conduct the survey task at hand. This should include a CV detailing his experience and qualifications.

Whilst formal relevant qualifications are strongly preferred, it is recognised that this may not always be possible in/appropriate to all vessels and areas of operation. At a minimum, the Vessel Master should have significant experience in the operation of his vessel in the waters in and around the survey area and be competent to operate his own vessel and safely conduct the survey task at hand.

Notwithstanding the above, where local regulations mandate that Vessel Masters must have specified qualifications, the proposed Vessel Master must, at a minimum, be compliant with this local requirement.

The decision as to whether a proposed Vessel Master is appropriate lies at the sole discretion of the Authority.

Once a Vessel Master has been approved, the Contractor should seek the Authorities prior agreement to substitute the agreed Vessel Master with another. The decision as to whether the proposed substitution is appropriate lies at the sole discretion of the Authority.

B13 Marine Crew

The Contractor must provide details of the proposed Marine Crew and their competency to safely perform their designated role and conduct the survey task at hand. This should include a CV detailing their experience and qualifications.

Whilst formal relevant qualifications are preferred, it is recognised that this may not always be possible in/appropriate to all areas of operation. At a minimum, all marine crew should have significant experience in the operation of their vessel in the waters in and around the survey area and be competent to operate their own vessels and safely conduct the survey task at hand.

Notwithstanding the above, where local regulations mandate that Marine Crew must have specified qualifications, the proposed Marine Crew must, at a minimum, be compliant with this local requirement.

B14 Chef/Cook

In larger Vessels and liveaboards, where there is a requirement for centralised preparation of food in a galley or communal area, the Contractor must provide details of the proposed Chef/Cook and his competency to safely prepare food for general consumption. This should include a CV, detailing his experience and qualifications in food safety and hygiene, as well as his capacity to produce a nutritionally balanced and varied menu given the facilities onboard.

B15 Engine Driver/Engineer

The Contractor must provide details of the engineering competency possessed by the Vessel Master or Marine Crew which will allow the proposed survey vessel to be maintained in good working order.

Whilst formal relevant qualifications are preferred, it is recognised that this may not always be possible in/appropriate to all areas of operation. At a minimum the Vessel Master and/or Marine Crew should have significant experience in the routine maintenance of their vessel and be competent to diagnose and successfully resolve typical mechanical and electrical issues.

Notwithstanding the above, where local regulations mandate that a member of the crew must have specified qualifications, for example Engine Driver or Marine Engineering qualifications, the proposed engineer must, at a minimum, be compliant with this local requirement.

B16 Flight Team

The Company must ensure all flight teams involved in flying lidar surveys are qualified iaw with local Civil Aviation Authority legislation (or ICAO regulation if no local authority exists). They must have adequate and formally recorded experience in flying lidar sorties.

Use of the IAGSA Safety Manual is recommended.

The Authority or its representatives are to be provided with copies of relevant documentation during onsite visits prior to lidar flights.

B17 Offshore Paramedic/ EMT

Exceptionally, there may be a requirement for a qualified Offshore Paramedic/EMT to be embarked in project Vessels or to accompany a lidar team.

It is anticipated that this requirement will be limited to:

- Larger vessels/liveaboards
- Where Remote Area operations are being conducted (C15)
- Where work is being conducted by an aircraft or lidar team from remote or small austere airfields

In these circumstances a basic first aider would be unlikely to have the training or equipment required to stabilise a seriously injured casualty to the extent necessary to prevent his/her deterioration or death during the transit. These circumstances suggest a higher level of training and equipment is appropriate, suggesting that an appropriately equipped Offshore Paramedic/EMT be embarked.

The decision to include an Offshore Paramedic/EMT in the field team will routinely lie with the Contractor subject to an identification of the QHSE requirement during the HIRA/HAZID. If the provision of an Offshore Paramedic/EMT is specifically required by the Authority, this will be specified in the HI.

Where an Offshore Paramedic/EMT forms part of the team, they will normally be delegated responsibility by the Party Chief for running the QHSE routine, including maintenance of documentation and returns.

B18 Medical Certification

All offshore survey personnel must have an in-date medical certificate of at least UK MCA ENG-1 standard or equivalent. Evidence of certification may be requested by the Authority or its nominated representatives at any time.

All manned aircraft flight personnel should have an in date medical certificate based on the requirements of the state over which the lidar survey will be taking place in accordance with ICAO Doc 8984 1.2.7/8.

All manned aircraft flight survey personnel including technicians must be certified as 'Fit to Fly' by their doctor.

RPAS Operators embarked in vessels are considered to be offshore survey personnel for the purposes of medical certification. Operators of large RPAS operating from an airfield must have appropriate medical certification based on the requirements of the state over which the RPA will be operated. If these are not clearly articulated they should comply with the requirements for the pilots of manned aircraft.

Evidence of certification may be requested by the Authority or its nominated representatives at any time.

B19 Safety Training Certification

All offshore personnel must have appropriate in-date certification in accordance with the current STCW regulations, (or national equivalent approved in advance by the Authority), for the size and class of vessel used. This must include the use of smoke hoods and immersion suits if carried (C49). Evidence of certification may be requested by the Authority or its nominated representatives at any time.

Flight crew should be in-date for all relevant safety training as required by the CAA under which they are regulated.

Survey flight crew should have conducted appropriate basic offshore survival training (e.g. BOSIET & HUET) or appropriate aviation industry equivalent.

If the routine use of light aircraft (including helicopters) for transportation of project personnel over water is envisaged, consideration should be given in the HAZID to the associated hazards and to appropriate safety training for passengers (e.g. HUET).

Evidence of certification may be requested by the Authority or its nominated representatives at any time.

B20 First Aid & First Responder Training

All members of the survey team, including Marine Crew and Aircrew, must hold an in-date nationally recognised first aid certificate equivalent or superior to the UK HSE First Aid at Work (FAW) (3 Day) course.

Where not already included in the FAW course, all members of the survey team must be trained in:

- The use of Automated External Defibrillators (AED)
- The control of major bleeding and the effective use of the use of the major bleeds kit
- The administration of Adrenaline autoinjectors (EpiPen)
- The correct treatment for envenomation by tropical marine creatures endemic to the area of operation (Vessel operations only)
- The correct treatment for snake and insect bites and envenomation

If Remote Area Operations are to be conducted (C33), designated members of the survey team must additionally be trained, by an appropriate authority, in higher level First Responder techniques appropriate to industry and set in the context of the area of operations and likely injuries that would be encountered and require stabilisation prior to transit/evacuation. The ratio of team members trained to a higher level should be such that it is unlikely that a situation would arise in which casualty is the only team member with the higher level of training. In practice, specific requirements will be suggested by the Contractor's HIRA/HAZID and the Remote Area Operations JHA. A representative example could however include but not be limited to the QNUK Level 3 Award for First Responders. If identified as a requirement, training in the administration of controlled drugs under remote supervision by a doctor should also be provided to an appropriate number of team members (C42).

Where the project is equipped with oxygen resuscitation equipment and/or disposable resuscitators, (as required by the HIRA/HAZID, JHA, or specifically stated in the HI), at least 50% of the project personnel must be qualified in its use, and the use of associated suction devices and artificial airways.

In projects which are manned by a small number of personnel, sufficient members of the project team, (i.e. survey personnel, Marine Crew, Aircrew (and RPAS crew if applicable)), must be trained as per the 'survey team' requirements above, such that a situation is unlikely to arise where a casualty is also the only higher level first aider present at the worksite. In practice, (e.g. vessels operating with 2 x marine crew and 1 x surveyor or an Aircraft operating with 1 x Pilot and 1 x survey system Operator), this may require that 100% of the personnel present are trained to the same level.

The Contractor is to indicate in the Health and Safety Management Plan the intention for provision of suitable training to designated key individuals.

B21 Pilot Certification (Manned Aircraft)

The Pilot of the Aircraft must hold a valid Commercial Pilot Licence and suitable endorsements for the type and class of Aircraft used iaw. the latest local Civil Aviation Authority regulations.

B22 Remote Pilot Certification (RPAS)

The default requirement is that the Remote Pilot of any RPAS must hold a valid UK CAA PfCO (i.e. Permission for Commercial Operations) qualification or recognised national equivalent qualification, together with endorsements for the type and class of Aircraft used iaw. the latest local Civil Aviation Authority regulations. The Contractor must ensure that the qualification held is valid in the Project country and if it is not, ensure that the Remote Pilot gains additional certification as locally required.

The RPAS Remote Pilot must in any case have a working knowledge of and adhere to the provisions of UK CAA's CAP 722 '*Unmanned Aircraft System Operations in UK Airspace – Guidance*'.

RPA Remote Pilots, (or other RPAS crew), intending to use radiotelephony on civil aviation airbands must ensure that they hold a Flight Radio Telephony Operators' Licence (FRTOL) locally valid for the privileges intended to be exercised.

If local regulations do not require RPA Remote Pilots to have formal certification for the class/size of RPA in use, (when conducting operations for commercial gain or otherwise), then the Authority may, at its sole discretion, allow an RPA to be flown without the Remote Pilot having a UK PfCO. This dispensation will only be considered where:

- It is allowed by the State in whose airspace the RPA is being flown
- The Contractor has demonstrated in the Project Execution Plan how the skills, knowledge and experience of the proposed Operator and the size and complexity of the RPA in use and the operating environment will allow for the safe and effective operation of the system in the proposed role
- The RPAS utilises a Small RPA having a mass < 7kg
- Operation of the RPA is within Visual Line of Sight (VLOS) of the Remote Pilot
- Operating altitude is <120m
- Appropriate third-party liability cover is in place to cover the intended activities
- The area of operation is not near to controlled airspace or adjacent to an area or route commonly frequented by other airborne objects including gliders, hand gliders, microlights, balloons, parachutists etc

It is envisaged that this dispensation will only normally apply to Small RPA which are being used for occasional ancillary project related activities, (i.e. not including day-to-day intensive surveying), and will typically involve operation over water and uninhabited land areas and away from other Vessels. For example, a lightweight multirotor 'drone', intended principally for the recreational market, which is being used at low level and in very close proximity to the Remote Pilot to take video or still imagery for marketing purposes, remote visual observation of a shoal patch over which it is the intention to navigate a manned survey Vessel or for close observation or positioning of a beached wreck which cannot be approached by the survey Vessel due to navigational constraints.

B23 Certification of Client Representatives

Client Representative(s) will hold medical, safety and first aid training and certifications meeting the minimum standards stated above.

Where local vessel, aviation (or aircraft class-specific) requirements mandate a higher standard of certification, this is to be made clear in the Tender. This will have no negative impact on the scoring of the Tender but will ensure that the Client Representative(s) have sufficient notice to attend training and meet the minimum standards before visiting the project.

Should the situation change during the course of the contract the Authority's Programme Manager is to be informed at the earliest opportunity.

B24 Working Hours & Conditions

For Vessel operations, Marine Crew ('seafarers') and Survey Personnel ('[a] worker on ships or boats') must comply with (UK) Working Time Regulations, the Maritime Labour Convention (UK) and, where applicable, the spirit of the ILO Maritime Labour Convention, notably Standard A2.3 and Regulation 2.7.

For Aircraft operations, Pilots and Survey Personnel must comply with (UK) Working Time Regulations, and the Civil Aviation Authority regulations of the state where the project is being conducted. If these are not clearly articulated, the regulations of the Aircraft's State of Registry must be complied with.

At ITQ, the Contractor must demonstrate how the plan for project manning, travel and accommodation will meet these legal requirements.

B25 Remote Working

Any changes to the above where the Contractor wish required field staff to be located elsewhere, are to be fully justified in the tender.

In such instance's tenders are to include a full communications plan, with evidence, to support the transfer of data, audio and video to ensure that productivity and output is not negatively impacted.

The Authority retains final say on the working location of all staff.

Part C

Quality, Health, Safety and Environment (QHSE)

The Authority's Intent 22
Principles of QHSE 23
Contractor Responsibility 24
General Data Protection Regulations 24
Stop Work Authority 24
Health & Safety Representative 25
Fitness for Work Policy 25
Fatigue Management Policy 26
Long Haul Travel Policy 26
Drugs and Alcohol Policy 27
Prescription & Non-Prescription Drugs and Medications Policy 29
Motor Vehicle Policy 30
Management of Change 31
Kick-Off Meeting 31
Customs/Immigration 31
HIRA/HAZID 32
Project Execution Plan 32
Survey Project Briefing 33
Mobilisation & Demobilisation Plan 33
Lift Plan 34
Autonomous Vehicle Concept of Operations 34
Remotely Piloted Aircraft Systems Operating Safety Case 35
Inspection and Test Plan (ITP) 35
Mobilisation & Calibration Report 36
Health, Safety & Environment Management Plan 38
Project Emergency Response Plan 38
Vessel Emergency Response Plan 39
Manned Aircraft Emergency Response Plan 40
Remotely Piloted Aircraft Emergency Response Plan 40
Rescue Training & Casualty Handling 41
Shallow Water Working Procedure 42
Lone Working Policy & Procedure 43
Remote Area Operations Policy & Procedure 46
Permit to Work Systems 48
Control of Substances Hazardous to Health (COSHH) 49
Safety Equipment & Personal Protective Equipment (PPE) 51
Work At Height 52
Work in Confined Space 54
Atmospheric Testing 57
Communicable Diseases 58

Natural Hazards 60
Medicine Chest 61
Personal Medical Kit 62
Employee Assistance Programme 62
Accommodation 63
Working Language 63
Vessel Suitability as a Workboat 63
Large Vessel Suitability 64
Vessel & Vehicle Suitability as a Survey Platform 65
Vessel Inspections 66
Vessel Audit 67
Vessel Coding and Approval 67
Vessel Flag 67
Vessel Commitment 68
Aircraft Registration, Inspection and Approval 68
Aircraft Operator 68
Aircraft Suitability 69
Air Coordination and Safety 69
Aircraft Commitment 70
Safety Equipment – Manned Vessels 70
Silent Hours Routine 76
Safety Equipment – Manned Aircraft 77
Safety Equipment – Remote Pilot Station 78
Client Representative Safety Checks 80
Hazard Hunt 81
Safety Induction – Manned Vessel 82
Safety Induction – Manned Aircraft 84
Safety Induction – Remotely Piloted Air System 86
Safety Induction – Shoreside Facilities 87
Daily Prestart Meeting 87
Toolbox Talk 87
Safe Work Method Statement 88
Hazard/Safety Observation Cards 90
StepBack 5x5 91
Drills and Exercises 92
Weekly Safety Meeting 93
Lessons Identified & Continuous Improvement 93
Client Representative Visits 94
Noise 94
Lighting 95
Project Office Ergonomics (Land Based) 95
Project Office (Afloat), Online Surveyor and Helmsman Ergonomics 96
Aircraft Survey Equipment Operator Ergonomics 96
RPAS Remote Pilot Station Ergonomics 97
Manual Handling 98
Operator Training 99
Forklift Trucks 99
Hot Work 100
Work in the Water 101
Diving Operations 102
Man Overboard 103
Electronic & Electrical Equipment 104
Equipment Isolations 106
Smoking 106
Rubbish Bins (Trash Cans) 106
Open flame cooking/ heating appliances 107
LPG Stowages 107
Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 107
Incident Reporting 108
Near Miss Reporting 112
Non-Conformance Reporting 112
Accident Book 113
First Aid Injury 113
Medical Treatment Injury 113
Light Duty Injury 113
Lost Time Injury 114
Environmental Impact Statement 114
Carbon Footprint 115
Waste Management 115

C1 The Authority's Intent

A well-run Quality, Health, Safety & Environment (QHSE) Management System provides an effective means of ensuring zero harm, by protecting Employees' Health, Safety and general Wellbeing, as well as the Environment and Equipment. This in turn inevitably leads to sound operational outcomes, achieved in a cost-effective and well-planned manner, with the rendering of high-quality data to the Authority.

An effective QHSE system is based on the understanding that all incidents are preventable if Hazards are identified through a structured process of Risk Assessment, with Control Measures, following the Hierarchy Of Controls, put in place to reduce the risk to an acceptable level - As Low As Reasonably Practicable (ALARP). Establishing effective QHSE management processes and procedures also results in improved training and administration methods.

It is the Authority's intent to demonstrate, throughout our organisation and by our Contractors and Sub-Contractors, an ongoing and determined commitment to QHSE execution and to Continuous Improvement.

The Authority will lead the global offshore survey industry by promoting and improving upon existing offshore industry QHSE best practice and meeting or exceeding the guidance of the UK Health and Safety Executive and other international regulatory bodies.

The UKHO has committed to be Net Zero by 2030 and as such will look to ensure its supply chain is similarly engaged on moving towards Net Zero.

All policies and representative examples of documentation referred to in Section C must be supplied as part of the tender.

C2 Principles of QHSE

A number of principles have been recognised as foundational to QHSE. These follow the Hierarchy of Controls and include:

- Safety comes first. The goal is to eliminate all injuries, instances of damage to equipment and environmental incidents
- Contractors must demonstrate that an effective QHSE system is in place and functional in practice
- QHSE includes all aspects of a Contractor's operation, including areas such as purchasing, logistics, the mobilisation of personnel and equipment and administrative services
- Management must fully support QHSE execution by all employees
- The potential for Health, Safety or Environment related incidents should be eliminated during the planning stage
- Good practices don't "just happen". They must be planned and properly executed
- Personnel must be competent to plan and safely perform their task and to react appropriately to safely manage an incident. Competency arises through a practical and demonstrable combination of Skills, Knowledge, Training and Experience
- All workers must 'buy-in' to a commitment to working safely, actively participating in and complying with all QHSE policies and procedures and demonstrating appropriate behaviours
- Individual workers are responsible for working safely and exercising their Duty of Care, taking proactive steps to protect themselves, their colleagues, other people and the environment from harm
- PPE and Safety Equipment appropriate to the task must be identified, supplied, worn correctly and as required by the Risk Assessment, regularly inspected, and maintained in accordance with the manufacturer's specifications
- Monitoring and assessment of QHSE processes, procedures and behaviours should be conducted regularly
- All QHSE related events, (as detailed in this Section), must be reported to the Authority, documented, and investigated. Whilst a no-blame culture of reporting to be implemented, this process allows performance tracking, identification of Lessons Identified (LI), Continuous Improvement (CI) and, most importantly, prevention of a recurrence

C3 Contractor Responsibility

Equipment and personnel provided by the Contractor for work in connection with the contract are the Contractor's responsibility at all times. Any loss, injury or damage suffered or caused by them is at the Contractor's risk throughout.

Any loss, injury or damage to personnel, equipment or the environment must be reported to the Authority in accordance with the guidance contained in this section, and also to any other relevant authority required by local regulations and, if applicable, the national legislation of the country in which the Contractor is headquartered. If doubt exists, the Authority is to be informed and UK standards and requirements followed as the default position.

The Authority reserves the right to request, and receive in a timely manner, documentary evidence to demonstrate Contractor compliance with, or the ability to meet the minimum standards laid down in this Survey Specification, at any time throughout the life of the contract; a refusal or inability to provide relevant documentary evidence automatically signals a departure from the Specification.

C4 General Data Protection Regulations

The Contractor is to comply fully with all General Data Protection Regulations (GDPR) as detailed in the UK Data Protection Act 2018.

C5 Stop Work Authority

Any person participating in the Project has both the right and the legal obligation, under their Duty of Care, to exercise Stop Work Authority (SWA) if they perceive a condition or behaviour that poses imminent danger to persons, equipment or the environment.

SWA must be formally stated as a Contractor policy which is supported by the head of the organisation. The policy should make it clear that it is an *expectation* that an employee will always exercise SWA if they are in doubt as to the safety of an activity and that they will never be subsequently held to be in the wrong when they have exercised SWA in good faith.

SWA should be managed in accordance with the Contractor's internal policies and procedures. It will typically follow the general procedure of Stop, Notify, Investigate, Correct, Resume and Follow-Up.

Where SWA is exercised, it must be recorded using a Safety/Hazard Observation Card, with specific reference made to the event in the DPR. If there was potential for an *Incident* or *Non-Conformance* it must also be reported and reviewed in accordance with the Contractor's *Near Miss Procedure or Non-Conformance Procedure* as appropriate.

The circumstances leading to the situation will be reviewed in the Weekly Safety Meeting which will formally brief any Follow-Up actions implemented to prevent a recurrence of the unsafe act or condition.

Exceptionally, SWA may be also be exercised, outside of the normal legal Duty of Care, if any person participating in the Project perceives a condition, behaviour or relationship which poses a reputational risk to the Authority or to the Government of the United Kingdom or the Government in whose jurisdiction the operation is taking place. If SWA is exercised under these circumstances it should be reported to the Authority as soon as possible. Work is not to resume until specifically authorised by the Authority.

C6 Health & Safety Representative

As the survey team leader, the Party Chief is responsible for the practical implementation of all Contractor, Authority and Legislative QHSE requirements in the field.

The Party Chief should maintain an active dialogue with the Contractor's Health & Safety Representative, (who will typically be located in the Contractor's main offices), particularly in respect of the conduct and outcomes of the Weekly Safety Meeting.

C7 Fitness for Work Policy

The Contractor must have in place a Fitness for Work Policy and Procedure.

Survey operations are conducted in inherently high-risk environments. Fitness for Work encompasses a general state of an employee's wellness, (physical, mental and emotional), which enables a worker to fulfil his legal Duty of Care, performing assigned tasks competently and in a manner, which does not compromise the safety or health of themselves or others for the duration of their shift.

Fitness for Work considerations should include but not be limited to:

- Safe work practices and procedures
- Health promotion
- Fatigue Management including effective management of long-haul travel
- A routine for sensible environmental acclimatisation
- Impairment
- Drug and alcohol management
- Mental health & stress management
- Functional physical fitness and the opportunity to exercise
- Appropriate project manning levels
- Management of shift lengths and rosters
- The opportunity for the employee to achieve adequate sleep when off shift
- Mandatory rest periods for Pilots and RPAS Remote Pilots as required by cumulative flying hours
- Correct shift lengths for Marine Crew as required by MCA and international regulations
- Appropriate leave/recovery time between swings and projects
- Regular employment health assessments conducted by a medical professional
- Employee Assistance Programme

C8 Fatigue Management Policy

Being fatigued can seriously impair an individual's mental capacity, judgement, and reactions, leading to an increased risk of accidents and injuries. Workers who present themselves for work whilst fatigued are also unlikely to have the physical, mental, and emotional condition to be able to carry out their duties effectively. Depending upon their role they may present a risk to themselves or to others. They are therefore unable to discharge their Duty of Care and are not Fit for Work.

The Contractor must have in place an effective Fatigue Management Policy and Procedure detailing the method by which the negative impact of fatigue will be managed, and Fitness for Work maintained. This should include a separate section for Pilots and Aircrew, (including survey Aircrew and RPAS Remote Pilots), and Marine Crew (including unmanned vessel and vehicle operators), if a different set of standards are mandated for these roles by a relevant authority.

The Fatigue Management Policy may be a stand-alone document or may be incorporated as a specific aspect of the Fitness for Work Policy.

C9 Long Haul Travel Policy

The Contractor must have in place an effective Long-Haul Travel Policy detailing the method by which the negative impact of Long-Haul Travel will be managed, effective environmental acclimatisation achieved, and Fitness for Work maintained.

If survey operations are to be conducted 24/7, this must include the method by which personnel mobilising to the project will adjust to being on shift if their allocated shift period falls significantly outside of the period that they would have been awake in their time zone of origin.

The Long-Haul Travel Policy may be a stand-alone document or may be incorporated as a specific section within the Fatigue Management Policy.

C10 Drugs and Alcohol Policy

Being under the influence of alcohol or (legal/medicinal or illegal) drugs can seriously impair an individual's mental capacity, judgement, and reactions, leading to an increased risk of accidents and injuries occurring. Workers who present themselves for work under the influence of drugs or alcohol are unlikely to have the physical, mental, and emotional condition to be able to carry out their duties without risk to themselves or others. They are therefore unable to fulfil their Duty of Care to themselves and to others and are not Fit for Work.

The Contractor must have in place a Drugs and Alcohol Policy which:

- Forbids the presence or possession of drugs illegal under UK or local law and of psychoactive substances or alcohol in Vessels, Aircraft, offices, facilities, or vehicles used under this contract
- Forbids the consumption, possession, or supply by project personnel of drugs which are illegal under UK or local law and of psychoactive substances
- Requires that personnel do not report or try to report for work when unfit due to alcohol or drugs, (whether illegal or not), or to substance abuse. Whether an employee is fit for work is a matter for the reasonable opinion of the Contractor management, the Vessel Master or Aircraft pilot, or the Client Representative
- Specifies the maximum Blood Alcohol Concentration (BAC) with which a worker may report for work
- Includes random and for-cause drug and alcohol testing whilst personnel are on the project
- Requires Aircrew, (including survey personnel working in the Aircraft and RPAS Remote Pilots), to comply with UK CAA or local CAA regulations and guidance in respect of drugs and alcohol consumption, whichever is the more stringent
- Requires Marine Crew, including personnel remotely operating unmanned vessels and vehicles, must comply with UK Maritime and Coastguard Agency (MCA) or equivalent local Maritime Authority regulations and guidance in respect of drugs and alcohol consumption, whichever is the more stringent
- Requires all project personnel to adhere to local Customs/importation laws in respect of drugs (including legal/medicinal drugs) and alcohol

C10 Drugs and Alcohol Policy Continued

The Contractor's Drugs and Alcohol Policy may allow for social consumption of alcohol ashore and in moderation whilst an employee is off shift. All workers must however be Fit for Work at the commencement of their next shift, with their BAC complying with the Contractor's Drugs and Alcohol Policy and any other applicable regulations pertaining to Marine Crew and Aircrew. If there is subsequently any doubt as to an employee's fitness for work at the commencement of a worker's next shift, a BAC of 0.0% is the required standard.

Any personnel accommodated overnight onboard a liveaboard vessel must not be in a condition in which they present a hazard to themselves or to others in the period between returning onboard and starting their next shift. Personnel should at all times be in a condition that they could respond effectively, without assistance, to an emergency.

Aircrew, including survey personnel working in an Aircraft and RPAS Remote Pilots, must comply with UK CAA or local CAA regulations and guidance in respect of drugs and alcohol consumption, whichever is the more stringent.

Marine Crew, including personnel remotely operating unmanned vessels and vehicles, must comply with UK Maritime and Coastguard Agency (MCA) regulations and guidance in respect of drugs and alcohol consumption, unless local regulations are more stringent, in which case they are to be followed.

The Authority or its nominated representatives reserve the right to request evidence of and approve the regime in place at any time throughout the life of the contract.

The Authority reserves the right to require that all project personnel are to be subject to an OGUK compliant Drug Test, (or recognised national equivalent), conducted not more than 2 weeks prior to mobilising to the Project. Personnel testing positive for a controlled substance are not to mobilise to the project and the Authority is to be informed of the situation and a replacement nominated. If the Authority exercises the right to require a pre-mobilisation Drugs Test, clearance certificates are to be provided to the Authority upon request.

The contractor must have in place a policy and rehabilitation system to assist any personnel who test positive for the presence of controlled substances or alcohol in the pre-mobilisation, random or for-cause testing.

C11 Prescription & Non-Prescription Drugs and Medications Policy

Being under the influence of prescription and non-prescription (legal) drugs can seriously impair an individual's mental capacity, judgement and reactions, leading to an increased risk of accidents and injuries occurring, particularly when conducting high risk tasks. There is potential that project personnel who are under the influence of legal drugs may be unable to fulfil their Duty of Care to themselves and to others and are therefore not Fit for Work in a high risk offshore or field environment, even if there would be limited risk to the same individual in their normal office employment. Further, if the worker is injured or incapacitated and unable to communicate, it is important and potentially life-saving for senior project personnel to be aware of the medications which the Injured Person (IP) has been taking so that this information can be communicated to local medical services on the IP's behalf. For these reasons, the Contractor must have in place a policy which requires that:

- All personnel assigned to the project must declare the use of any prescription & non-prescription medications and supplements to Contractor management. This should be completed in good time prior to travel so the Contractor can confirm there are no local laws prohibiting the importation, possession or use of the medications and to obtain doctor's/customs certificates for importation if required
- All personnel, who are routinely taking medications which are fundamentally critical to their continued health and wellbeing, must ensure that they have sufficient supply of the drug or medication to cover their requirements for the duration of their time deployed on the project and an additional allowance to cover unforeseen eventualities including project overrun, emergencies or disruption to demobilisation travel plans. If the intention is to re-supply the drug or medication locally in the country of operations, (as opposed to importing a potentially large supply), it must be confirmed that the drug or medication is easily available locally in the quantities required and that an arrangement with a local doctor exists to ensure ease of procurement and that the opportunity to resupply is manageable within the realities of the project schedule
- All personnel taking prescription and (legal) non-prescription drugs, medications and supplements must be aware of the side effects of the substances, including those that may impact on their capacity for work
- Personnel who are assigned to the Project must take early steps to raise with their line manager any concerns that they may have about their capacity to safely undertake field work, in a high-risk environment
- All personnel must declare the use of any prescription & non-prescription medications and supplements to the relevant authority as appropriate to the Project. This may be the Party Chief, Vessel Master, Project EMT/Paramedic or Aircraft Operator as appropriate
- All personnel must ensure they are aware of any common drugs which are contraindicated by any prescription and non-prescription drugs, medications, and supplements that they are taking. Where this is the case the relevant authority should be informed, as appropriate to the Project. This may be the Party Chief, Vessel Master, Project EMT/Paramedic or Aircraft Operator as appropriate

C12 Motor Vehicle Policy

The Contractor must have in place a Motor Vehicle Policy and Procedure detailing the method by which all Motor Vehicles, including passenger cars, 4x4 vehicles, forklift trucks, cranes and bespoke RPAS support vehicles, will be safely employed during the project.

This should include but not be limited to:

- Policy for the safe operation of normal road vehicles
- Equipment to be caried in project vehicles including but not limited to Personal Protective Equipment, safety equipment, communications equipment and any specialist equipment required for the safe operation of specialist vehicles
- Training requirements for the safe operation of normal road vehicles under the prevailing conditions in country (e.g. defensive driving)
- Training requirements for the safe operation of specialist vehicles. (e.g. operation of 4x4s on unmade roads, forklift trucks, and the employment of a mobile RPAS suite)
- Training requirements for the safe use of specialist equipment required for the safe operation of the specialist vehicles. (e.g. use of winches, high lift jacks, sand ladders etc. for the recovery of 4x4 vehicles)
- Routine for confirming the basic functionality and safety of a hire vehicle when first taking it on-hire
- A weekly checklist to be completed by a designated responsible person, (typically the Survey Engineer), to ensure that the vehicle remains free from basic and easily detectable defects which negatively affect safety
- In longer projects, the inspection and servicing routine for the vehicle by a competent vehicle mechanic

C13 Management of Change

If a requirement emerges to depart from the survey plan as embodied in the HI, from the provisions of the Survey Specification, or from the detail described in any Contractor supplied project documentation, the change must be communicated to and agreed with the Authority's Survey Manager or Client Representative as soon as possible.

The Contractor is to capture the change using the Contractor's Management of Change (MoC) Form and Procedure. A completed copy of this form is to be forwarded to the Authority's Programme Manager and Client Representative for discussion and approval before work re-commences under the new regime. The decision to authorise the change lies at the sole discretion of the Authority.

C14 Kick-Off Meeting

Project Management Staff will be required to attend a Kick-Off Meeting. This will be held either at the UKHO, via teleconferencing, or using a combination of the two to enable remote staff to attend. This should ideally include all staff participating in the project including vessel Master and aircraft Pilot. The Contractor's Project Manager, (Field Manager if applicable), Party Chief, Charge Surveyor and most senior Survey Engineer are however to attend as a minimum.

An agenda should be supplied to the Authority ahead of the meeting. The Contractor should be ready to provide all project details not already provided in the original tender including:

- Project dates
- Project Execution Plan
- Summary of the HIRA/HAZID
- Emergency Response Plan
- Health Safety & Environmental Management Plan
- Field accommodation
- Details of personnel and equipment mobilisation
- The detail of vessels and aircraft
- Planned tide gauge, geodetic and other fixed equipment sites as required by the HI
- Any proposed equipment or personnel amendments which depart from the tender

The Authority will provide a brief report on the meeting including confirmation of any amendment to the specification/tender/HI agreed during the meeting.

C15 Customs/Immigration

While the Company must be responsible for arranging all licences, consents, customs clearance and permits in accordance with DI, the Authority will assist with in-country official arrangements, specifically customs and immigration. To this end the Company is to provide the equipment shipping waybill and all project personnel passport details on completion of the kick-off meeting to allow smooth access to the project country.

C16 HIRA/HAZID

The Contractor must conduct a formal Hazard Identification Risk Assessment/Hazard Identification (HIRA/HAZID) early in the planning stage of the Project. To ensure a wide range of contributing viewpoints, this should be attended by as many of the nominated field team as possible. As a minimum, this should include the Party Chief, Charge Surveyor, Survey Engineer and ASV/AUV/ROV Operator and vessel Master for Vessel operations or the Charge Surveyor, Pilot (and/or RPAS Remote Pilot if applicable) and the Survey Equipment Operator for operations involving Aircraft. It is strongly encouraged that more junior team members also attend to ensure the widest range of perspectives. Personnel not able to attend in person should attend by video teleconference.

The HIRA/HAZID meeting should be held shortly before but separate to the Kick-Off Meeting. The Authority is to receive early invitation to attend the HIRA/HAZID such that the Client Representative can make arrangement to attend in person or by video teleconference.

It is strongly recommended that the Contractor maintains a Generic HIRA/HAZID pertinent to hydrographic survey operations, in the designated operational environment, conducted by representative vessel and aircraft types. This document should be regularly reviewed and kept up to date as part of the Contractor's Lessons Identified and Continuous Improvement process. Prior to the HIRA/HAZID meeting the Generic HIRA/HAZID should be tailored to a Project specific document. This will ensure that the HIRA/HAZID meeting is conducted efficiently, in a timely fashion and results in the identification of all relevant hazards and mitigation strategies.

Once issued, the HIRA becomes a 'live document'. Accompanied by effective version control, the document should be subject to regular review and update as planning for and conduct of the Project progresses.

C17 Project Execution Plan

Prior to mobilisation, the Contractor is to provide a Project Execution Plan (PEP). This document is to contain the technical detail of how the Contractor intends to execute the HI, together with a representative line plan.

Where different sizes and classes of Vessels and vehicles are proposed (including ASVs, AUVs, ROVs and RPAS), the PEP is to detail how these assets will be employed, together with considerations regarding simultaneous operations with project and other local Vessel traffic.

Where different sizes and classes of Aircraft are proposed which include RPAS, the PEP is to refer to the RPAS OSC and summarise how these assets will be seamlessly employed, together with considerations regarding simultaneous operations with project and other local Aircraft traffic.

The PEP is to contain a gantt style chart detailing the timeline of key project activities from award of contract to rendering of data to the Authority.

Additionally, (where a Mobilisation/Demobilisation Plan is not provided as a separate document), the PEP should contain a section considering the specifics of Vessel/Aircraft/RPAS mobilisation and demobilisation.

C18 Survey Project Briefing

The Contractor must conduct a formal Project Briefing with all personnel mobilising to the project, including vessel master's and aircraft pilots. Ideally this should be conducted in the Contractor Offices immediately prior to mobilisation of personnel. Where this is not possible, the Party Chief should conduct the Project Briefing on arrival in the field and before commencing mobilisation activities.

The Project Briefing should ensure that all personnel are aware of the contents of the HI, Survey Specification, Project Execution Plan (and Remotely Piloted Aircraft Operating Safety Case (OSC) (RPAS OSC) if RPAS are to be flown) and the Project Emergency Response Plan.

Additionally, any relevant Lessons Identified from previous projects should be raised, highlighting with measures to be taken to prevent a recurrence.

The Authority is to receive early invitation to attend the Project Briefing such that the Client Representative can make arrangement to attend if appropriate.

C19 Mobilisation & Demobilisation Plan

Prior to mobilisation, the Contractor is to provide a Mobilisation and Demobilisation Plan. This document is to contain the technical detail of how the Contractor intends to execute the mobilisation and demobilisation of equipment to the survey Vessel or Aircraft.

For Vessel operations, the Mobilisation & Demobilisation Plan should include deck plans indicating the location and layout of any fabrication required, including the installation of the MBES pole (if applicable).

For Aircraft operations, the Mobilisation & Demobilisation Plan should include schematics of the layout of the survey equipment inside the Aircraft, and details of any fabrication or structural modifications required.

Where different sizes and classes of Vessels and vehicles are proposed (including ASVs, AUVs, ROVs and UAVs), the Mobilisation and Demobilisation plan must detail how the mobilisation of these assets will be achieved and how any control and telemetry systems will be deconflicted and integrated into the mother vessel (if applicable).

Where different sizes and classes of aircraft, including RPAS are proposed the Mobilisation and Demobilisation plan must detail how the mobilisation of these assets will be achieved and how their control and telemetry systems will be deconflicted and integrated into RPA Control Station (if applicable).

In smaller vessels, with simple mobilisations and no requirement for crane operations, it is acceptable for this document to be included as a section within the Project Execution Plan. If crane lifts are to be conducted, the Mobilisation & Demobilisation plan must be a stand-alone document which additionally contains or references a Lift Plan.

In light aircraft which are already fitted with or for lidar equipment, this document may be included as a section within the Project Execution Plan.

C20 Lift Plan

When crane lifts are to be conducted during the Mobilisation and Demobilisation, (including the use of Man Baskets for the conduct of work at height), they must be subject to a formal Lift Plan and JHA/JSA. This must detail the sequence of loads to be lifted, any notable rigging considerations and, referencing the Deck Plan in the Mobilisation & Demobilisation Plan, the area of deck to which each load is to be transferred.

Personnel operating machinery and rigging for the lift must be competent to undertake the assigned activity.

The Lift Plan may be produced as a stand-alone document or included as a section of the Mobilisation & Demobilisation Plan.

C21 Autonomous Vehicle Concept of Operations

Where Autonomous Vehicles, (ASV, AUV and ROV), are to be used during a project, a Concept of Operations (ConOps) is to be provided for that system detailing how it will be operated, including any relevant system-specific safety considerations.

C22 Remotely Piloted Aircraft Systems Operating Safety Case

Where Remotely Piloted Aircraft Systems (RPAS) of any size or characteristics are to be used during a project, an Operating Safety Case (OSC), following the ConOps methodology, is to be provided for that system detailing how it will be operated, together with any relevant system-specific safety considerations.

The OSC must follow the general format proposed in Appendix B to UK CAA's CAP 722 'Unmanned Aircraft System Operations in UK Airspace – Guidance' and contain the sections proposed under the section 'UAS OSC Requirements', commensurate with the size and complexity of the RPA in use and the operating environment.

The Authority may, at its sole discretion, allow an RPA to be flown without a formal RPAS OSC. This dispensation will only normally be considered appropriate when:

- It is allowed by the State in whose airspace the RPA is being flown
- The Contractor has comprehensively demonstrated in the Project Execution Plan how the skills, knowledge and experience of the proposed Operator and the size and complexity of the RPA in use and the operating environment will allow for the safe and effective operation of the system in a clearly defined role
- The RPAS utilises a Small RPA having a mass < 7kg
- Operation of the RPA is within Visual Line of Sight (VLOS) of the Remote Pilot
- Operating altitude is <120m
- Appropriate third-party liability cover is in place to cover the intended activities
- The area of operation is not near to controlled airspace or adjacent to an area or route commonly frequented by other airborne objects including gliders, handgliders, microlights, balloons, parachutists etc

It is envisaged that this dispensation will only normally apply to Small RPA which are being used for occasional ancillary project related activities, (i.e. not including day-to-day intensive surveying), and will typically involve operation over water and uninhabited land areas and away from other Vessels. For example, a lightweight multirotor 'drone', intended principally for the recreational market, which is being used at low level and in very close proximity to the Remote Pilot Station to take video or still imagery for marketing purposes, remote visual observation of a shoal patch over which it is the intention to navigate a manned survey Vessel or for close observation or positioning of a beached wreck which cannot be approached by the survey vessel due to navigational constraints.

C23 Inspection and Test Plan (ITP)

Prior to mobilisation, the Contractor must provide a comprehensive ITP for the project covering the key activities from the start of personnel and equipment mobilisation to the end of personnel and equipment demobilisation. The ITP should be in active use by project personnel to ensure Quality standards and that no required element of the operation is overlooked.

C24 Mobilisation & Calibration Report

The Contractor's Charge Surveyor is to render a draft Mobilisation and Calibration Report to the Authority on completion of the Mobilisation and within 48 hrs of commencement of data collection.

The draft report is to include initial results of all calibrations conducted. A final report is to be rendered to the Authority within 2 weeks of completion of pre-survey calibrations with all figures finalised with any amends to the initial figures noted.

For Vessel operations, the contents of the Mobilisation and Calibration report must include but not be limited to:

- A description of all survey equipment and systems installed in all Vessels including ASVs, AUVs, ROVs and RPAS
- Vessel and vehicle sensor offsets
- Geodetic Parameters Check (if required)
- Description of all geodetic marks and benchmarks used during mobilisation and calibration
- Details of TG installation, levelling and pole to gauge calibration
- Details of offshore TG/Current Meter installation
- Static position check results
- Node Comparison
- Dynamic position check results
- MBES gross error check
- Patch Test results
- MBES repeatability check results
- SV probe comparison
- Comparison with other MBES/lidar results (when more than one Vessel/Aircraft is in operation)
- Inter-calibration details of backscatter/reflectivity outputs

C24 Mobilisation & Calibration Report Continued

Additionally, if specified in the HI (not normally expected):

- SBES Bar Check
- USBL Calibration
- Magnetometer function check

For Aircraft operations (including RPAS), the contents or the Mobilisation and Calibration report must include but not be limited to:

- A description of all survey equipment and systems installed in all Aircraft/RPA
- A description of all survey, control and telemetry equipment associated with the Remote Pilot Station (if applicable)
- Sensor offsets
- Geodetic Parameters Check (if required)
- Description of all geodetic marks and benchmarks used during mobilisation and calibration
- Details of TG installation, levelling, and pole to gauge calibration
- Details of offshore TG / Current Meter installation
- Static position check results
- Node Comparison
- Dynamic position check results
- Lidar system calibration
- Vertical Accuracy Scan Direction Comparison
- Vertical Accuracy Flightline Comparison
- Repeatability check
- System comparison (when more than one lidar sensor is in use)
- Integration of Topographic, Shallow and Deep lidar sensors (when more than one lidar sensor is in use)
- Comparison with MBES results (when a Vessel is also in operation)
- Comparison with other lidar results (when more than one Aircraft or RPA is in operation)

C25 Health, Safety & Environment Management Plan

A HSEMP must be supplied to the Authority prior to survey operations being undertaken for each HI.

The HSEMP must be tailored to the HI and reflect the actual survey area, Aircraft/RPAS, vehicles, offices and accommodation to be used.

C26 Project Emergency Response Plan

A Project ERP must be provided for the project and supplied to the Authority prior to personnel mobilising on each HI.

The Project ERP must be tailored to the HI and the specific Vessel, Aircraft/RPA, vehicles and the area of operations.
The Project ERP should include but not be limited to:

- Contractor Incident management procedures
- Identification of a Contractor duty officer / 24/7 response number
- Communications Plan, e.g. GSM Voice/GSM Data/SATCOM/EPIRB/PLB/Satellite Messenger
- Response to Vessel related emergencies (See Vessel Emergency Response Plan)
- Response to Aircraft related emergencies (See Manned Aircraft Emergency Response Plan)
- Response to RPAS related emergencies (See RPA Emergency Response Plan)
- Access to EAP
- Response to First Aid Incidents
- Response to Medical Treatment Incidents
- Response to serious Medical Emergencies
- Repatriation of injured personnel (or transfer to appropriate medical facilities)
- Actions in the event of a disaster warning as appropriate to the region and the time of year (e.g. Natural Hazards including Hurricane, Tsunami and Volcano)
- Actions in the event of unpredicted disasters as appropriate to the region and the time of year (e.g. Natural Hazards including Earthquake, Fire, Tsunami, Flood, Civil Unrest)
- Recovery from natural disasters
- Easy-access summary of key contacts and telephone numbers

The Project ERP must be locally tested within 24hrs of personnel mobilising to the HI. The successful completion of this test must be documented in the DPR.

C27 Vessel Emergency Response Plan

A Vessel ERP must be provided for each Vessel involved in the Project and supplied to the Authority prior to the Vessel sailing on completion of mobilisation. Issues to be considered in the Vessel ERP should include but not be limited to:

- Fires (including machinery spaces, galley, laundry, and other identified high-risk compartments)
- Fuel fire (including lithium batteries if applicable)
- Flood
- Man Overboard
- Fouled rudder or propeller
- Engine Failure
- Steering Failure
- Electrical Failure
- Collision and Grounding
- Muster Stations & Abandon Ship
- Loss of containment (Oil and Fuel)
- Response to First Aid incidents
- Response to Medical Treatment Incidents
- Response to serious Medical Emergencies
- Response to MARPOL incidents
- Casualty Handling
- MEDEVAC

Where ASVs, AUVs, and ROVs are to be used during the project they are to be considered Vessels and a Vessel ERP must be provided for each make and model of vehicle in use.

The Vessel ERP must be locally tested in accordance with Section C75, Drills and Exercises. This must include a practical check of the Communications Plan and the easy-access summary of key contacts and telephone numbers. The successful completion of this test must be documented in Vessel Logbook and the DPR.

C28 Manned Aircraft Emergency Response Plan

A Manned Aircraft ERP must be provided for each class of manned Aircraft involved in the Project and supplied to the Authority prior to the Aircraft being used for survey work. Issues to be considered in the Manned Aircraft ERP should include but not be limited to:

- Fires
- Engine failure
- Other mechanical, control and electrical failures
- Radio communications failure
- Loss of containment (Oil and Fuel)
- Response to First Aid Incidents
- Response to Medical Treatment Incidents
- Response to serious medical emergencies (on the ground and airborne)
- Response to emergency landing on land and on water

C29 Remotely Piloted Aircraft Emergency Response Plan

An RPA ERP must be provided for each class of RPA involved in the Project and supplied to the Authority prior to the Aircraft being used for survey work. Issues to be considered in the RPA ERP should include but not be limited to:

- Issues required by the Manned Aircraft ERP which also apply to the RPA in use

The RPA ERP should additionally include system specific issues, for example including but not limited to:

- Loss of telemetry and/or remote control
- Loss of navigation through GNSS failure
- Emergency landing on land and water
- Crash on land and water
- Fuel fire (including lithium batteries if applicable)
- Action in the event of encountering another Aircraft unexpectedly
- Communications with local ATC and other (manned and unmanned) Aircraft

C30 Rescue Training & Casualty Handling

Where the operation involves Working at Height (C37) and/or Work In Confined Spaces (C38), a workable rescue plan must be in place prior to commencement of the operation to ensure the safe recovery and handling of the casualty in the event of an incident. This high-risk activity is likely to involve the use of specialist equipment provided for the purpose and tailored to the survey platform in use.

Further, in vessels and aircraft, (particularly but not exclusively small vessels and light aircraft), internal conditions may under normal operating conditions be cramped, with relatively difficult access from inside the structure of the vessel or aircraft to the outside even under ideal circumstances. Challenging factors may include but not be limited to small doors and hatches, high thresholds and low overheads, narrow passageways and steep stairs and ladders. Full consideration must be given, prior to commencing mobilisation how, in the event of an incident, the largest member of the survey team would be extracted to a place of safety by the available remaining personnel. Consideration should be given to all routinely manned compartments and spaces for an unconscious and seriously injured casualty. This should be with due regard to both the safety of the casualty and of the rescuers, particularly considering the effects of vessel motion.

Depending upon the situation and the vessel design, this place of safety should be the normal gangway position for vessels alongside, or the normal muster point for vessels at sea. Additionally, in vessels with a dedicated sick bay and/or helicopter operating area, extraction to these locations should also be considered.

In the case of manned aircraft operations, the place of safety would normally be considered to be the ground immediately adjacent to the aircraft, in an area free of propulsion related hazards.

Contractor must ensure that:

- Appropriate rescue and casualty handling equipment is provided to allow for the safe rescue of a casualty conducting a Work at Heights or Work in Confined Spaces task
- Appropriate rescue and casualty handling equipment is provided to allow for the safe rescue of a casualty from within the structure of the vessel or aircraft to a safe location on deck or adjacent to the aircraft
- Sufficient project personnel are trained to ensure, in the specific context of the vessel/aircraft in use and using the equipment provided, the safe and successful execution of these rescues and casualty handling activities

C30 Rescue Training & Casualty Handling Continued

In larger ships, rescue and casualty handling is likely to be conducted by a dedicated Emergency Response Team (ERT) using the vessel's own equipment. In normal small boat operations however, it is likely that the majority of embarked personnel would become involved in the rescue and handling of a casualty and that the required equipment will be supplied by the Contractor. If this is the case, all project personnel should be trained and competent to assist or direct operations as required.

In light aircraft operations, unless otherwise suggested by the HIRA/HAZID or JHA, it would be expected that rescue and casualty handling would only be required once the aircraft is on the ground. This activity is therefore likely to be conducted by a dedicated ERT; survey team participation and training would be limited to providing advice to the ERT on any specific hazards associated with that aircraft type. In austere airfields however, or those which may otherwise lack support from competent and/or well-equipped ground personnel, all project personnel must be trained and competent to assist or direct operations as required.

The Client Representative will verify that workable Rescue Plans and Casualty Handling Plans are in place. This will apply to Working at Height and Confined Space (mobilisation) activities (Rescue Plans) and to general incident/medical response within the structure of the vessel or aircraft (Casualty Handling Plan). If in doubt, the efficacy of these plans must be practically demonstrated using the available equipment and personnel. If the plan proves to be unworkable, Stop Work Authority may be exercised, at Contractor liability, until such time as a workable plan is demonstrated.

C31 Shallow Water Working Procedure

The vessel Master is responsible for the overall navigational safety of the vessel and crew. If the Master considers that there is a conflict of interest in terms of the safety of the vessel and crew with regard to the proposed survey areas, they have the overriding authority to refuse to survey those areas.

The Contractor must have a comprehensive 'Shallow Water Working' procedure set out as part of their quality/safety management system which must be appropriate to the actual vessels in use.

All areas within HI requirements deemed inaccessible to survey vessels are to be photographed and reported to the Client Representative and the Authority.

Where autonomous vehicles are to be used, the Shallow Water Working Procedure is to specifically consider the safe operation of these vehicles and a full operational method statement is to be provided at ITQ.

C32 Lone Working Policy & Procedure

For the purposes of this Specification, Lone workers are those who work on the Project by themselves, without the support of other colleagues or close or direct supervision, in a place other than the Contractor's offices or their normal place of residence. i.e. 'field staff' as distinct from 'Remote Workers' (who are workers who choose to routinely conduct their normal office work from their own home).

Lone Working is an activity which may significantly increase the potential impact of the hazards already inherent in the activity being undertaken, i.e. of the risk of harm. Lone Workers are subject to the same hazards and risks as other employees in the field. Working alone leaves them more vulnerable however as support, advice or help is not as easily accessible in a difficult or emergency situation. Lone Workers may be left in a situation where they are unable to alert someone and obtain help in the case of an accident, confrontation, sudden illness or emergent operational or emergency situation which they may not have the skills, knowledge, experience, or capacity to manage independently.

Lone workers may also be more at risk from theft, violence, assault, extortion, and exposure to other criminal or inappropriate conduct as they may be viewed as an easier target. Lone working may also introduce additional hazards and stressors depending upon the environment and unique to the person undertaking the task.

The Contractor must have in place a Lone Working Policy and Procedure. The Lone Working Procedure must be tailored so as to be specific to the realities of the operational environment and the personnel undertaking the activity and detail the method by which Lone Workers will be safely employed and supervised during the project. In practice the Lone Working Procedure may be included as part of the PEP, however it should be easily identifiable as a stand-alone section.

A Lone Worker risk assessment should identify all workers who could be considered Lone Workers whether for all or part of their working day. It should identify the different risks each of these Lone Workers face. This should additionally be captured in the Project HAZID/HIRA. Further, there may be several types of Lone Workers. Examples could include but not be limited to personnel:

- On transit mobilising to/from the project
- Carrying out day/night-time work in the field in a Remote Area
- Carrying out day/night-time work in the field in a populated area
- Tide pole/GNSS watchers
- Working late in the processing office
- Working as silent hours watchkeepers and roundsmen

C32 Lone Working Policy & Procedure Continued

The associated risks could therefore be very different and differ by geographic area, time of day or night or year and, potentially, with the innate characteristics of the worker which must be taken into account if applicable. Separate policies and procedures may need to be put in place following the development of a comprehensive JHA for each operation.

If requirement for Lone Working is identified, it must be captured in the HIRA/HAZID. A comprehensive JHA must be conducted, and control measures put in place to mitigate the additional hazards or elevated risks involved.

Hazards and risk factors that particularly affect Lone Workers may include but are not limited to:

- New to the role and/or the operating environment
- Cultural dislocation
- The worker's innate characteristics
- Operating in an environment where English may not be (commonly) spoken
- Shortfalls in relevant skills, knowledge, and experience. Particularly:
  - An otherwise competent worker is used to working collaboratively in a team but struggles with hazard perception or making sound safety-critical decisions in isolation
  - Limited or no direct supervision to control, guide and help in uncertain situations
  - Appreciation, assessment, and management of Risk
  - In enabling workers to cope with unexpected situations including those involving violence, medical issues, natural disasters, equipment failure and other unforeseen logistic challenges
  - Shortfalls in appropriate PPE

C32 Lone Working Policy & Procedure Continued

- Shortfalls in appropriate equipment to allow the worker to routinely function without unnecessary additional stress
- Shortfalls in appropriate safety, emergency, and survival equipment to allow the worker to effectively manage an emergency situation
- Shortfalls in training preventing the worker from using provided equipment to best effect
- Poor field communications for routine and emergency communications and access to the EAP
- Fatigue management, stress and mental health or wellbeing
- Ability to effectively respond to first aid, medical or other incidents and emergencies
- A person's physical and medical suitability to work alone
- The workplace itself, for example if it is in a rural or isolated area
- Theft, violence, assault, extortion, and exposure to other criminal or inappropriate conduct

These will be highly specific to the individual, the operational environment and potentially the time of day or year. The simplest measure to eliminate many of the hazards associated with Lone Working may simply be to mobilise two members of staff for that activity. It should however be noted that, should one person in a two-person team be injured or incapacitated, an appreciable burden may fall directly onto the second person in the team, particularly in a Remote Area (C33) (ashore and/or afloat). For this reason, the considerations which apply to Lone Workers should also be actively considered when addressing the composition, training, experience, equipment and logistics and overall competency of any small field team; due consideration should be given to what would happen if an incident, sickness, injury, or unintentional separation resulted in a Lone Worker situation potentially exacerbated by an otherwise uninjured worker being constrained by provision of care to a casualty.

Comprehensive advice in respect of Lone Workers is available on the UK HSE website and in the guidance document Protecting Lone Workers.

C33 Remote Area Operations Policy & Procedure

For the purposes of this Specification, Remote Area Operations are those where survey operations are:

- Conducted at significant physical distance or practical transit or journey time from a port or other place of safety with ambulance and medical facilities equipped and staffed to at least UK standards
- Conducted in an area which cannot be reached by appropriately equipped Search and Rescue (SAR) units within realistic survival times in the prevailing circumstances and conditions
- Conducted in a region which is not provided with advanced emergency medical care facilities, equipped and staffed to at least UK standards

In general terms, if a casualty cannot be stabilised and provided with professional and appropriately equipped emergency medical assistance within 60 minutes, i.e. within 'the golden hour' following a Medical Treatment Incident (MTI), then a Remote Area Operation is taking place.

Remote Area Working, in common with Lone Working, is an activity which may significantly increase the potential impact of Hazards inherent in the activity being undertaken, i.e. of the Risk of harm. This is as a consequence of the fact that, in the event of an incident resulting in an MTI, advanced emergency medical care will not be quickly accessible; incidents that may be relatively easily resolved in less isolated or more developed areas can quickly become life threatening. This will be particularly significant in the event that both Remote Area Operations and Lone Working are undertaken concurrently.

The Contractor must have in place a Remote Area Working Policy and Procedure. The Remote Area Working Procedure must be tailored so as to be specific to the realities of the operational environment and the personnel undertaking the activity and detail the method by which workers in Remote Areas will be safely employed and supervised during the project. In practice the Remote Area Working Procedure may be included as part of the PEP, however it should be easily identifiable as a stand-alone section.

The hazards and elevated risk factors associated with Remote Area Operations should be specifically addressed in the HIRA/HAZID, the Remote Area JHA and other operational JHAs as appropriate, with appropriate Control Measures put in place to mitigate the additional risk.

Control Measures must include but not be limited to:

- Availability of all Safety Equipment specified in Sections C60, C62 and C63 (Safety Equipment – Manned Vessels; Safety Equipment – Manned Aircraft; and Safety Equipment – Remote Pilot Station respectively)
- In date for offshore medical (STCW or UKOOA):
  - Medical fitness assessments undertaken where known medical conditions may impact on working remotely
  - Pre-deployment dental check to minimise the potential for emergent problems in the field
  - Offering of appropriate vaccinations and prophylactics against endemic diseases

C33 Remote Area Operations Policy & Procedure Continued

- Comprehensive Emergency Response Plan which must include an Emergency Communications Plan, including emergency contact arrangements, that are fully understood both field team and those nominated in the plan
- Provision of:
  - Appropriate PPE for the prevailing conditions. This must include the environmental conditions and minimisation of exposure to harmful fauna and flora
  - Sunscreen and insect repellent
  - Suitable accommodation, shelter and facilities for maintenance of hygiene
  - Appropriate transportation
  - Appropriate communications equipment for routine voice and data communications and EAP access
  - Appropriate emergency communications equipment
  - Comprehensive medical, first aid and dental kit tailored to the size of the team, the efficacy of local EMT services and the proximity, (in distance and time), to the nearest emergency medical care facility
  - Food and water supply and the ability to procure clean water in an emergency
  - Appropriate cooking arrangements
  - Power supply for routine and emergency communications and survival
  - Survival equipment including food, water and essential supplies. These should be appropriate to the prevailing conditions and the length of time that the worker could reasonably be expected to remain self-sufficient in the event of a significant incident at the worksite
- Full assessment of the workers' competency to perform the required tasks in the prevailing circumstances and conditions. Training provided must be appropriate to the operational environment and the use of any additional equipment provided, including emergency and survival equipment

Additional Control Measures which should be considered, include the provision of an Offshore Paramedic/EMT (B17), a higher level of First Responder training for designated team members (B20) and additional medical and first aid equipment (C60, C62, C63) appropriate to that higher level of training.

Before personnel deploy to the field, their understanding of the Remote Area Working Policy and Procedure should be confirmed.

C34 Permit to Work Systems

Where proposed work is identified as having a high risk, and particularly if Simultaneous Operations (SIMOPS) are being carried out in adjacent areas, strict controls are required to ensure that the work is carried out against previously agreed safety procedures and deconflicted with adjacent activities. This may be managed using a Permit to Work (PTW) system. PTW Systems are management systems used to ensure that inherently hazardous work is conducted safely and efficiently. These involve procedures to request, review, authorise, document and most importantly, de-conflict tasks to be carried out onboard vessels and in port and harbour facilities within a specified time frame. PTW systems may also be used at airfields and onboard aircraft when undergoing maintenance on the ground.

The PTW is a documented procedure that authorises certain people to carry out specific work within a specified time frame. It sets out the precautions required to complete the work safely, based on a risk assessment. It describes what work will be done and how it will be done; the latter can be detailed in Safe Work Method Statement.

The permit-to-work requires declarations from the people authorising the work and carrying out the work. Where necessary it requires a declaration from those involved in shift handover procedures or extensions to the work. Finally, before equipment or machinery is put back into service, it will require a declaration from the permit originator that it is ready for normal use.

Typical dedicated PTWs are likely to apply to specific hazardous activities include but are not limited to:

- Working at Height (C37)
- Work in Confined Space (C38)
- Hot Work (C88)
- Work in the Water (C89)
- Diving Operations (C90)

Small vessels and aircraft are unlikely to maintain or in practice require their own PTW system. When conducting mobilisation/demobilisation activities or maintenance alongside in port or at an airfield respectively, they may however be required to participate in the PTW systems of other adjacent vessels or aircraft or in that of the surrounding infrastructure. Larger vessels, (and potentially larger aircraft in maintenance), will almost invariably run their own PTW system. Consideration should be given during the planning phase of the Project to determine whether project activities will be conducted under a formal PTW system in operation onboard the vessel or aircraft and/or be expected to interact with the PTW system of adjacent vessels, aircraft or authorities. If so, full details, including any training requirements, must be provided in the Project Execution Plan and the Mobilisation/Demobilisation Plan.

Where Contractor personnel will be expected to operate under a PTW regime, they must be trained and competent to take part in this regime at an appropriate level. This will typically be at the level of the Permit Holder, (i.e. the person undertaking the task), who will interact with the Permit Issuing Authority/Permit Issuer to ensure that they are authorised and safe to proceed with the task in the defined timeframe. If a member of the Survey Team is to be the Permit Issuer, for example in operations involving the operation of larger RPAS, appropriate training must be provided to allow him/her to safely perform that role.

Comprehensive advice in respect of Permit to Work Systems is available on the UK HSE website.

C35 Control of Substances Hazardous to Health (COSHH)

The UK Control of Substances Hazardous to Health (COSHH) Regulations 2002 must be followed, together with any local legislation applicable to the country in which operations are being conducted.

COSHH is a set of regulations put in place to protect workers from ill health when working with any form of Hazardous Substance including liquids, solids, fumes, dust, vapours, fibres, nanoparticles, mists, gasses and biological agents. The hazard includes damage to lungs, skin, nose, mouth, genes, internal organs, eyes or central nervous system, as well as risk of injury due to combustion or explosion.

Offshore survey activities, vessel and aircraft operations typically involve a wide range of Hazardous Substances including but not limited to oils, greases, solvents, resins, fuels and lithium batteries, exhaust fumes and cleaning products for both domestic and industrial use. These must be appropriately stored and handled and workers must be provided with information, training and equipment to mitigate risk and prevent injury. Workers must ensure that they follow the employer's policies and procedures and carry out tasks safely, ensuring that no harm comes to themselves or others.

The Contractor must have a Hazardous Substances Policy and Procedure which identifies Hazardous Substances in the workplace and sets out how the use of these will be safely managed. This must include but not be limited to:

- Employer Responsibilities:
  - All Hazardous Substances must be safely stored to prevent accidental exposure or release. Incompatible substances must not be stored together
  - Exposure to Hazardous Substances must be prevented or controlled. This includes the provision of appropriate personal protective equipment (PPE) and safety equipment where necessary
  - Control measures must be implemented around Hazardous Substances. These must be maintained and kept up to date, in full working order and clean where appropriate
  - Safety Data Sheets (SDS) must be provided for all Hazardous Substances
  - Workers must be provided with information, instruction and training when they are required to working with Hazardous Substances
  - Procedures must be in place to deal with accidents and emergencies relating to Hazardous Substances
  - Employees exposed to Hazardous Substances must be under adequate health surveillance to ensure that any negative effects of exposure are detected early
  - COSHH Risk Assessments must be carried out
  - The use of Hazardous Substances does not exceed the Workplace Exposure Limit (WEL)
  - Employees must be supervised to ensure that tasks are being performed in accordance with the Safe Work Method Statement (SWMS) and COSHH Risk Assessment

C35 Control of Substances Hazardous to Health (COSHH) Continued

- Employee Responsibilities:
  - All employees must work together to create a safe working environment. This can include supporting colleagues to abide by the regulations specific to their workplace
  - Procedures put in place to stop accidents and overexposure must be followed
  - The correct PPE must be worn. All PPE must be stored correctly, maintained in accordance with manufacturer's instructions and in good condition
  - All accidents, spillages and breakages must be reported
  - Medical check-ups must be attended as directed by the employer
  - Cleaning and showering facilities provided by employers must be used in line with employer policy and procedures
  - Training must be undertaken in accordance with employer policies and procedures

A Safety Data Sheet (SDS) must be readily available at the workplace for all Hazardous Substances Held. These should be held in a single, easily identifiable, and clearly marked (yellow) binder which must be held in a prominent location which is easily accessible in an emergency.

Where Hazardous Substances are held in significant quantities or in a location which presents a reasonably foreseeable Hazard or increased Risk, the Project, Vessel or Aircraft (as appropriate) Emergency Response Plan must contain a section which details how an incident, (including but not limited to firefighting, spillage/loss of containment), involving these substances is to be managed. A copy of this document must be included in the Safety Data Sheet binder.

Where a task involves the use of a Hazardous Substance, the SWMS (C72) must reflect the use of the Hazardous Substance and identify all the control measures to be put in place to mitigate the risk. Consideration should be given to whether the use of the substance inside a vessel, aircraft, vehicle, or structure makes the exposed area a Confined Space (C38) within the meaning of the term.

C36 Safety Equipment & Personal Protective Equipment (PPE)

The Contractor must provide its Employees, free of charge, any Safety Equipment and Personal Protective Equipment (PPE) required to safely complete a task. A regime must be in place to ensure that all appropriate Safety Equipment and PPE is identified, properly looked after and, if applicable, inspected, serviced, and replaced at the required interval.

The Contractor must ensure that its Sub-Contractors, (notably vessel marine crew), are provided with Safety Equipment and PPE which conforms to the same standards as that provided to its own staff.

Field Personnel are responsible for selecting and correctly wearing and using appropriate Safety Equipment and PPE provided for the task by the Contractor and for identifying any Safety Equipment and PPE which is not fit for purpose or requires servicing or replacing.

Project specific requirements for Safety Equipment and PPE will vary with a range of factors including but not limited to the nature of the survey operation, the climatic environment, the physical environment, the time of year/season, Natural Hazards prevalent in the area of operation, whether the area of operations is a Remote Area and whether Lone Working is envisaged. The requirements for project-specific Safety Equipment and PPE must be established early in the planning stages of the Project, through a rigorous HAZID/HIRA and JHA process which identifies reasonably foreseeable hazards and determines appropriate Safety Equipment and PPE which will assist in reducing the risk to ALARP.

All personnel must receive training in the correct selection and use of the supplied Safety Equipment and PPE.

Note: Experience has shown that the standard offshore PPE issued to the personnel of survey Contractors who normally operate in cold/temperate environments, (and with a focus on the Oil and Gas sector), is typically comprehensive, high quality and in a good state of repair. Unfortunately, much of it is poorly suited to hot/tropical operations in small vessels and often introduces more problems than it mitigates. If the operation is to take place in hot/tropical conditions, thorough consideration must be given to the way in which hazards express themselves under the prevailing conditions and the best PPE to protect against the hazard in that context. Further, the use of cold weather PPE under hot tropical conditions is often a significant disincentive for personnel to wear (uncomfortable and inappropriate) PPE when required, defeating the purpose of its supply. This is a failing in Duty of Care both on the part of the Contractor and the field staff.

The HAZID/HIRA and JHA process must thoroughly consider climatology/'the weather' and how high temperature, humidity, UV (and potentially rainfall) affects the task, the hazards and therefore the Safety Equipment and PPE which is provided. If project personnel involved in the Risk Assessment process lack the experience of operating in hot/tropical environments and/or of what hot weather PPE and Equipment may be commercially available and appropriate, specialist advice should be sought at an early stage.

C37 Work At Height

Falls from height are one of the biggest causes of workplace fatalities and major injuries. Work at Height means work in any place where, if there were no precautions in place, a person could fall a distance liable to cause personal injury.

Common causes of falls from height in the offshore survey industry are:

- Falls from ladders
- Falls from unprotected bridge roofs and platforms
- Falls into compartments when lids and hatches are removed or left open and unguarded
- Falls from the structure of a vessel when it is on a road trailer
- Falls from the outside of the aircraft airframe when conducting maintenance and inspection

C37 Work At Height Continued

All work conducted at height must be conducted safely and in accordance with the UK Work at Height Regulations 2005.

Contractor must ensure that:

- A Working at Height policy and procedure is in place
- Work at height is avoided where it is reasonably practicable to do so
- All personnel who may be required to work at heights are trained and have appropriate skills, knowledge and experience to ensure that they can safely plan and conduct the operation at height
- All personnel who may be required to work at heights are aware of common additional hazards unique to the vessel environment, e.g. radio transmitters, rotating antenna, noise hazards (sirens and engine) and exhaust fumes and of the requirement for appropriate Lock-out-tag-out isolations to be made
- Appropriate PPE, Collective and Personal fall prevention/arrest, and other safety equipment appropriate to the operation is supplied and used correctly
- Appropriate Collective and Personal fall prevention measures are identified and implemented
- Appropriate measures are in place to prevent dropped objects
- Appropriate measures are in place to minimise the risk to others working below
- A workable Rescue Plan is in place and appropriately communicated prior to the commencement of work
- Appropriate rescue equipment is available at the worksite, as determined by the Rescue Plan
- Sufficient personnel are appropriately trained to participate in the execution of the rescue plan if required
- In vessels and aircraft with a Permit to Work system, the activity is compliant with that system, including the issue of a 'Work at Height' or 'Person Aloft' Permit as required

Where applicable, this training must meet the legislative requirements of the country in which the operation is being undertaken. If no such legislative requirements exist, (or if the local legislative requirement falls below the equivalent UK standard), this training should be of a standard meeting or exceeding equivalent UK legal requirements. Evidence of training and competency may be requested by the Authority.

Comprehensive advice in respect of regulations and requirements applicable to lifting operations is available on the UK HSE website.

C38 Work in Confined Space

A Confined Space is a place which is substantially (though not always entirely) enclosed, and where serious injury or death can occur from exposure to Hazardous Substances (C35) or conditions within the space or nearby. Hazards and conditions, which are present or reasonably foreseeable, include flammable substances and oxygen enrichment, excessive heat, toxic gas, fume or vapour, oxygen deficiency, the ingress or presence of liquids and free flowing solids.

Confined Spaces are typically, but not exclusively, ones which are not routinely occupied by personnel and fundamentally may not be designed with personnel access and occupancy in mind.

Common Confined Spaces encountered in the offshore survey industry may include but are not limited to:

- Any compartment formally designated as a Confined Space
- Bilges
- Void spaces
- Water tanks
- Cable lockers
- Unmanned engine and machinery spaces
- Steering gear compartment
- Battery charging compartment
- Any other space on an unmanned vehicle or aircraft to which access or egress is physically restricted or which is not intended for routine access by a person

It must be appreciated that the inside of the normally occupied structure, (including vessel compartments and aircraft fuselage and rooms in buildings), may become a Confined Space if an activity is being conducted or condition occurs which changes the usual working conditions experienced inside a space which is routinely occupied under normal working conditions. For example:

- Soldering, welding or the use of solvents and chemicals inside the wheelhouse of a small vessel could change the area into a Confined Space for the duration of the task
- Vessel motion increases due to the prevailing environmental conditions such that a space which is normally relatively benign and easily entered, (e.g. a fo'c'sle locker), becomes inherently hazardous due to motion and shifting contents
- In hot climates the environment inside a light aircraft may become dangerously hot whilst the aircraft is shut down on the apron. The greatly increased risk of heat injury in this environment could change the inside of the aircraft into a Confined Space for the duration of the task (and would in any case constitute a hazard which should be specifically identified and mitigated)

C38 Work in Confined Space Continued

All work conducted in Confined Spaces, including any work inside a vessel or aircraft which may change the normal conditions and make the area a Confined Space for the purposes of the definition, must be in accordance with the UK Confined Space Regulations 1997.

Contractor must ensure that:

- A Work in Confined Space Policy and Procedure is in place
- Entry into Confined Spaces is avoided where it is reasonably practicable to do so
- All project personnel are trained to recognise what constitutes a Confined Space and the requirement not to enter it until appropriate risk control measures have been put in place
- All personnel who may be required to work in a Confined Space are trained and have appropriate skills, knowledge, and experience to ensure that they can safely plan and conduct the operation in a Confined Space
- Where the task is also a Work at Heights task, all personnel must also be trained to safely undertake that task and have skills, knowledge, and experience to ensure that they can safely plan and conduct the operation combining a Confined Space with Work at Height
- A comprehensive SWMS is in place for the task
- Appropriate PPE and other safety equipment appropriate to the operation is supplied. This should include appropriate Work at Height/fall arrest equipment if the task also involves this hazard
- Calibrated gas testing equipment is available to ensure safe oxygen levels and the absence of hazardous/explosive gases
- A workable Rescue Plan is in place and appropriately communicated prior to the commencement of work
- A 'Stand By' supervisor is present outside of the Confined Space at all times and that they are aware of how to initiate the Rescue Plan if required. The Standby must never enter the Confined Space
- Sufficient personnel are appropriately trained to participate in the execution of the rescue plan if required
- In vessels with a Permit to Work system, the activity is compliant with that system, including the issue of Confined Space Entry Permits and Gas-Free Certificates

C38 Work in Confined Space Continued

is being undertaken. If no such legislative requirements exist, (or if the local legislative requirement falls below the equivalent UK standard), this training should be of a standard meeting or exceeding equivalent UK legal requirements. Evidence of training and competency may be requested by the Authority.

If there is a requirement to enter a Confined Space for the purposes of installation or inspection of survey equipment, it would be usual for the activity to be conducted alongside and for the space to be made safe by adequate ventilation and gas testing prior to entry. Exceptionally, typically in the case of larger survey vessels at sea, there may be a requirement to wear Breathing Apparatus (BA) in order to ensure the safety of personnel entering the space if adequate ventilation cannot be achieved. If this is the case, then only personnel trained and competent in the use of BA are to conduct the task. If this is a reasonably foreseeable scenario given the vessel design and the disposition of survey equipment, designated members of the Survey Team should be trained. Alternatively, appropriately trained members of the Marine Crew may be delegated the task, subject to their technical ability to successfully work on the survey equipment.

Comprehensive advice in respect of regulations and requirements applicable to working in Confined Spaces is available on the UK HSE website.

C39 Atmospheric Testing

Where there is a requirement to enter a Confined Space (C38) *which is not ventilated under normal operating conditions*, Atmospheric Testing must be conducted to ensure that the environment inside the space is safe to enter. This is in respect of flammable substances and oxygen enrichment, toxic gas, fume or vapour and oxygen deficiency.

If this requirement exists, Contractor must ensure that:

- A Work in Confined Space policy and procedure is in place
- A Safe Work Method Statement is produced describing the procedure to be followed
- A JHA is produced describing the hazards and control measures to be put in place to reduce the risk to an acceptable level
- In vessels with a Permit to Work system, the activity is compliant with that system, including the issue of Confined Space Entry Permits and Gas-Free Certificates
- Appropriate hand-held gas testing equipment is available which is in date for calibration
- The person conducting the Atmospheric Testing is trained and competent

The results of the Atmospheric Testing are recorded on the JHA and on the Gas-Free Certificate if applicable.

C40 Communicable Diseases

A Communicable Disease is any disease that passes between people (or animals). Pathogens, including bacteria, viruses, fungi and protists cause communicable disease. A person may develop a Communicable Disease after becoming infected with the pathogen. This may happen through:

- Direct contact with a person or animal carrying the pathogen
- Contact with contaminated fluids such as blood, mucus, or saliva
- Inhaling contaminated droplets from another person's cough or sneeze
- Receiving a bite from an animal or insect carrying the pathogen
- Consuming contaminated water or foods

The project HAZID/HIRA, relevant JHA/JSAs and the Health, Safety & Environment Management Plan must identify all significant Communicable Diseases endemic to or pandemic in the area of operation or to areas through which personnel will travel during mobilisation and which present a notable hazard to the health of personnel. This must include reference to the UK NHS fitfortravel and Travel Health Pro online resources, together with any equivalent resources offered by the country in which operations are to be conducted. If required, early health advice should also be sought from a competent medical authority specialising in travel medicine.

Appropriate measures, following the Hierarchy of Controls, must be put in place to mitigate the hazard to Project personnel to ALARP.

All Contractor personnel must be offered vaccinations and prophylactics for infectious diseases endemic to or pandemic in the area of operation or to areas through which personnel will travel during mobilisation. These should be provided sufficiently in advance of operations as to allow for a course of vaccinations and to confer maximum immunity. When operating in malarial areas, all Contractor personnel are to be offered an appropriate Antimalarial prophylaxis for the area of operations.

Where infectious diseases are endemic to or pandemic in the area of operation or to areas which personnel will travel during mobilisation, to which there is no available vaccination or prophylactics, personnel must be briefed on the hazard, together with the recommended measures which should be implemented to reduce the hazard to ALARP.

Appropriate measures must be implemented to minimise the exposure of staff to biting insects. This includes the use of appropriate PPE and Safety Equipment including but not limited to long sleeved clothing, mosquito nets and insect repellent sprays and devices. Wherever possible, project buildings and vessels should be fitted with doors and 'bug' screens which preclude the entry of insects, with air conditioning used to maintain an environment which is not conducive to mosquitos. Personnel must be trained to recognise the hazard presented by biting insects at the relevant times of day and to take appropriate precautions to avoid being bitten.

C40 Communicable Diseases Continued

Where waterborne Communicable Diseases are prevalent, (both during normal conditions and in the event of natural disaster), appropriate measures must be put in place to minimise exposure to this hazard. This may include the use of appropriate water purification equipment and techniques.

It is a condition of entry for many countries that the traveller is vaccinated against specified diseases, (e.g. Yellow Fever), and carries an international vaccination certificate to this effect. Whilst it is an individual's choice as to whether or not they will have this vaccination, a decision not to have it may ultimately render him/her unable to participate in a project which requires travel to or through a country requiring a vaccination certificate.

Statistical evidence of the number of personnel offered vaccinations and prophylactics, together with the uptake/refusal rate, are to be provided to the Authority upon request.

C41 Natural Hazards

The Project ERP must identify Natural Hazards prevalent in the area of operations, together with measures to be put in place to mitigate the risk. Natural Hazards may be inherent, unpredictable and occur at very short or no notice, e.g. Earthquake, Tsunami, Volcano, Fire, Landslide, or may be associated with some degree of warning and be seasonal or linked to other foreseeable indicative events, e.g. Hurricane, Tropical Storm, Storm Surge or Civil Unrest.

The HAZID/HIRA and JHA process must thoroughly consider the Likelihood of these events and the Consequence of exposure of project personnel to Natural Hazards and their aftermath. In Risk Matrix terms these events would typically be assessed to range in Likelihood between Unlikely and Likely, carrying with them a Consequence of Major or Catastrophic. Depending upon the nature of the project and the time of year, Tropical Storm or Hurricane could potentially be assessed as having a Likelihood of Certain. In reality however, extreme weather events are the only Natural Hazard which may potentially be mitigated by the prior evacuation of personnel and, even then, only if forecasting is reliable and flights available. (Or alternatively if the vessel/aircraft has the size and endurance to evacuate the area with project personnel embarked). The HAZID/HIRA/JHA process must therefore identify relevant procedures which should be established and individual and collective training and Safety Equipment with which the team should be provided, to enable them to best deal with the foreseeable conditions during and in the immediate aftermath of such an event.

Note: Experience has shown that Natural Hazards, (particularly Hurricane and Tropical Storm), are mentioned in the Project and Vessel ERPs. They are however subsequently substantially disregarded in terms of the practical provision of relevant procedures, equipment, and training. This is generally through a fundamental assumption that personnel will be able to evacuate by air prior to a foreseeable event or be quickly extracted, safe and well, in the immediate aftermath of an unforeseeable one. The assumption that personnel will be able to be expeditiously evacuated before or extracted after a natural disaster is however flawed. Procedural, Safety and Emergency Equipment, PPE and training provision must therefore be made for the inevitable consequences of Natural Hazards on local infrastructure, society, and project personnel.

C42 Medicine Chest

Where Vessels, Aircraft, RPAS or detached field personnel are working in a Remote Location, or a location with limited local medical services, a requirement for a 'Medicine Chest', containing Prescription Medicines (potentially including controlled drugs), may be suggested by the HIRA/HAZID or activity specific JHA. This will most commonly apply to live-aboard survey vessels and to RPAS operations where a mobile RPAS crew is deployed to a Remote Location where there is little prospect of outside assistance or supply of appropriate prescription medicines in a useful timeframe. It could however also apply to manned aircraft operating from a small austere airfield.

Guidance as to the content of the Medicine Chest should be sought from an appropriate medical authority, together with the ancillary equipment, level of training and degree of remote supervision (by a Clinician) required for project personnel to administer the drugs included in the kit. These factors must be addressed in the project HSEMP. If remote supervision is required, the project ERP must address the method by which this will be achieved in an emergency.

For vessels, it would be anticipated that the contents of the kit would generally conform to the 'Doctor's Bag' as detailed in Annex 2 to MCA MSN 1768 (M+F) – Ship's Medical Stores. Further guidance is offered by the World Health Organisation's International Medical Guide for Ships. In larger vessels there will typically be a Class and/or STCW requirement for the vessel Master, (at a minimum), to have training in administration of controlled drugs, typically subject to a remote consultation with a doctor. Where this is the case, evidence of appropriate training and a robust communications plan is to be provided to the Authority. Where this is not the case, the Contractor is to indicate in the Health and Safety Management Plan the intention for provision of suitable training to designated key individuals (B20) or the inclusion of an industrial paramedic or EMT on the team (B17).

In the context of remote RPAS operations it is anticipated that the provision of controlled drugs would either be by the inclusion of an industrial paramedic or EMT on the team (B17), and/or by provision of appropriate training to an experienced first aider, enabling him to select and administer controlled drugs under remote supervision by a doctor (B20). In the latter case, evidence of appropriate training and a robust communications plan is to be provided to the Authority. The Contractor is to indicate in the Health and Safety Management Plan the intention for provision of suitable training to designated key individuals.

Early advice must be sought from the customs authorities of the country in which operations are being conducted as to the procedure to be followed to allow for the legal importation of the medicines held in the Medicine Chest and to complete the required documentation and certification.

All Prescription Medicines (including controlled drugs) must be securely stored and accounted for. This must meet the legislative requirements of both the UK and the country in which operations are being conducted.

C43 Personal Medical Kit

Where small teams or Lone Workers are working in a Remote Location, or a location with limited local medical services, a requirement for a 'Medicine Chest', (C42) containing Prescription Medicines (potentially including controlled drugs), may be suggested by the HIRA/HAZID or activity specific SWMS. In practice however it is likely that a Medicine Chest would be impractical given the size of the team and, potentially, logistical reality.

In this event advice should be sought from a medical authority specialising in expedition medicine; a small range of appropriate medications may be supplied, on prescription to the individual traveller, together with advice on the signs and symptoms which indicate when they should be self-administered in the field.

The HIRA/HAZID or activity specific SWMS may also suggest that a Sterile Kit be supplied to the individual worker. This typically contains a small injection kit, cannulas and IV equipment for use by medical professionals in an emergency and where sterile equipment is either in short supply or contaminated by reuse.

C44 Employee Assistance Programme

The Contractor must offer a confidential Employee Assistance Programme (EAP) to all employees. Communications from the field should be sufficiently robust that this service can in practice be accessed if required.

C45 Accommodation

The Contractor is to pass the details of the field accommodation to the Authority as soon as they are known.

Where the survey team is based ashore, to maximise physical security and minimise logistical and communications complications, the Client Representative will seek to base himself in the same hotel accommodation as the Contractor survey team.

Where the intention is to use rental accommodation, the address of the accommodation should be passed to the Authority as soon as it is known, so that the Client Representative can seek hotel accommodation nearby.

Where the survey team and Client Representative are accommodated onboard the survey vessel, the Client Representative is to be supplied with a cabin of at least the same grade as the Contractor's Party Chief. If fitted, the cabin is to have a desk and chair compliant with paragraph (B24), with adequate provision for mains power. On larger vessels, appropriately configured desk space is additionally to be provided for the Client Representative near to the online survey desk.

Where the vessel or RPAS ground station is fitted with satellite data and/or voice communications for use by the Contractor's staff, the Client Representative is to have routine voice and data access to the communications for business use.

C46 Working Language

The working language onboard all Vessels and Aircraft, and for all reporting, is to be English.

C47 Vessel Suitability as a Workboat

Any small (up to 24m) vessel, or 'workboats' used on the project must, as a minimum standard, fully comply with applicable SOLAS requirements. They must also comply with the requirements of the current edition of the UK Maritime & Coastguard Agency (MCA) publication *The Workboat Code and the Industry Working Group Technical Standard*.

When undertaking work in UK waters, the vessel must additionally be in date for MCA Survey and Inspection.

Where this Survey Specification mandates a higher standard than contained in *The Workboat Code or the Technical Standards*, the provisions of this Specification must be adhered to.

Notwithstanding the above, a vessel which does not meet these minimum standards *may, at the sole discretion of the Authority,* be approved prior to award of contract for use on UKHO projects outside of UK waters. If this is the case, Contractor must identify, as part of the tender submission, the specific shortcomings of the proposed vessel relative to SOLAS requirements, The *Workboat Code* and this Survey Specification together with the measures that will be put in place to mitigate against any resulting hazards or increased risk.

For safety reasons, vessels with two independent propulsion systems are preferred.

C48 Large Vessel Suitability

Any large (greater than 24m) vessel used on the project must, as a minimum standard, fully comply with applicable SOLAS requirements. They must be in an appropriate Class as defined by a Recognised Classification Society and must be in date for the Inspection and Survey regime required to comply with this certification. They must hold the required in-date certificates and safety equipment as required for their Class, the voyage that they will undertake and, in the case of manned vessels, the number of persons onboard.

If a large (manned) vessel is to be used which is in a Class which does not routinely carry passengers, (e.g. a fishing vessel used as a vessel of opportunity), the vessel must additionally fully comply with the requirements of the Passenger Ship Safety Certificate issued by their Recognised Classification Society, appropriate to the vessel size, the voyage that it will undertake, and the number of persons onboard. It need not however specifically hold this certificate.

When undertaking work in UK waters, the vessel must additionally be in date for MCA Survey and Inspection.

Where this Survey Specification mandates a higher standard than mandated by Class requirements, the provisions of this Specification must be adhered to.

Notwithstanding the above, a vessel which does not meet these minimum standards may, at the sole discretion of the Authority, be approved prior to award of contract for use on UKHO projects outside of UK waters. If this is the case, Contractor must identify, as part of the tender submission, the specific shortcomings of the proposed vessel relative to SOLAS requirements, Class requirements and this Survey Specification together with the measures that will be put in place to mitigate against any resulting hazards or increased risk.

For safety reasons, vessels with two independent propulsion systems are preferred.

C49 Vessel & Vehicle Suitability as a Survey Platform

All vessels and vehicles used for surveying must:

- In the case of small vessels (under 24m), comply with Paragraph C47 of this Specification
- In the case of large vessels (greater than 24m), comply with Paragraph C48 of this Specification
- Meet all relevant requirements detailed in Section C, HSEQ
- Unless otherwise approved by the Authority, comply with all other aspects of this Survey Specification
- When operating in UK waters be in date for MCA Survey and Inspection
- Be of appropriate size and draught for surveying to the bathymetric contour specified in the HI
- Be of appropriate size and manoeuvrability for surveying around obstructions and navigational aids in the prevailing depth of water
- Be sufficiently directionally stable in a straight line at low speed so as to permit effective line-keeping without excessive holidays in the data/requirement for infill lines
- Be sufficiently dynamically stable to allow swath bathymetry survey operations and, if specified, lidar survey operations to be successfully conducted in the conditions typically prevailing on site at the time of year and during the proposed working hours and given the required survey equipment operating parameters
- Have appropriate enclosed superstructure and/or equipment housings to protect equipment from the effects of adverse exposure to the elements
- Have appropriate and reliable power to supply survey equipment

C49 Vessel & Vehicle Suitability as a Survey Platform Continued

Additionally, any manned vessels are to:

- Be sufficiently stable in respect of both crew welfare and fatigue
- Have appropriate enclosed superstructure to provide shelter to personnel from the adverse effects of exposure to the elements
- Meet or exceed minimum ergonomic and lighting standards for all exposed personnel, notably the seating and workstation arrangement for the helmsman, online surveyor (and data processor if embarked)

In small vessels where the proposed vessel does not have inbuilt heads, galley facilities and seating arrangements, the Contractor must detail:

- Intentions for provision of toilet facilities
- Intentions for provision of hot and cold food and drink
- Intentions for maintenance of personal hygiene, notably hand hygiene
- Intentions for allowing embarked personnel to take regular rest breaks

For safety reasons, vessels with two independent propulsion systems are preferred.

C50 Vessel Inspections

All vessels employed in the survey must be compliant with Paragraphs C47, C48 and C49 of this Specification and with relevant SOLAS regulations for their size, class, the voyage that they will undertake and, in the case of manned vessels, the number of persons onboard.

All vessels must be in date for Survey and Inspection by the relevant authority of the Flag State in which the vessel is registered.

When operating in UK waters, all vessels must additionally be in date for MCA Survey and Inspection. Outside of UK waters, all vessels must be inspected and approved in accordance with the local legislation of the coastal state in which the survey is being undertaken.

Evidence of inspections and approvals may be requested by the Authority or its nominated representatives at any time. The cost of any inspection and any subsequent actions required by the coastal state and any re-inspection must be borne by the Contractor.

C51 Vessel Audit

All (manned) vessels proposed for use in the project, including any to be used as floating accommodation, must be subject to a full Vessel Audit to confirm their suitability and identify any potential shortcomings. In the case of charter vessels not previously used by the Contractor, this should be sufficiently in advance of mobilisation that emergent defects and shortcomings can be rectified without impacting on Project timelines or an alternative vessel selected.

The Contractor may use their own Vessel Audit form for this purpose with the checks carried out by the Contractor's staff or suitably qualified local nominee.

Whilst not intended to be prescriptive, all manned vessels proposed for use in the HI would, in addition to the specific requirements outlined in this Survey Specification, be expected to meet the minimum standards suggested in IMCA's "Marine Inspection for Small Workboats" (Common Marine Inspection Document for Small Workboats)" and, where appropriate to larger vessels, the IMCA "Common Marine Inspection Document".

Appropriate documentary evidence may be requested by the Authority that a Vessel Audit has been conducted and these minimum standards met.

C52 Vessel Coding and Approval

Each vessel tasked with surveying must be subject to approval by the Authority prior to survey work commencing under the relevant HI. Any vessel to be used solely as overnight accommodation must be subject to approval by the Authority prior to the embarkation of Project personnel.

All vessels (and crew) must comply with the relevant MCA codes of practice or relevant Merchant Shipping Legislation as applicable. The Authority will have the final say as to which legislation is appropriate.

The Contractor must provide proof that the required codes and inspections for all vessels used for the purposes of this contract are in place.

Autonomous vehicles are to be fully compliant with any UK, international and local legislation that may be in place at time of operation, whichever is the more stringent. Certification demonstrating compliance may be requested at any time by the Authority.

C53 Vessel Flag

It is not a requirement that a flagged vessel is used for survey operations. However, if a flagged vessel is used, vessels registered with a Flag State on the International Chamber of shipping Black or Grey Lists* will not be accepted for any work in relation to the Project.

* Paris MoU, Tokyo MoU & USCG target list (Safety).

C54 Vessel Commitment

Once a Vessel Audit has been conducted and the Vessel approved for use on the Project, the Contractor should seek the Authorities prior agreement to remove or replace the vessel with another.

The Authority will only approve a vessel replacement if the oncoming vessel is an appropriate like-for-like exchange and continues to abide by the requirements of the HI, Survey Specification, and tender bid.

C55 Aircraft Registration, Inspection and Approval

Each Aircraft and RPAS tasked with surveying must be subject to approval by the Authority prior to survey work commencing under the relevant HI.

Aircraft Registration and Air Worthiness Certificates for manned Aircraft are to be provided to the Authority prior to work commencing.

Where RPAS are to be used on the project, appropriate certification is to be provided to the Authority prior to work commencing. In practice this certification will be determined by the requirements of the Commercial Aviation Authority under whose jurisdiction the system is registered, (if required), and under whose jurisdiction the Pilot is registered and qualified. There may also be additional requirements imposed by the State in whose airspace the system will fly. In practice the Authority requires Contractor to demonstrate that all relevant authorities have been engaged with to ensure that the required Registration, Inspection and Approvals are in place prior to the commercial employment of the Aircraft. If there is any doubt, particularly if local standards do not exist, then the UK Civil Aviation Authority's document CAP 722, "Unmanned Aircraft System Operations in UK Airspace – Guidance" must be followed.

All Aircraft, including RPAS, are to be fully inspected as required by local CAA legislation. If no such legislation exists, ICAO guidelines and UK CAA guidelines are to be used for manned Aircraft and RPAS respectively. The cost of any inspection and any subsequent actions required by the local CAA and any re-inspection must be borne by the Contractor.

Evidence of inspections and approvals may be requested by the Authority or its nominated representatives at any time.

Aircraft, (including RPAS), are to be fully compliant with any international and local legislation that may be in place at time of operation. Certification demonstrating compliance may be requested at any time by the Authority or its representative.

C56 Aircraft Operator

Aircraft from Carriers on the EU Air Safety List (https://ec.europa.eu/transport/modes/air/safety/air-ban_en), or any similar list operated by the nation state in whose airspace the aircraft will operate, will not be accepted for any work in relation to this contract.

C57 Aircraft Suitability

All Aircraft used for surveying must:

- Meet all relevant requirements detailed in Section C, HSEQ
- Be of appropriate size and with sufficient endurance for surveying the area specified in the HI
- Be sufficiently directionally stable in a straight line at low speed so as to permit effective line-keeping without excessive holidays in the data or requirement for infill lines
- Have appropriate and reliable power to supply survey equipment

Additionally, any manned Aircraft are to:

- Have characteristics which do not adversely impact crew welfare or induce excessive fatigue. For example, excessive noise, temperature and vibration or inadequate space for the comfort of personnel once survey equipment has been installed
- Meet or exceed minimum ergonomic and lighting standards for all exposed personnel, notably the seating and workstation arrangement for the Pilot, Survey Equipment Operator, and other flight crew

Where the proposed Aircraft does not have inbuilt heads and galley facilities (i.e. the majority of light Aircraft), the Contractor must detail:

- Intentions for provision of toilet facilities
- Intentions for provision of hot and cold food and drink
- Intentions for maintenance of personal hygiene, notably hand hygiene
- Intentions for allowing embarked personnel to take regular rest breaks

For safety reasons, multiple-engine Aircraft are preferred, particularly in the case of manned Aircraft and large RPAS (i.e. those weighing more than 20kg), however, it is understood that availability, and operating parameters might preclude this. In all cases the choose of aircraft is to be discussed in the tender and be included in the HIRA/HAZID and Project ERD.

C58 Air Coordination and Safety

The Captain of the Aircraft/RPAS Remote Pilot is responsible for the safety of the Aircraft and, in manned Aircraft, of the crew. If, during survey operations, the Captain of the Aircraft/RPAS Remote Pilot considers that there is a conflict of interest between the safety of the Aircraft and crew with regard to operating in the proposed survey areas, he has the overriding authority to refuse to survey those areas.

The Authority is to be notified at the earliest opportunity in the event of such an occurrence so that the practical impact on overall data collection and coverage can be assessed.

C59 Aircraft Commitment

Once an Aircraft, (including RPAS), has been approved for survey, the Contractor must seek the Authority's prior agreement to remove or replace the Aircraft with another. The Authority will only approve an Aircraft replacement if the oncoming Aircraft is an appropriate like-for-like exchange and continues to abide by the requirements of the HI, Survey Specification, and tender bid (and RPAS OSC).

C60 Safety Equipment – Manned Vessels

Any manned vessel employed on the Project must carry safety equipment as required by paragraphs C47, C48 and C49.

Notwithstanding the above, where The Workboat Code or Class requirements specify a less stringent requirement, (notably in very small RIBs and Dory type vessels), the following equipment is the minimum standard which must apply:

- A Marine VHF Radio:
  - The radio must include Digital Selective Calling (DSC) and include inbuilt or networked GNSS to complement the feature. The radio must be programmed with the vessel's Maritime Mobile Service Identity (MMSI)
  - The radio (and networked GNSS if applicable) must be hard-wired into a power supply backed up by batteries; a loss of electrical generation capacity must not immediately result in the loss of emergency radio communications
  - A waterproof 'cheat sheet' should be secured immediately adjacent to the radio describing, in layman's terms, how to configure the radio to make a Distress or Urgency call and include a script to ensure that the correct information is conveyed
- A stand-alone GNSS:
  - The GNSS must be hard-wired into a power supply backed up by batteries, such that a loss of electrical generation capacity does not immediately result in the loss of the ability to read the vessel's GNSS position
  - The GNSS display must be illuminated and be positioned such that it can be easily read from the operating position of the Marine VHF Radio
- Flares compliant with the Marine Equipment Directive (Marine Directive 96/98/EC) or local equivalent
- Hand-held Marine VHF Radio. At least one hand-held marine VHF radio must be designated for emergency use and not used for any other purpose. It should be stored, together with a spare fully charged battery, in a separate location to the vessel's hard-wired marine VHF radio. This location should be one which is unlikely to be immediately denied in the event of an emergency
  - The radio must be inherently waterproof or, less preferably, be enclosed in a waterproof sleeve. If the latter approach is adopted, all features of the radio must be accessible without the need to remove it from the sleeve
  - The radio must be buoyant or, less preferably, be enclosed in a buoyant sleeve
  - The radio must include Digital Selective Calling (DSC) and include inbuilt GNSS to complement the feature. The radio must be programmed with its own unique Maritime Mobile Service Identity (MMSI) issued by a licensing authority

C60 Safety Equipment – Manned Vessels Continued

- The radio must be provided with at least one spare battery for emergency use which must be kept with the radio at all time
- A waterproof 'cheat sheet' should be secured immediately adjacent to the radio describing, in layman's terms, how to configure the radio to make a Distress or Urgency call and include a script to ensure that the correct information is conveyed

- A 406 MHz Emergency Position Indicating Radio Beacon (EPIRB). In larger vessels and liveaboards this should be stowed in an upper deck housing with an in-date hydrostatic release. In smaller vessels without an enclosed structure, it may be appropriate to stow the EPIRB in a grab bag, containing other emergency equipment, which is stowed in a location easily accessible in an emergency
- A Search and Rescue Transponder (SART)
- Emergency waterproof torch and spare batteries
- First Aid Kit. The contents of the kit should be appropriate to the size of the vessel, number of crew and distance of the survey area from the source of professional medical assistance identified in the ERP. The contents of the kit should include but not be limited to:
  - Items as detailed in MCA MSN 1768 (M+F)
  - Eye wash
  - Equipment suitable for controlling a major bleed, e.g. compression 'Israeli' type dressings, tourniquets and haemostatic dressings
  - 'SAM splints' or similar
  - Vinegar, (tropical jellyfish envenomation), heat-packs and cold-packs
- Automated External Defibrillator (AED). All project personnel are to be trained in its use
- One adult life jacket (Compliant with ISO12402-3, ISO12402-2 or equivalent) for each individual working on the vessel. The Contractor must supply an additional adult life jacket for each of the Client Representatives embarked. In larger vessels it may be appropriate to have additional lifejackets, specifically designated for emergency use, to be stored in a float-free stowage in an accessible location at the designated Muster Station(s). Lifejackets should be fitted with a spray hood, automatic light, whistle, retro-reflective tape, lifting strop and a means of securing survivors together
- One correctly fitted Immersion Suit for each individual working on the vessel. In larger vessels it may be appropriate to have additional Immersion Suits stored in a float-free stowage in an accessible location at the designated Muster Station(s). The Immersion Suits must comply with Sections 2.3, 2.4 and 2.5 of the IMO Life-Saving Appliances (LSA) Code and should be sized appropriately for the people onboard the vessel

C60 Safety Equipment – Manned Vessels Continued

- The requirement to carry Immersion Suits may however, with the prior approval of the Authority, be waived for vessels operating in "warm climates". This includes survey areas between the parallels of latitude 30° North and 30° South, the sea area of the Mediterranean Sea south of latitude 35° North and the sea area within 20nm from the coasts of Africa not included in the sea area above. Time of year and whether the vessel will operate in Remote Areas or at night, will be amongst those factors also considered
- As detailed at Paragraph C91, an effective means of recovering a Man Overboard:
  - A SOLAS compliant life raft appropriate to the vessel and crew. The life raft should be stowed in such a position that it can be easily and quickly launched on either side of the vessel. In survey launches it should typically be stowed in a cradle on the coach-house roof and secured with a hydrostatic release which is in-date for test. In smaller boats, a valise-type device may be appropriate, stowed where best accessible in an emergency, but ideally on the weather deck. In larger vessels two such life rafts may be appropriate such they can be easily deployed on either or both sides of the vessel or from forward and aft muster stations as best suits vessel design
  - Two x 30 inch SOLAS compliant Lifebuoys with at least 18m of 9.5mm buoyant line. Where night operations are to be conducted and on liveaboard vessels, these must be fitted with an appropriate light which illuminates automatically when the lifebuoy is deployed. In open boats (i.e. dory type vessels) this may be reduced to 1 x 24 inch SOLAS compliant Lifebuoy. Lifebuoys should be clearly marked with the vessel's name and one other means of identification, e.g. home port or registration/IMO number
  - Buoyant Heaving Line in rescue throw bag
- Portable firefighting equipment appropriate to the vessel in use and the hazards identified, including the additional concentration of survey equipment. Experience has shown that vessels of all sizes are typically provided to UKHO projects with the bare minimum of handheld firefighting appliances, which may not be logically distributed throughout the vessel or be easily accessible in an emergency. This is particularly true of CO_2 extinguishers and fire blankets which should be available in the immediate vicinity of the survey spread (which would not normally be embarked and is therefore invariably not adequately catered for in the vessel's standard fit of firefighting equipment)
- Portable firefighting equipment must be the subject of a thorough risk assessment which should identify the requirement for additional extinguishers of a type appropriate to operations and the additional equipment in use
- Fixed firefighting equipment appropriate to the vessel in use and the survey equipment embarked. Where the vessel is fitted with an enclosed machinery space (or spaces) it must be fitted with an appropriate remotely or automatically operated fire extinguishing system. Where the system is actuated remotely and the machinery space is accessible to personnel whilst the vessel is underway, the space protected should be fitted with an audible and visual warning system which sounds when the control cabinet is opened and before the system is discharged
- In larger vessels where there are dedicated laundry and galley compartments and compartments, lockers or stowages containing hazardous or flammable stores, it may also be appropriate for these compartments, lockers or stowages to be fitted with fixed firefighting equipment and, if applicable, ventilation dampers

C60 Safety Equipment – Manned Vessels Continued

- Efficient fire detectors must be fitted in the machinery space(s), galley area, laundry and any spaces containing heaters or open flame devices, areas of concentrated electrical equipment (including survey equipment and battery charging area), all cabins/overnight accommodation, and other areas at risk from fire for example storerooms or lockers used for the storage of flammable material. The fire detectors should:
  - Be interlinked such that should one detector be triggered, the other detectors will also sound
  - Give an audible warning that can be heard in the space
  - Be monitored by a central control panel located in a position which is routinely crewed whilst the vessel is underway
  - Provide early warning of fire that alerts occupants of the sleeping accommodation and provides them with sufficient time to escape from the accommodation
  - Be appropriate to the hazard identified. Fire detectors in machinery spaces should detect smoke and heat or flame
  - The vessel's interlinked fire/smoke detection system must adequately protect the space in which the additional survey equipment is installed. If there is any doubt as to the efficacy of the fire detection system given the additional equipment, the fire/smoke detection system must be upgraded by the installation of additional interlinked sensors positioned to protect the additional equipment. If this is not practicable, additional stand-alone fire/smoke alarms are an acceptable alternative, however they must be installed in such a way that they would alert personnel outside of the space of a fire within it
- All compartments extending below the waterline, including the bilges, must fitted with a flood detection system. The flood detection system should:
  - Be monitored by a central control panel located in a position which is routinely crewed whilst the vessel is underway
  - Include an alarm that provides early warning of flooding to occupants of the sleeping accommodation and provides them with sufficient time to escape from the accommodation
- Where open flame cooking or heating appliances are installed, efficient Carbon Monoxide detectors must be fitted. Carbon Monoxide detectors should also be provided in accommodation and other accessible spaces where there is a possibility of exhaust gas penetration in the event of an exhaust leak from machinery or open flame cooking or heating appliances
- Where open flame cooking or heating appliances are instilled which are fired by LPG, an LPG alarm must be fitted. The sensor(s) should be positioned where gas is most likely to collect in the event of a leak

C60 Safety Equipment – Manned Vessels Continued

- Where open flame cooking or heating appliances are installed, there must be a remote isolation to allow, in an emergency, the fuel supply to be safely isolated from the appliance. The remote isolation must be sufficiently far from the appliance that it can be actuated without exposing personnel to the hazard. In practice the isolation may be a mechanical valve or an electrically operated solenoid which should be closed in the de-energised state. All open flame appliances must be fitted with a flame supervision device which shuts the fuel supply off should the flame accidentally go out
- Each compartment extending below the waterline must be fitted with a bilge pump or similar fixed eductor system to allow water to be pumped overboard
- In larger vessels which carry spare fuel cans for the use of ship's boats, the fuel cans must be securely stored in a dedicated stowage on the weather deck. This must be in a safe location relative to any muster point or reasonably foreseeable adjacent fire hazard. The fuel stowage must be fitted with a manually operated mechanism to allow the fuel cans to be safely jettisoned overboard in the event of an emergency
- All passenger cabins must be provided with a smoke hood for each normal occupant. These should be appropriately rated for the duration of time, (under realistic conditions of limited visibility), that it would take the occupant to escape to clear air from that compartment. Passenger cabins which have a direct access to clear air, for example through a skylight or (escape) hatch leading directly to the upper deck, need not comply with this requirement. Nevertheless, it is best practice to do so to reduce risk of entrapment should the direct exit be denied
- All spaces which are routinely crewed whilst the vessel is underway must be provided with a smoke hood for each occupant. These should be appropriately rated for the duration of time, (under realistic conditions of limited visibility), that it would take the occupant to escape to clear air from that compartment. Routinely crewed spaces which have direct access to clear air, e.g. through a door leading directly to the upper deck, need not comply with this requirement
- Escape routes, muster points and all safety equipment must be marked with appropriate signage, which should include operating instructions where applicable. All signage installed within enclosed structures must be glow in the dark type. In very small vessels without an enclosed structure, i.e. RIB or Dory type vessels, this requirement may be waived if, through the limitations of vessel design, the installation of signage is not practicable
- Escape routes inside the structure of vessels should be fitted with emergency lighting which should automatically illuminate in the event of a failure of power supply to the main lighting. The emergency lighting should be positioned where it best aids in escape. In very small vessels this requirement may be waived if, in practice, it is improbable that the escape route would not be immediately apparent

C60 Safety Equipment – Manned Vessels Continued

Additionally, if applicable to the size or design of the vessel in use, the area of operations or the prevailing environmental conditions:

- Engine 'Kill Cord'. Small open powerboats will normally be fitted with a kill cord which is designed to stop the engine if the driver becomes dislodged from the helm position
- Handheld bailer
- Where 'Working At Heights' is required, appropriate safety harnesses, fall arrest equipment and tool lanyards must be available
- Safety harnesses to ensure that exposed personnel on deck cannot fall overboard
- Personal Locator Beacons (PLB) and direction-finding equipment

In vessels where work in Remote Areas is envisaged, in larger vessels (typically liveaboards), or where identified in the HAZID/HIRA:

- Medical oxygen providing equipment (e.g. 'Oxyviva' equipment and Oropharyngeal and Nasopharyngeal airways
- Spinal immobilisation board
- Cervical collar
- 'SAM Splints' or similar
- Basket stretcher suitable for transfer of a casualty and helicopter operations
- Ship's medical stores appropriate to the category of vessel, the location of the worksite, number of Persons on Board and the availability and proximity of external assistance including helicopter rescue services. Refer MCA MSN 1768 (M+F) for further guidance. At a minimum it is envisaged that a 'Doctor's Bag' should be provided (Refer MCA MSN 1768 (M+F) Annex 2)

All equipment must be serviceable, in good condition and, where applicable, in date for test by the relevant certifying authority. All embarked personnel must be familiar with the location and operation of all safety equipment.

In smaller vessels, particularly those without an enclosed structure, it may be appropriate to store designated safety and emergency equipment in a single waterproof and buoyant grab bag. This should be stowed in a location easily accessible in an emergency and unlikely to be immediately denied.

The Client Representative may verify that all items in this section have been provided to the project and are in date for inspection/test/expiry as appropriate. The Authority maintains the strongest commitment to ensuring the health and safety of its personnel and those of the Contractor. If shortcomings are noted in respect of this minimum requirement, Stop Work Authority may be exercised, at Contractor liability, until such time as defects or deficiencies are rectified.

Any deviation from this list must be discussed with and approved with The Authority.

C61 Silent Hours Routine

If personnel are accommodated onboard a vessel overnight, i.e. a 'liveaboard' arrangement, active consideration must be given to the method by which sleeping personnel would be alerted to an emergency, (including but not limited to fire, flood, Man Overboard and the sounding of Carbon Monoxide and LPG alarms), overnight/during 'Silent Hours' when the vessel is alongside or at anchor. This 'Silent Hours Routine' must be captured in the HIRA/HAZID and operationally implemented.

Where the vessel's Class requirements and/or Certificate of Inspection requires it, a roving patrol or watchkeeper must be maintained. Where this is not a specific legal requirement, the implementation of this regime may be the best way to ensure the safety of the vessel and personnel. This could be achieved in practice by embarking an additional surveyor as a night-worker, conducting data processing and ensuring that there is always someone awake and productively employed.

Alternatively, a complete reliance on fixed fire and flood detection systems may be considered appropriate in small vessels where every cabin is provided with a direct means of escape to clear air (e.g. through a skylight or escape hatch) and in which it is improbable that the sounding of stand-alone Carbon Monoxide or LPG alarms would go unnoticed. In this case an alternative system to mitigate the risk of Man Overboard should be implemented, for example placing the weather deck out of bounds during silent hours and leaving a boarding ladder over the side such that a person falling overboard would have a means of re-boarding the vessel unaided.

C62 Safety Equipment – Manned Aircraft

Any manned Aircraft employed on the survey must have safety and survival equipment, as required for the class of Aircraft, by the National Aviation Authority of the State of Registry. In general, it would be anticipated that the following equipment would be amongst that carried:

- Adult life jackets for all embarked personnel
- A 406 MHz Emergency Position Indicating Radio Beacon (EPIRB)
- A life raft appropriate to the Aircraft and crew. The life raft should be stowed in such a position that it can be easily and quickly launched
- Flares & emergency signalling kit
- Handheld firefighting equipment appropriate to the Aircraft in use and the survey equipment installed
- A portable waterproof VHF Radio and spare batteries
- Waterproof torch and spare batteries
- First Aid Kit. The contents of the kit should be appropriate to the size of the Aircraft, number of crew and distance of the survey area from the source of professional medical assistance identified in the ERP. The contents of the kit should include (if not already specified by CAA requirements):
  - Eye wash
  - Equipment suitable for controlling a major bleed, e.g. field dressings, tourniquet and haemostatic dressings
  - Automated External Defibrillator (AED). Each Aircraft is to carry an AED or, if its use onboard would be impractical, to have one available immediately at the airfield. All project personnel are to be trained in its use

Any deviation from this list must be discussed with and approved by The Authority.

The Client Representative may verify that all items in this section have been provided to the project and are in date for inspection/test/expiry as appropriate . The Authority maintains the strongest commitment to ensuring the health and safety of its personnel and those of the Contractor. If shortcomings are noted in respect of this minimum requirement, Stop Work Authority may be exercised, at Contractor liability, until such time as defects or deficiencies are rectified.

C63 Safety Equipment – Remote Pilot Station

The safety equipment provided to the Remote Pilot Station (RPS) will vary greatly depending upon the nature and location of the RPS and the RPA in use. The JHA for RPS operation should give detailed consideration to the hazards present and to the safety equipment and potentially the survival equipment required to mitigate these. For example, a static RPS suite set up in a hangar at a large commercial airfield, (for control of a large RPA by a potentially sizable support team), would be expected to have significantly different equipment and training requirements to the RPS for a small multirotor 'drone' operated by a Lone Worker or two-person team basing themselves out of a 4x4 in a Remote Location. It would however be anticipated that the following equipment would be the minimum requirement for an RPS in all circumstances:

- Comprehensive first aid kit tailored to the size of the team, the efficacy of local EMT services and the proximity, (in distance and time), to the nearest hospital
- Eye wash
- Equipment suitable for controlling a major bleed, e.g. field dressings, tourniquets and haemostatic dressings
- Automated External Defibrillator (AED)
- Handheld firefighting equipment appropriate to the Aircraft in use and the survey equipment installed

C63 Safety Equipment – Remote Pilot Station Continued

Additionally, for Lone Workers or small mobile teams working independently in remote locations, active consideration should be given, (in addition to basic environment-appropriate field PPE), to the equipment and associated training requirement for:

- Vehicle emergency and recovery equipment appropriate to the vehicle, terrain and roads
- A 406 MHz Emergency Position Indicating Radio Beacon (EPIRB)
- Satellite telephone
- GSM telephone
- Portable radio communications between team members and ideally the project offices
- Flares & emergency signalling kit
- Waterproof torch and spare batteries
- First Aid Kit. The contents of the kit should be appropriate to the number of personnel and the distance of the operating area from the source of professional medical assistance identified in the ERP. The contents of the kit should additionally include:
  - Eye wash
  - Equipment suitable for controlling a major bleed, e.g. field dressings, tourniquets and haemostatic dressings
  - Snakebite kit
  - Automated External Defibrillator (AED). Each Aircraft is to carry an AED. All project personnel are to be trained in its use
- Survival equipment appropriate to the operating environment and the distance from potential sources of assistance. Shelter and a supply of and the ability to then obtain additional clean drinking water is likely to be the dominant consideration in the current (hot/tropical) area of operations

The Client Representative will discuss the JHA for RPS operation with the RPAS crew and will give active consideration to the appropriateness of emergency and survival equipment and training provided to the RPAS crew. The Authority maintains the strongest commitment to ensuring the health and safety of its personnel and those of the Contractor. If evident shortcomings are noted in respect of equipment, training provision or general competency in operating in challenging field conditions, Stop Work Authority may be exercised, at Contractor liability, until such time as defects or deficiencies are rectified.

C64 Client Representative Safety Checks

The Client Representative will verify that all safety items listed in paragraphs C60 to C63 have been provided to the project and are in date for inspection/test/expiry as appropriate. If shortcomings are noted in respect of this minimum requirement, Stop Work Authority may be exercised until such time as defects or deficiencies are rectified.

If significant safety shortcomings are identified the Client Representative will conduct a full vessel audit and record findings on a UKHO vessel inspection form. This is based on IMCA's "Marine Inspection for Small Workboats (Common Marine Inspection Document for Small Workboats)" with appropriate modifications drawn from IMCA's "Common Marine Inspection Document" and additionally tailored to capture the specific requirements of this Survey Specification. As a starting point when the Contractor is considering the suitability of a proposed survey vessel prior to the Tender stage, if it is apparent that the vessel fails to meet the expectations for workboats articulated in the IMCA documentation then it is likely that it will also subsequently fail Authority requirements.

The Client Representative will be a balanced individual with broad survey experience. Inevitably he will not however have an in-depth knowledge of every possible vessel, aircraft, and survey system configuration. The Client Representative will therefore adopt a common-sense approach to any issues or shortcomings which he perceives in the conduct of operations and will intelligently discuss these with relevant Project personnel and/or local officials as appropriate to clarify matters. If however perceived issues cannot be resolved by discussion, Stop Work Authority may be exercised until such time as an independent qualified specialist can be engaged to provide a definitive view on the matter to at least the minimum standard applicable to the UK. The cost of any such consultation or inspection, any subsequent remedial actions and any re-inspection must be borne by the Contractor.

C65 Hazard Hunt

For vessel operations, on completion of mobilisation activities and before sailing a whole Vessel Hazard Hunt must be conducted. This should be attended by the Vessel Master/Cox'n, the Charge Surveyor and the lead Survey Engineer and, if present, the Client Representative.

For Aircraft operations, on completion of mobilisation activities and before first flight a whole Aircraft/RPS Hazard Hunt must be conducted. In the case of RPS, this should include the Remote Pilot Station and any support vehicles. This should be conducted by the Senior Pilot/Remote Pilot, the aircraft engineer, the Charge Surveyor, the Survey Equipment Operator and, if present, the Client Representative. While responsibility for hangar and hard standing space stands with the airfield authorities, the Hazard Hunt should include such areas as well as the Remote Pilot Station which is to be routinely used for project operations. Any issues should be brought immediately to the authorities notice and if necessary, operations stopped until rectified.

Where in-field data processing is to be conducted in shore offices/accommodation, a Hazard Hunt must be conducted. This should be attended by the Party Chief, Survey Engineer and, if present the Client Representative.

Where personnel are to be accommodated ashore, a hazard hunt should be conducted of the shore accommodation to the extent reasonably practicable. For example, in hotel accommodation, this could include escape routes and fire doors, designated muster points and other safe areas, the presence and apparent serviceability of firefighting, detection and alarm systems and escape route markings and other emergency signage and emergency lighting.

Shortcomings identified during the Hazard Hunt are to be formally recorded, together with what actions were recorded to resolve the hazard.

In larger Vessels it may be appropriate to include other personnel in the Hazard Hunt. Good results are often achieved by using personnel not familiar with a specific work area to look for hazards, e.g. the cook viewing the back deck – a fresh set of eyes of a person who has had no prior involvement in an area can bring a new viewpoint to an arrangement which other people have just come to accept.

Although not mandated it is often best practice, particularly in larger Vessels with substantial geophysical survey spreads, to have the Vessel Master sign a pre-formatted release on completion of the Hazard Hunt, stating that the mobilisation of the survey spread has had no adverse impact on watertight integrity, smoke boundaries, fixed firefighting arrangements, electrical safety or Vessel stability or class requirements and that the Vessel remains in class and safe to proceed to sea. This ensures that the Charge Surveyor can demonstrate after the event that the Vessel master was content on sailing that the survey mobilisation had no effect on the safe operation of the Vessel.

Although not mandated, it is often best practice to have the Captain of the Aircraft sign a pre-formatted release on completion of the Hazard Hunt, stating that the mobilisation of the survey spread has had no adverse impact on the (certificate of) airworthiness of the Aircraft and that Aircraft remains in condition for safe flight. This ensures that the Charge Surveyor can demonstrate after the event that the Captain of the Aircraft was content that the survey mobilisation had no effect on the safe operation of the Aircraft.

C66 Safety Induction – Manned Vessel

All embarked personnel must undertake a Vessel Safety Induction prior to sailing. This must ensure that, at a minimum, they are able to:

- Participate in any 'T-Card' or equivalent gangway management system in operation for maintaining a record of personnel onboard the vessel
- Communicate with other persons on board on elementary safety matters and understand safety information symbols, signs and alarms
- Identify any compartments or areas which are restricted, out of bounds or require approval to enter
- Participate in any Permit To Work (PTW) system in operation onboard
- Know what to do if; a person falls overboard; fire or smoke is detected; a flood is detected; the fire, muster stations or abandon ship alarm sounds
- Take immediate action upon encountering an accident or other medical emergency
- Identify emergency escape routes, muster locations, and liferaft embarkation stations
- Be familiar with the escape routes from their cabin and normal place of work. Personnel should be able to escape to clear air even if the environment is smoke-filled with no lighting
- Operate escape equipment, for example escape hatches and ladders
- Locate and operate flares, EPIRB, PLB and SART (as carried)
- Locate and operate fixed and handheld marine VHF units to make a distress call, including the use of the Distress button in VHF Digital Selective Calling (DSC) units
- Locate and don smoke hoods (if carried)
- Locate and don immersion suits (if carried) including those in upper deck stowages
- Locate and don life-jackets including those in upper deck stowages
- Locate, launch and enter life-rafts
- Have a working knowledge of the types of portable firefighting equipment onboard, including centre feed hose reels if fitted, and their correct use in an emergency

C66 Safety Induction – Manned Vessel Continued

- Where the vessel has manually actuated fixed firefighting arrangements, for example in the galley, machinery spaces or laundry, embarked survey personnel are to have a working knowledge of how these systems are remotely operated in an emergency such that they could go to the required location and actuate the system if directed to do so in an emergency by a member of the ship's crew
- Where the vessel has arrangements for the establishment of smoke boundaries, for example smoke curtains and hatches, embarked survey personnel are to have a working knowledge of how these are to be correctly used to ensure that smoke is effectively controlled
- Where the vessel has manually actuated flaps and dampers to control the spread of smoke and isolate key compartments, survey personnel are to have a working knowledge of how these are operated in an emergency such that they could go to the required location and close the flap or damper if directed to do so in an emergency by a member of the ship's crew
- Where the vessel has equipment emergency stop positions and (fuel) isolation valves, embarked survey personnel are to have a working knowledge of how these are remotely operated in an emergency such that they could go to the required location and actuate the system if directed to do so in an emergency by a member of the ship's crew
- Be familiar with the location of first aid kits and AED devices
- Be familiar with the location and operation of all safety equipment listed under "Safety Equipment – Manned Vessels"
- As appropriate, close or open the fire, weather and watertight doors fitted to the vessel
- Participate in any 'darken ship' routine

Evidence of training may be requested by the Authority or its nominated representatives at any time.

C67 Safety Induction – Manned Aircraft

All flight personnel including the survey team must undertake familiarisation training prior to flying which must ensure they are aware of Aircraft-specific safety issues, including but not limited to:

- How to safely approach and disembark from the Aircraft when engines are running (if applicable)
- Any external hazards to be avoided, e.g. moving or rotating equipment, pinch points, radiation hazards (radio and laser), hot surfaces, sharp and protruding surfaces, and no-step areas
- How to safely embark and disembark from the Aircraft
- Any internal hazards
- Use of the internal intercom system to communicate verbally with the pilot
- Understand and correctly respond to any visual signals which may be used be used by the pilot, Aircrew or groundcrew
- Correctly operate and secure doors and ladders
- Communicate with other persons on board on appropriate safety matters and understand safety information symbols, signs, and alarms
- Know what to do if fire or smoke is detected
- In the event of fire, know how to raise the alarm and have basic knowledge of the use and types of portable fire extinguishers on board
- Know what to do in case of an emergency landing at sea or on land
- Locate and don lifejackets (and immersion suits if carried)
- Identify emergency escape routes and operate emergency egress equipment, e.g. emergency escape hatches, exits and push-out windows
- Locate, launch, and enter life-rafts

C67 Safety Induction – Manned Aircraft Continued

- Where the Aircraft has onboard (i.e. inbuilt) firefighting systems, embarked survey personnel are to have a working knowledge of how these are operated such that they could go to the required internal or external location and actuate the system in an emergency. They should also be aware of any respiratory hazards associated with the gas used in the extinguisher
- Be familiar with the location and contents of first aid kits and of AED devices (if carried)
- Be familiar with the location and operation of all safety equipment listed under Paragraph C67
- Take immediate action upon encountering an accident or other medical emergency

In light Aircraft where the crew comprises a single pilot, an early and frank discussion may be appropriate regarding the best course of action in the unlikely event of the pilot experiencing a medical emergency in the air, such will best serve to result in a least-worst outcome for project personnel in the Aircraft and members of the public on the ground

Evidence of training may be requested by the Authority or its nominated representatives at any time

C68 Safety Induction – Remotely Piloted Air System

The information to be imparted in the safety induction for a RPAS will vary greatly depending upon the size and nature of the RPA, the complexity of the RPS and overall RPAS, the size of the support crew and the nature of the launch and recovery point.
The information to be imparted under Safety Induction – Manned Aircraft may be used as a starting point in so far as it applies to the RPA in use. Additional RPAS specific safety issues may include but not be limited to:

- RF hazards associated with telemetry links
- In electrically powered RPA, how to connect and disconnect batteries
- In combustion powered RPA how to start and shut down engines routinely and in emergency
- Lifting and slinging arrangements
- Charging of Lithium batteries
- Refuelling operations
- System pre-flight and post-flight checks and procedures
- RPA launch and recovery
- For mobile RPS, particularly vehicle based RPS working in a Remote Location, any hazards to personnel or the RPA associated with the environment
- Crew actions in the event of loss of telemetry and/or remote control
- Crew actions in the event of loss of navigation through GNSS failure
- Crew actions in the event of emergency landing on land and water
- Crew actions Crash on land and water
- Lithium battery fire and/or liquid fuel fire
- Action in the event of encountering another Aircraft unexpectedly
- Communications with local ATC and other (manned and unmanned) Aircraft

Evidence of training may be requested by the Authority or its nominated representatives at any time.

C69 Safety Induction – Shoreside Facilities

All personnel must undertake and satisfactorily complete any safety induction required by the authority operating any shoreside facilities used by the project team. This is likely to include safety inductions for commercial ports and airfields.

Evidence of training may be requested by the Authority or its nominated representatives at any time.

C70 Daily Prestart Meeting

The Charge Surveyor is to hold a Daily Prestart Meeting with all survey personnel and Vessel/Aircraft/RPAS crew prior to the start of work.

The conduct of Prestart Meetings is to be reported in the DPR.

Meetings must be minuted (briefly), posted in the mess and must include the following headings as a minimum:

- Date, Time, List of attendees
- Activities - Last 24 Hours
- Planned Activities – Next 24 Hours
- Safety/Hazards

The minutes of the Daily Prestart Meeting are to be retained for inspection by the Authority as required.

In the case of small teams operating on a routine and repeating daily schedule, the requirement to formally minute the Daily Prestart meetings may be waived with the agreement of the Authority. This likely to be appropriate to small boat operations with crews of 5 or less and to routine flying operations in which the Pilot already files a daily Flight Plan with the local ATC. The conduct of the meeting is however still to be reported in the DPR.

C71 Toolbox Talk

Prior to commencing any discrete activity, the person leading the operation is to hold a Toolbox Talk to brief the participating team members on the activity, their role in it and any health and safety considerations. Toolbox Talks are to be minuted (briefly) with the minutes retained for inspection by the Authority as required. Only team members who have participated in the Toolbox Talk are to take part in the activity.

In the case of manned Aircraft operations, the pre-flight brief may take the place of a Toolbox Talk.

C72 Safe Work Method Statement

A formal Safe Work Method Statement (SWMS) (also known in industry as a Job Hazard Analysis (JHA)/Job Safety Analysis (JSA)) must be in place for each survey activity. These must be tailored to the Vessel, Aircraft, and equipment in use, including RPAS, and to the prevailing environmental conditions. Examples of activities to be subject to a JHA/JSA include but are not limited to:

- Personnel Mobilisation & Long-Haul Travel
- Motor Vehicle Operations
- Vessel and/or Aircraft Mobilisation & Demobilisation activities
- Dimcon
- Fieldwork Ashore
- Working in and around the airfield
- Tide Gauge Installation
- Offshore Tide gauge Deployment & Recovery
- Berthing and Unberthing
- Anchoring
- Small Vessel Operations
- Shallow Water Operations
- SVP deployment and recovery
- Secchi Disk Operations
- Grab Sampler Operations
- MBES Pole Mobilisation & Demobilisation
- Raising/Lowering MBES Pole
- Offshore MBES Operations

C72 Safe Work Method Statement Continued

- Laser safety
- RPAS mission planning, airspace considerations and site risk-assessments
- RPAS pre-flight inspection, launch, recovery and shutting down/making safe the Aircraft
- Implementation of a RPAS return-to-home function following control-link failure. Fixed wing RPA should demonstrate an equivalent procedure that results in a suitable automated, low-impact descent and landing
- Vessel refuelling operations
- Vessel routine maintenance
- RPA lithium battery charging
- Aircraft/RPA refuelling operations
- Aircraft/RPA routine maintenance
- Diving and ROV Operations if these are to be conducted
- Any activity utilising a Hazardous Substance (C35)

The Contractor's standard 'Generic SWMSs' are an acceptable starting point in this process but there must be hard-copy documentary evidence that these templates have been reviewed and updated by all participating personnel prior to commencement of work and that they reflect the actual operating conditions present on the Project. Only personnel who are signed onto the SWMS are to participate in the activity.

SWMS must be subject to regular After-Action Reviews (AAR) to ensure that they remain fit for purpose. A new SWMS is to be conducted whenever the procedure covered is subject to change.

The conduct of SWMS and AARs are to be reported in the DPR.

SWMS records and AARs are to be retained for inspection by the Authority as required.

C73 Hazard/Safety Observation Cards

Hazard Observation Cards ('HOC Cards') or Safety Observation Cards/STOP cards, are to be readily available to all team members participating in the Project. Ideally each employee should hold a small pack of these for personal use, (together with 'StepBack 5x5' cards). They may, less preferably, be held in the Vessel, the Aircraft, at the RPS, or in a support vehicle as most appropriate.

All project personnel are to be encouraged to submit HOC Cards, (to the Party Chief), as part of the positive health and safety and continuous improvement culture. The Party Chief is to forward the cards to the designated Contractor HSE manager in accordance with internal Contractor policy.

Where the vessel, aircraft, port or airfield Safety Management System already uses HOC cards or similar reporting mechanism, the survey team may alternatively and/or additionally participate in this system. The Party Chief is however to ensure that all reports submitted through this system are recorded and forwarded to the designated Contractor HSE manager in the Contractor's main offices.

Where the subject raised is particularly noteworthy or worthy of commendation it should be remarked upon in the Party Chief's comments section of the DPR. It is recommended that the Contractor operates a reward/recognition regime for 'good spots' to encourage participation and active identification and rectification of hazards. Similarly, observed instances of good HSE behaviours may be considered under the reward/recognition scheme.

HOC cards submitted are to be statistically recorded in the HSEQ section of the DPR. They are to be retained for inspection by the Authority as required.

C74 StepBack 5x5

StepBack 5x5 is an informal personal planning process that is essentially a mental run through the SWMS applied before starting all jobs. It encourages workers to identify hazards associated with all tasks before starting. It helps to promote a hazard management culture through continual self-evaluation. It is based on the principle of 'Engaging the mind before the hands by:

- Stepping back 5 paces from the job
- Investing 5 minutes (nominal) to step through the job in the worker's mind and identify plans to control hazards before starting the job. This should include:
  - Stop and think
  - Observe the work area and surroundings
  - Step through your mind what you are going to do
  - Think about what else is happening in the area or nearby
  - Identify what else could go wrong
  - Satisfy yourself that the hazards are controlled before starting the work

After the job the worker should:

- Observe the work area
- Take action to control any hazards that may have been created by the work
- Reflect on how well the job went and the mental planning process used
- Consider whether they felt safe undertaking the work
- Consider whether others were working safely
- Consider whether improvements to the procedure could be made next time
- Inform line manager of their observations

Many offshore companies formalise this procedure through the provision (and potentially mandatory use) of StepBack 5x5 cards. This is not a specific Authority requirement for relatively low risk activities involving small teams. Nevertheless, all project personnel should be trained to mentally conduct the StepBack 5x5 process prior to starting and on completion of all tasks. In practice this may be conducted as part of a Toolbox or 'walkthrough' conducted on site immediately prior to commencement of the task.

C75 Drills and Exercises

Regular emergency drills and exercises are to be held. The periodicity of these this will typically be in accordance with the Safety Management System in use on the vessel or aircraft.

The conduct of Drills and Exercises are to be reported in the DPR and statistically recorded.

In the case of vessels, as a minimum standard, a Firefighting Drill, a Casualty Handling Drill, Muster Drill/Abandon Ship Drill, and a Man Overboard Drill must be conducted, under realistic conditions, prior to or immediately after first sailing. All embarked personnel must actively participate. These drills must comprehensively test the Vessel ERP and the Project ERP, including communications protocols. Thereafter it is strongly recommended that a randomly selected drill is conducted weekly, for example as part of a 'Safety Sunday' routine. At a minimum however, the required drills must be repeated at each crew change and whenever a new member of staff embarks.

Where the vessel is only provided with portable firefighting equipment – i.e. handheld extinguishers and fire blankets – all embarked personnel are to practically demonstrate a knowledge of the location of the equipment and the type of fire to which its use is appropriate.

Where the vessel has fixed firefighting arrangements, all embarked personnel are to practically demonstrate a working knowledge of these systems. For example, in vessels fitted with remote fuel isolations for main machinery, fire dampers and intake flaps, galley and laundry power isolations, and remotely activated drenches, all personnel should be able to go to the required location unsupervised and confidently operate the system if directed to do so in an emergency by a member of the Marine Crew. This should be exercised during the required firefighting drills.

Where the vessel is fitted with a fire pump and hose stations, all embarked personnel are to practically demonstrate a user-level knowledge of this system. This should include the ability to identify and use any remote-start systems, open relevant valves, run and charge hoses and conduct basic firefighting using the nozzles provided.

In the case of aircraft, regular emergency drills and exercises must be held. The nature and periodicity of these this will typically be in accordance with the schedule set for the aircraft type.

In the case of small, manned aircraft, which will typically have two personnel embarked including the pilot, an early and frank discussion should be had between the pilot and embarked survey personnel as to the best course of action in an emergency onboard, including a medical emergency involving the pilot. All personnel embarked in the aircraft must be familiar with the required response to emergency situations and with the location and operation of emergency equipment commensurate with their role and aircraft type. This will typically include but not be limited to emergency exits, handheld firefighting equipment, life rafts, first aid equipment and an emergency grab bag containing a radio, EPIRB, flares and sea survival equipment.

Where an aircraft, (both manned and RPAS), are fitted with manually actuated fixed firefighting arrangements and fuel or power isolations and emergency stops for the use of ground crew in an emergency, all project personnel involved in the handling of the aircraft must have a working knowledge of how these are operated such that they could actuate the system required and make the aircraft safe. This competency must be demonstrated during an appropriately structured emergency exercise.

C76 Weekly Safety Meeting

The Party Chief must hold Weekly Safety Meetings with all field personnel including marine crew and aircrew. This would normally be conducted as part of a 'Safety Sunday' routine when a weekly emergency drill and Hazard Hunt would be conducted.

Meetings must be minuted (briefly) and made available to all personnel and to the Contractor Health and Safety Representative. Weekly Safety Meetings must include the following items as a minimum:

- Date, Time, List of attendees
- Safety Moment
- Review of minutes of previous meeting
- Review of all Safety/Hazard Cards submitted in the previous week together with outstanding actions to rectify
- Review of all SWA exercised together with required Follow-Up actions to prevent a recurrence
- Review of all Incidents occurring in the last week under the project or as part of any other Contractor project conducting similar operations or operating similar Vessels, Aircraft or RPAS
- Review of all Non-Conformances reported in the last week
- Update of Lessons Identified
- Review of any UK Civil Aviation Authority (CAA), or equivalent national Safety or Information Bulletins relevant to the Aircraft, RPAS or operation
- Review of any ARPAS-UK or equivalent national RPAS Operator association Safety or Information Bulletins relevant to the RPAS or operation
- Review of any MCA and IMCA, Alerts, Safety Flashes or Safety Bulletins relevant to the operation
- Any Other Business

The conduct of Weekly Safety Meetings is to be reported in the DPR.

C77 Lessons Identified & Continuous Improvement

The Charge Surveyor should maintain a running list of Lessons Identified. Ideally this should be held on a communally available PC which all participating personnel can access as required. The Lessons Identified should be reviewed at the Weekly Safety Meeting and entries developed as appropriate.

On completion of the project the Lessons Identified should captured in the Contractor's Lessons Identified repository to ensure Continuous Improvement. Typically, this will be through the mechanism of the Project Debrief. A copy of the Lessons Identified is to be forwarded to the Client Representative and the Authority.

C78 Client Representative Visits

The Authority reserves the right to send a Client Representative to visit during survey operations.

Visits are intended to primarily focus on the conduct of survey operations and the quality of hydrographic processes and deliverables. They will however also include an assessment of safety aspects relating to (as applicable) the Vessel, Aircraft, RPAS, hanger, field office, accommodation, and other facilities, and of compliance with the detail of the Survey Specification. If significant safety or quality concerns are raised the Client Representative has Stop Work Authority. Issues identified are to be resolved before work recommences.

If significant issues with a vessel are identified, the Contractor is to contact the coastal state authority responsible for vessel safety standards to resolve any issues prior to recommencement of work.

If significant issues with an Aircraft/RPAS are identified, the Contractor is to contact the local CAA to resolve any issues prior to recommencement of work.

C79 Noise

Personnel must not be exposed to hazardous levels of noise. The UK Health and Safety Executive guidance on noise at work shall be adhered to. In summary the employer has a duty to prevent damage to employees, including hearing damage due to noise exposure.

If sound levels are found to be in breach of HSE guidance with attendant risk of injury of survey personnel, then the Client Representative may exercise Stop Work Authority until the problem is rectified.

A calibrated electronic Sound Level Meter is to be available to demonstrate that noise levels are acceptable.

On vessels with an enclosed superstructure, the level of noise inside the accommodation/at the survey desk (and processing office if applicable) must not, during normal running, be so high that hearing protection is required as standard practice during normal survey operations.

In small vessels without enclosed superstructure, whilst every effort should be made to implement engineering controls and/or at the outset to select a vessel which is acoustically clean, it may not be possible in practice to limit machinery noise to non-damaging levels. In this event it should be reported to the Authority as a Non-Conformance, together with the steps taken to protect exposed personnel. e.g. the wearing of appropriately certified foam earplugs and other steps to ensure adequate Fatigue Management.

Personnel embarked in Aircraft must wear appropriate aviation rated hearing protection whenever the engines are running. It is anticipated that this would normally constitute an approved aviation headset combining hearing protection and wired or wireless communications between the Pilot and other embarked personnel.

Ground crew, (including RPAS crew), must wear appropriate industrial hearing protection whenever operating near to running engines which produce damaging levels of noise. To enable effective communications between participating personnel this may constitute hearing protection integrated with 2-way radio communications. In the case of larger RPAS where the ground crew may be in close proximity to the Aircraft but be unable to directly view visual signals from the Pilot at the RPS, hearing protection should be integrated with 2-way radio communications.

C80 Lighting

The default standard for office lighting intensity, (including the workstations of the Online Surveyor (vessel) Survey Equipment Operator (aircraft), processing office and static RPS suites), is that it must meet the UK requirements for office and workshop lighting.

The UK Health and Safety Executive guidance on workplace lighting is to be adhered to. A user guide suggesting common problems and best practice is available on the UK HSE website:

http://www.hse.gov.uk/pubnS/priced/hsg38.pdf

In summary the employer has a duty to prevent damage to employees due to poor workplace lighting. The most commonly witnessed problems in previous projects have been associated with glare across VDU screens leading to discomfort, irritability, distraction, visual and overall fatigue and, fundamentally an inability for the data processor, Survey Equipment Operator or RPAS Remote Pilot to see the data presented well enough to operate the systems with the required level of attention, accuracy and safety.

It is however accepted that this will sometimes be difficult to fully achieve in light Aircraft and small vessels, particularly open boats. An assessment of workstation lighting, (in all settings), must therefore be conducted prior to start of work and reported as part of the formal Ergonomic Assessment.

Where this assessment determines that it is not possible for the workstation lighting to meet UK standards, action is to be taken to reduce all hazards presented to As Low As Reasonably Practicable (ALARP).

Where it is identified that the lighting of any positions does not meet or exceed UK office standards, this is to be reported to the Authority as a Non-Conformance. The report is to include:

- A copy of the ergonomic assessment
- A list of the personnel exposed to the hazard
- A description of material modifications undertaken to reduce the hazards identified to ALARP
- A description of what systems or work patterns have been implemented to mitigate any adverse impact on exposed personnel

C81 Project Office Ergonomics (Land Based)

Workstation ergonomics in the (land based) Project Office must meet or exceed UK office standards. This includes situations in which personnel are operating for an extended duration from hotel accommodation and using standard hotel room furniture in lieu of a formalised office arrangement.

A formal ergonomic assessment of workstation configuration must be conducted prior to start of work and any identified defects rectified.

C82 Project Office (Afloat), Online Surveyor and Helmsman Ergonomics

The default standard for the ergonomics of the Project Office (afloat), online surveyor's workstation and the helmsman's position is that they must meet or exceed UK office standards. A formal ergonomic risk assessment of workstation configuration is to be conducted prior to start of work.

Where this assessment determines that, through the design of the vessel, it is not possible for the workstation ergonomics to meet UK office standards, action must be taken to reduce all hazards presented to As Low As Reasonably Practicable (ALARP).

Where it is identified that the ergonomics of any positions do not meet or exceed UK office standards, this is to be reported to the Authority as a non-conformance. The report is to include:

- A copy of the ergonomic assessment
- A list of the personnel exposed to the hazard
- A description of material modifications undertaken to reduce the hazards identified to ALARP
- A description of what systems or work patterns have been implemented to mitigate any adverse impact on exposed personnel

C83 Aircraft Survey Equipment Operator Ergonomics

The default standard for the ergonomics of the Survey Equipment Operator's workstation is that it must meet or exceed UK office standards. A formal ergonomic risk assessment of workstation configuration is to be conducted prior to start of work.

Where this assessment determines that, through the design of the aircraft, it is not possible for the workstation ergonomics to meet UK office standards, action must be taken to reduce all hazards presented to As Low As Reasonably Practicable (ALARP).

Where it is identified that the ergonomics of any positions do not meet or exceed UK office standards, this is to be reported to the Authority as a non-conformance. The report is to include:

- A copy of the ergonomic assessment
- A list of the personnel exposed to the hazard
- A description of material modifications undertaken to reduce the hazards identified to ALARP
- A description of what systems or work patterns have been implemented to mitigate any adverse impact on exposed personnel

C84 RPAS Remote Pilot Station Ergonomics

The default standard for the ergonomics of the Survey Equipment Operator's workstation is that it must meet or exceed UK office standards. A formal ergonomic risk assessment of workstation configuration is to be conducted prior to start of work.

The nature of the Remote Pilot Station (RPS) will vary greatly depending upon the size of the RPAS in use. The RPS for a small multirotor 'drone' would typically be a small hand-held control unit, whereas the RPS for a large, fixed wing unmanned Aircraft could be a control cabin housing a simulated Aircraft flight deck which fully replicates all the instruments, controls and seating normally associated with a full-sized manned Aircraft with two Pilots.

The practical implementation of this intent will therefore vary greatly with the RPS in use and the complexity of the control system, and any telemetry displays. Where the ergonomic risk assessment determines that it is not possible for the workstation ergonomics to meet UK office standards, action must be taken to reduce all hazards presented to As Low as Reasonably Practicable (ALARP). In practice this might be as simple as providing a padded chest strap to support the weight of a hand-held control unit or providing appropriate office furniture and adjustable monitors for larger setups featuring several flight and survey system telemetry displays.

Where it is identified that the ergonomics of any positions do not meet or exceed UK office standards, this is to be reported to the Authority as a non-conformance. The report is to include:

- A copy of the ergonomic assessment
- A list of the personnel exposed to the hazard
- A description of material modifications undertaken to reduce the hazards identified to ALARP
- A description of what systems or work patterns have been implemented to mitigate any adverse impact on exposed personnel

C85 Manual Handling

Employees must be protected from, the risk of musculoskeletal injury from hazardous manual handling in the workplace. Manual handling means transporting or supporting a load by hand or bodily force. It includes lifting, putting down, pushing, pulling, carrying or moving loads. In general, Contractor must ensure that:

- A Manual Handling Policy and Procedure is in place
- All project personnel are trained in recognising the hazards associated with manual handling, hazard mitigation strategies which may be employed, and correct techniques to be employed when conducting manual handling
- Hazardous manual handling is avoided
- The risk of injury from any manual handling operations that cannot be avoided is assessed
- The risk of injury from hazardous manual handling is reduced to as low as reasonably practicable by the adoption of appropriate control measures

All survey operations, including mobilisation and demobilisation activities must be risk assessed (through the mechanism of the HAZID and JHA), for manual handling hazards. Appropriate control measures must put in place to reduce that risk to as low as reasonably practicable.

In general terms hazardous manual handling operations may be avoided by:

- Redesigning the task to avoid moving the load
- Breaking the load down into smaller pieces which can be safely handled
- Automating or mechanising the process

Typical routine survey and vessel related activities which carry a manual handling risk include but are not limited to movement and embarkation/disembarkation of equipment, stores and fuel, MBES pole mobilisation and demobilisation, Tide Pole Mobilisation and Demobilisation and deployment, recovery of 'wet' equipment, for example SV probes, ROVs and towed bodies, recovery to deck of a Man Overboard from the water, extraction of a seriously injured or unconscious casualty from within the confines of a vessel structure, launch and recovery of boats and unmanned vehicle and vessels from a manned platform and deployment and recovery of seabed sensors and buoys. Automation or mechanisation of all these activities would typically be appropriate unless, (e.g. SV probes and ROVs), a particularly small device is in use.

Comprehensive advice in respect of manual handling regulations and requirements is available on the UK HSE website.

C86 Operator Training

Where Risk Assessment and Hazard Mitigation identifies that automation or mechanisation is the best way to mitigate against an identified Manual Handling hazard, personnel engaged in the activity must be adequately trained and assessed as competent to safely plan and risk assess the operation and use the equipment.

In the case of engineered solutions using hand powered systems, for example raising and lowering of a MBES pole by hand winch or davit, this may be local/on the job training by another competent/experienced team member.

Where mobile powered machinery is in use, for example Lift Trucks ('Forklifts'), aircraft handling equipment or static deck mounted powered equipment, for example cranes, davits, hoists, LARS and winches, formal training may be appropriate, (or legally mandated), to ensure the competency of the operator and that they have adequate practical and theoretical knowledge and experience of the lifts being undertaken.

Where applicable this training should be of a standard meeting or exceeding equivalent UK legal requirements. Evidence of training and competency may be requested by the Authority.

Comprehensive advice in respect of regulations and requirements applicable to lifting operations is available on the UK HSE website.

C87 Forklift Trucks

Forklift Trucks are a commonly used piece of machinery which assist greatly in the manual handling aspects of vessel and aircraft mobilisations and the transfer of heavy, bulky, and awkward equipment both on the quayside/airfield and potentially on the back deck of larger vessels. Where they are available their use is encouraged to facilitate operations and eliminate the risk of injury related to manual handling and also of the risk of heat injury in hot environments.

Forklift Trucks can however be dangerous machines if not used by a competent operator. The UK HSE mandates the training appropriate for personnel using Forklift Trucks. Any Project personnel operating a Forklift Truck, including in the warehouse during the course of equipment mobilisation, must be trained to a standard meeting or exceeding the equivalent UK legal requirement in the HSE Approved Code of Practice on Forklift training. (Whilst the requirements of local legislation takes primacy, training by international providers, to a standard equivalent to that of the UK, is acceptable where no local licensing requirements exist). Evidence of training and competency may be requested by the Authority.

If Forklift Trucks are to be used during the project, including in the warehouse during the course of equipment mobilisation, the Contractor must have in place a Forklift Truck policy and procedure detailing the method by which Forklift Trucks will be safely employed during the project.

If Forklift Trucks are to be used in direct support of the project, but by non-project personnel, (e.g. local national port authority/marina/airfield staff), a member of the Project Team, (ideally the Party Chief or Survey Engineer), should be sufficiently competent in the safe operation of Forklift Trucks as to be able to safely supervise operations and to exercise SWA should they observe any procedures or behaviours which are non-compliant with UK regulations and requirements.

Comprehensive advice in respect of Forklift Truck training and also regulations and requirements applicable to Forklift Truck operations is available on the UK HSE website.

C88 Hot Work

Hot Work means the use of open fires, flames and work involving the application of heat by means of tools or equipment. This includes the unintentional application of heat, for example by the use of power tools or hot particles from cutting or welding operations, falling onto, and igniting flammable material or flammable vapours, on both sides of the structure being worked.

Hot work is typically required during survey vessel mobilisation and demobilisation during the installation/removal of MBES and antenna pole mounts and bracketry and, on larger vessels, LARS, and sea containers.

If Hot Work is required, Contractor must identify this requirement in the Mobilisation/Demobilisation Plan and, in conjunction with the Deck Plan, detail the specific hazards associated with the activity and the measures to be put in place to mitigate them. In larger vessels where a Permit to Work and Hot Work Permit system is likely to be in place, the permit system should also be described.

Contractor must ensure that:

- A Hot Work policy and procedure is in place
- A JHA has been conducted prior to commencing the task
- All project personnel are trained to recognise what constitutes Hot Work and appropriate risk control measures that should be put in place
- All personnel who may be required to conduct Hot Work are trained and have appropriate skills, knowledge, and experience to ensure that they can safely plan and conduct the operation
- Appropriate PPE and other safety equipment appropriate to the operation is supplied
- Where hot work is being conducted on the vessel structure, a fire watch is maintained on both sides of the surface being worked until the surface has fully cooled
- In vessels with a Permit to Work system, the activity is compliant with that system, including the issue of Hot Work Permit

C89 Work in the Water

In general, project personnel should not enter the water for the purposes of conducting project related operations.

In some situations, this may however be appropriate or become necessary as a planned event. Should this be the case the activity should be fully risk-assessed through the mechanism of the JHA/JSA, with appropriate measures put in place to mitigate all identified hazards and reduce the level of risk to an acceptable level.

In vessels with a Permit to Work system, the activity must be compliant with that system. Typically, this will involve the issue of a Permit to Dive, even if it is only the intention to conduct the work on the surface.

Where work occurs in the water in proximity to larger commercial vessels and port facilities there will almost certainly be a formal Permit To Work regime in force in adjacent vessels and infrastructure. All relevant authorities must be approached to ensure that relevant PTWs are in force before any personnel enter the water.

Experience has shown that there are often emergent situations which, due to unavoidable circumstances, can be best and most safely be managed by a member of the survey team or vessel crew intentionally entering the water to conduct a survey related task. These have notably included removal of rope fouling a survey launch propeller, installation of the bracket supporting an over-side pole and achieving adequate securing of a tide gauge, installing a marker buoy on a submerged obstruction at very shallow depth and ADCP installation.

Entering the water in the work context remains broadly undesirable as it inevitably increases exposure of personnel to additional hazards not experienced whilst onboard the vessel. It may however be the least-worst option or even the safest one in practice. For example, conducting the work from a small boat adjacent to a larger vessel or structure may actually present more significant hazards including motion, pinch points and risk of damage to equipment and vessel structure.

This project operates in areas with warm water and, in reality, the work activity may be appreciably less hazardous than snorkelling from the adjacent beach after hours. Fundamentally therefore it is not the position of the Authority to ban such activity (although Contractor personnel should always act in accordance with their own Company policy if this imposes greater restriction upon their actions).

If the survey plan evolves through circumstance to require personnel to enter the water or suggest that this is in practice the least hazardous way of conducting a task it should, like any other work activity, be fully risk assessed through the mechanism of the JHA/JSA with all hazards mitigated and risks reduced to an acceptable level. If this is not achievable then the activity is not to take place and an alternative solution is appropriate following the Hierarchy of Controls.

Anyone entering the water should be a volunteer and should consider themselves a strong swimmer, ideally with a relevant and formally assessed competency and should be appropriately equipped and dressed for the task. A robust plan should be in place to recover the swimmer to the vessel or to dry land as well as an emergency plan to safely recover him if he becomes incapacitated.

C90 Diving Operations

For the purposes of this Survey Specification, any use of compressed air for breathing underwater constitutes a Diving Operation when conducted in direct support of the Project. The default standard is that Diving Operations are only to be conducted by qualified Commercial Divers, meeting or exceeding applicable UK HSE training and employment standards.

A commercial dive team will generally comprise a Dive Supervisor, Diver, Standby/Rescue Diver and a boat cox'n if an additional workboat/dive support vessel is involved. There may additionally be a Diver Medical Technician, or the Dive Supervisor may be trained to a comparable standard. The Charge Surveyor should satisfy himself that any variation from this standard arrangement is both safe and explained.

The Charge Surveyor is to satisfy himself that Commercial Divers employed have appropriate certification, an in-date dive medical and can present a current dive log. Absence of any of these, a cavalier attitude to appropriate documentation (e.g. JHA/JSA/PTW) or the presence of equipment which appears in poor repair, should be regarded with suspicion.

As with any activity, the Charge Surveyor or any other member of the has the right to exercise Stop Work Authority if they are uncomfortable with an aspect of the operation.

Note: Experience suggests that there are typically members of the survey team or vessel crew present who are certified recreational divers who can demonstrate, by qualification and logbook, a level of competency far in excess of that required to safely carry out any of the minor emergent or one-off tasks commonly associated with a hydrographic survey. For example, attaching a recovery line to an ADCP shallow water or clearing a line fouling the propeller of a small vessel. In some circumstances it may therefore be appropriate for an appropriately competent member of the survey team or vessel crew to carry out the emergent task particularly if their level of formal qualification would allow them to operate in a limited commercial context, for example as a Scientific Diver. The formal risk assessment of this activity and liability for the decision lies entirely with the Contractor. It should however be noted that a that a recreational diver is unlikely to have an appropriate commercially approved Certificate of fitness to dive as required for any diving at work requirements and that an incident investigation HSE investigators would start poorly if this was not in place. Whilst a 'grey area' may be envisaged by allowing recreationally qualified local national sub-contractors (i.e. the boat crew) to conduct the activity, it is suggested that the liability should be passed entirely to a local commercial diving company, thereby passing all liability to a third party operating under local legislative frameworks.

Notwithstanding the above, if a requirement to conduct diving operations emerges, the situation is to be discussed with the Authority before the operation takes place - In some circumstances overseas a lesser standard of diving certification may be appropriate to emergent requirements under benign local conditions.

This will however be at the discretion of the Authority and always subject to a fully developed JHA and Safety Plan and the issue of relevant Permits to Work and/or Permits to Dive.

C91 Man Overboard

All manned vessels, (or ASVs which are sometimes operated by embarked personnel), are to have a workable plan for timely safe and successful recovery of a conscious and unconscious man overboard to deck.

The Client Representative will verify that a workable MOB plan is in place. If in doubt, the efficacy of this plan is to be practically demonstrated. If the plan proves to be unworkable, Stop Work Authority may be exercised, at Contractor liability, until such time as a workable plan is demonstrated.

A Man Overboard (MOB) Recovery 'plan' which has the unconscious casualty brought to the side of the vessel and left floating in the water pending arrival of undefined 'external help' in an uncertain timeframe will inevitably result in the death of an unconscious, non-breathing casualty. This is not the basis for a MOB plan and is not acceptable. Experience shows that:

- In small boat operations involving crews of 2 or 3 personnel, there must a robust manual handling plan which would allow a fully clothed, unconscious adult male casualty to be safely and quickly brought inboard
- Mechanical aids and lifting equipment are almost inevitably appropriate unless the vessel has a removable section in the gunwales specifically designed for the recovery of swimmers or divers by reducing the freeboard at that point to a few centimetres
- When the boat crew comprises a qualified Cox'n and a Surveyor, it may be the Cox'n in the water leaving the Surveyor to affect the recovery including safe vessel handling. The plan and selection of the Surveyor should take account of this reality and, (whilst he need not be formally ticketed as a Cox'n), the surveyor should be able to practically demonstrate his ability to handle the vessel in an emergency to the extent required to safely recover a situation in which the Cox'n is no longer onboard or is incapacitated
- If doubt exists, Client Representative will ask the Charge Surveyor to demonstrate the practical execution of the plan. If this cannot be demonstrated, it will be the subject of Stop Work Authority until adequate provisions can be put in place

C92 Electronic & Electrical Equipment

The mobilisation of a survey spread to a vessel of opportunity, particularly to small vessels the design and construction of which may be orientated towards passenger transport/the leisure market, typically involves an ad-hoc and expedient installation of a large amount of electronic and electronic equipment. This is often in a small space where the installation of such equipment was not envisaged, where onboard power supply arrangements may lend themselves poorly to the amount and locations of survey and personal equipment requiring power and where inbuilt fire detection systems may not provide adequate coverage. Further, project personnel typically embark with a wide range of Personal Electronic Devices (PEDs) which require regular charging.

Great attention must be paid to the fire hazard which may be caused by this equipment, both in terms of the heat generated and the risk of fire in the equipment itself. When configuring the survey collection and processing spreads and equipment charging stations, including those used for PEDs in both communal spaces and overnight accommodation, the following considerations should be amongst those considered:

- Whether the vessel's interlinked fire/smoke detection system adequately protects the space in which the equipment is installed. If there is any doubt as to the efficacy of the fire detection system given the additional equipment, the fire/smoke detection system must be upgraded by the installation of additional interlinked sensors positioned to protect the additional equipment. If this is not practicable, additional stand-alone fire/smoke alarms are an acceptable alternative, however they must be installed in such a way that they would alert personnel outside of the space of a fire within it
- How a fire in the survey equipment would be fought and how electrical power supplies would be quickly and safely isolated. There should be a generous number of CO_2 extinguishers positioned around the survey equipment to allow firefighting from a safe location. Electrical breakers should be easily accessible, clearly labelled and be in a location that they would in practice be safely accessible in the event of a fire in the equipment and circuits which they protect. Ideally these breakers should be outside of the space in which the equipment is installed
- How fire in any location would affect access and egress both to and from the space and to and from the wider structure of the vessel including cabins, both during firefighting and during evacuation. A fire in the survey equipment or charging stations must not negatively impact upon any designated or de-facto escape or access routes which would normally be expected to be clear
- The overall loading of the mains voltage supply to the survey spread, including cable runs, power strips, adaptors, transformers etc
- The practice of 'daisy-chaining' multiple powerstrips together should be avoided. If this is unavoidable, active consideration should be given to total load at each point in the chain
- When locally procuring electrical equipment, (e.g. from local hardware stores), the equipment must conform to recognised international safety standards. Subjectively, if the quality of manufacture appears suspect then the equipment should not be used

C92 Electronic & Electrical Equipment Continued

- UPS and inverter units should be installed in well ventilated locations and should include a circuit breaker to prevent overloading
- Desktop PCs and other equipment with inbuilt cooling fans or convective cooling arrangements should be positioned so that the cooling fans and convective cooling arrangements can draw air and function as designed. Laptop PCs should not be left resting on any surface which obstructs cooling fans
- The survey spread, including wiring runs and powerstrips should not be installed on or adjacent to soft furnishings or any other inherently combustible surface
- All mains' circuits should include an appropriately rated circuit breaker, preferably of RCD type
- The area should be covered by a smoke detection system to ensure early warning of a problem. Active consideration should be given to whether the installed fire detection system is adequate/correctly positioned given the significant additional amount of electronic equipment present in a potentially unusual location. If not, the fixed system must be supplemented by a number of additional stand-alone detectors positioned around the survey equipment so as to give early warning of any problems
- Travel type plug adaptors to convert between international pin patterns should not be used on any survey system including charging stations. These are a universally recognised hazard. Contractor should mobilise with a good supply of equipment leads with different pin configurations so that survey equipment may be plugged directly into the appropriate socket
- In cabins/bunk rooms, PEDs should not use travel type plug adaptors. If mains voltage leads and Power Supply Units with appropriate pin configurations cannot be sourced, an acceptable alternative could be the provision of good quality powerstrips with a suitable pin pattern (e.g. UK), hard-wired with a local pattern plug which is compatible with the vessel's outlets. Care should however be taken to ensure that these are not overloaded
- All electronic equipment in cabins/bunk rooms must be unplugged when the space is unoccupied. PEDs should not be left on charge/on standby unattended
- All electronic equipment in cabins/bunk rooms must be placed on hard surfaces away from any soft furnishings
- Wherever possible all survey equipment should be shut down overnight/when not attended. This should limit running equipment to the Processing PC which is unlikely on its own to constitute a significant hazard
- If a cabin is unoccupied/not in use, vessel staff should wherever possible make isolations to mains voltage circuits supplying that cabin, ensure all equipment which cannot be independently isolated is turned off and then lock the door of the cabin to prevent access

In accordance with The Workboat Code, all soft furnishings must be fire rated.

In shore offices and hotel accommodation, the same general principles must apply to the installation of normal office equipment, charging stations and PEDs.

C93 Equipment Isolations

The vessel Emergency Response Plan must detail all major equipment isolations to be made in the event of an emergency. These should include but not be limited to the ventilation/air conditioning, main machinery, galley, and laundry appliances and should include electrical, mechanical, fluid and intake/exhaust isolations as appropriate.

Active consideration must additionally be given to the way in which the survey spread would be isolated in the event of a fire in that equipment, ensuring that circuit breakers are clearly identified and would in practice be accessible in the event of a fire. This should be discussed with the vessel Master (and in larger vessels the engineering officer/designated head of the ERT), such that there is a common understanding of the hazards presented by the additional equipment and the optimum way to mitigate them. This information should be captured in an appropriate location, for example through update of the Vessel ERP or in a JHA detailing survey emergency response procedures.

As part of the Silent Hours Routine (C61) there must be a routine in place to ensure the overnight isolation of equipment which is not required. This should include but not be limited to galley and laundry appliances and all parts of the survey spread which do not need to be running.

C94 Smoking

Smoking and the use of e-cigarettes is not permitted anywhere inside the enclosed structure of a vessel, aircraft, vehicle, building or facility in use on the Project, or in any location where the smoke/vapour may be blown or drawn inside the structure.

In vessels, smoking/the use of e-cigarettes may only take place on the weather deck, in a designated location where smoke/vapour will not impact upon other personnel. The designated smoking location should be provided with fire-proof receptacles to allow for the extinguishing and safe disposal of all materials arising. It should be in a location which is clear of all other flammable hazards.

In aircraft operations, smoking/the use of e-cigarettes may only take place in accordance with the policies in force at the airfield. Notwithstanding this, smoking may not take place inside the structure of any building or facility in use on the Project.

C95 Rubbish Bins (Trash Cans)

Any rubbish bin used inside the enclosed structure of the vessel must be made of a non-combustible material and must be of a design which would contain any fire within it. Bins should be positioned in such a location that a fire in the bin would not present an immediate hazard in respect of any combustible material or soft furnishings adjacent to the bin. They must be secured such that they cannot move due to vessel motion.

All rubbish bins stowed on the weather deck must be secured so that they do not move and cannot blow open and discharge material overboard in the event of strong winds. They must be positioned in a location where a fire in the bin would not present a hazard to any muster point, evacuation route, piece of emergency equipment or adjacent flammable hazard.

C96 Open flame cooking/ heating appliances

In addition to the safety equipment requirements specified in Paragraph C60, where open flame cooking or heating appliances are installed, the appliance must be isolated when not in use. An effective regime should be in place to ensure that this occurs during silent hours/overnight.

In a typical workboat, the galley stove will be LPG fired and may be isolated overnight by turning off the switch controlling a solenoid valve in the supply line. Less preferably this may be achieved by turning off the valve at the remote LPG cylinder.

C97 LPG Stowages

LPG cylinders must be securely stowed, in an upright position, in a cylinder locker. The cylinder locker must not be located near heat sources or other equipment which presents a reasonably foreseeable fire hazard. The locker must be ventilated to allow any escaping gas to flow directly overboard. The cylinders should be readily accessible and movable and accessible directly from the weather deck.

In the case of vessels which were not manufactured with a dedicated cylinder locker, the simplest option may be to secure the bottle on deck. If this solution is adopted, it should be carefully considered to prevent accidental damage to the cylinder and fuel line. The cylinder should not be in a position which allows leaking gas to enter the interior of the vessel or otherwise 'pool' around the structure and, in hot climates, it should be protected from exposure to excessive sunlight/heat.

C98 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013

The Contractor must report, to the UK Health and Safety Executive, all Injuries, Diseases and Dangerous Occurrences as required under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR).

Where the Contractor is headquartered in a country other than the UK, the Contractor must additionally make reports in accordance with the legislative requirements of the Country or State in which the Contractor is headquartered.

The Contractor must additionally make reports to any local national authority, in accordance with the legislation and requirements of the country in which survey operations are being conducted.

Where it is the Contractor's intention to report an incident to the UK Health and Safety Executive and/or international equivalents, this is to be made clear in the verbal and written reporting submitted to the Authority. A copy of the RIDDOR report, and any equivalent report submitted to an overseas agency, must be forwarded to the Authority as soon as possible as it is submitted.

C99 Incident Reporting

Notwithstanding the RIDDOR reporting requirements outlined above (C98), the following Incidents must be reported to the Authority:

- The death of a person
- A Serious Injury or Illness of a person
- All Medical Treatment Incidents (MTI), Light Duty Incidents (LDI) and Lost Time Injuries (LTI)
- A Dangerous Incident
- Environmental Incidents
- All incidents resulting in loss or damage to equipment
- Any unplanned entry into the water including Man Overboard and falls from the quayside
- Bird Strikes (manned aircraft and RPAS)
- All Incidents which are notifiable under the legislative requirements of the Country or State in which the Contractor is headquartered
- All Incidents which are notifiable under the legislative requirements of the Country or State in whose jurisdiction, waters or airspace the operation is being conducted

A Serious Injury or Illness shall include but not be limited to an injury or illness:

- Causing death
- Where, for whatever cause, the person requires treatment as an in-patient in a hospital or equivalent medical facility including a vessel sick bay
- Where the person suffers:
  - The amputation of any part of his or her body.
  - Fracture of any bone
  - Loss of consciousness
  - A serious head injury
  - A serious eye injury
  - A serious burn
  - The separation of skin from an underlying tissue (such as degloving or scalping)

C99 Incident Reporting Continued

- A spinal injury
- The loss of a bodily function
- The loss or partial loss of any part of a person's body
- Serious lacerations
- External bleeding where the bleed cannot be controlled solely by the application of external direct pressure
- Bites, stings and envenomations which cannot be resolved as a First Aid Incident
- Anaphylactic reactions
- Adverse reactions to any prescription or non-prescription drug or medication
- A Notifiable Disease
- Signs or symptoms of exposure to any substance at the workplace
- Any injury resulting from criminality or deliberately inflicted
- Any injury, including psychological injury and mental health issues which make an employee unfit for work
- Any self-inflicted injury or occurrence pertaining to self-harm

- Requiring the person to have medical treatment within 48 hours of exposure to a substance
- All occurrences of electric shock
- Any other injuries or illnesses which are notifiable under the legislative requirements of the Country or State in which the Contractor is headquartered
- Any other injuries or illnesses which are notifiable under the legislative requirements of the Country or State in whose jurisdiction, waters or airspace the operation is being conducted

A Dangerous Incident means an incident that exposes a worker or any other person to a serious risk to a person's health or safety. Common examples of Dangerous Incidents include but are not limited to:

- Collisions and groundings of project vessels whether or not damage or injury resulted
- Collisions involving project aircraft and vehicles whether or not damage or injury resulted
- All aircraft and RPAS Occurrences, Accidents and Serious Incidents which are reportable under the legislative requirements of the Country or State in which the aircraft is registered and/or the Country or State in which the aircraft is operating

C99 Incident Reporting Continued

- Road Traffic Incidents
- Floods onboard a vessel
- Any incident onboard a vessel which affects stability or buoyancy
- Bird Strikes (manned aircraft and RPAS)
- Fires onboard a vessel or aircraft or in a project vehicle or building including accommodation
- Any explosion or fire caused by an electrical short circuit or overload
- Any fire, explosion or ignition at a site used for the storage of pyrotechnics or explosives
- Any damage caused to a vessel or aircraft caused by adverse weather conditions which could cause an injury to a person
- Noxious gasses onboard a vessel, aircraft or project vehicle, including exhaust gasses
- Atmospheres with depleted oxygen
- The full or partial evacuation of a vessel or aircraft in the interests of safety
- An uncontrolled escape, spillage or leakage of a hazardous or flammable substance
- An uncontrolled implosion or explosion
- An uncontrolled escape of gas or steam
- An uncontrolled escape of a pressurised substance
- Electric shock
- The fall or release from a height of any plant, substance or thing
- The collapse or partial collapse of a structure
- The collapse, overturning or failure of any load-bearing part of any lifting equipment (other than an accessory for lifting)
- Complete or partial collapse of scaffolding
- Any plant or equipment unintentionally coming into contact with an uninsulated overhead electric line in which the voltage exceeds 200 volts, or close proximity with such an electric line that it causes an electrical discharge
- The malfunction of a radiation generator or its ancillary equipment (meaning any electrical equipment emitting ionising radiation and containing components operating at a potential difference of more than 5kV)

C99 Incident Reporting Continued

- The malfunction of breathing apparatus where the malfunction causes a significant risk of personal injury to the user or during testing immediately prior to use where the malfunction would have caused a significant risk of personal injury to the user had it occurred during use
- All diving related incidents which cause a significant risk of personal injury to a diver or a member of the diving team. As well as equipment failure, this includes entrapment, uncontrolled ascent and omitted decompression
- Exposure to criminality including theft, violence or threats of violence, extortion and the soliciting of bribes
- Significant Natural Hazards including but not limited to Hurricane and extreme weather events, Tsunami, Earthquake, Fire, Flood and Landslides
- Any other Dangerous Incidents which are notifiable under the legislative requirements of the Country or State in which the Contractor is headquartered
- Any other Dangerous Incidents which are notifiable under the legislative requirements of the Country or State in whose jurisdiction, waters, or airspace the operation is being conducted

An Environmental Incident means an incident that exposes the environment to harm. This includes air, water, land, wildlife, local habitat, designated Heritage Sites and designated Sites of Special (Scientific) Interest. Examples of notifiable Environmental Incidents include but are not limited to:

- Any occurrences contravening MARPOL regulations
- Any loss of containment of Hazardous Substances (C35) including fuels and oils
- Unauthorised damage to any state or locally significant relic or heritage item
- Bird Strikes (manned aircraft and RPAS)
- Failure to comply with the requirements of any Environmental legislative requirements of the Country or State in whose jurisdiction, waters, or airspace the operation is being conducted
- Any other Environmental Incident which is notifiable under the legislative requirements of the Country or State in which the Contractor is headquartered
- Any other Environmental Incident which is notifiable under the legislative requirements of the Country or State in whose jurisdiction, waters, or airspace the operation is being conducted

C99 Incident Reporting Continued

All Incidents are to be verbally reported to the Authority as soon as practicable, with follow up documentary reporting submitted within 24 hrs. Where the conduct of operations is impacted, this should be addressed, together with the actions required to rectify the situation, the anticipated timeframe for resumption of operations and any longer-term impacts on project scheduling.

Documentary reporting is to be conducted using the appropriate Contractor form and statistically recorded in the DPR. Where incident reporting is also submitted to an external authority in accordance with the legislative requirements of the Country or State in which the Contractor is Headquartered or in which operations are being undertaken, the Authority must be provided with a copy of that documentation.

The Authority operates a no-blame policy in respect of all QHSE related reporting; Incident reporting is for the purpose of discharging Duty of Care responsibilities, operational planning, informing the Lessons Identified (LI) and Continuous Improvement (CI) processes, to assist all parties in the prevention of a recurrence and to fulfil legislative requirements.

C100 Near Miss Reporting

A Near Miss is a dangerous occurrence, not causing harm, but which had the potential to cause an Incident as defined under Incident Reporting (C99).

All Near Misses must be reported to the Authority as soon as reasonably practicable and in any case within 48 hrs of the Near Miss.

All Near Misses must also be reported in accordance with the legislative requirements of the Country or State in which the Contractor is headquartered and/or the Country or State in which operations are being undertaken.

Documentary reporting is to be conducted using the appropriate Contractor form and statistically recorded in the DPR. Where Near Miss reporting is also submitted to an external authority in accordance with the legislative requirements of the Country or State in which the Contractor is Headquartered or in which operations are being undertaken, the Authority must be provided with a copy of that documentation.

The outcome of any subsequent investigation is to be reported to the Authority, in accordance with Contractor processes and procedures as soon as the outcome is known.

The Authority operates a no-blame policy in respect of all QHSE related reporting; Near Miss reporting is for the purpose of discharging Duty of Care responsibilities, operational planning, informing the Lessons Identified (LI) and Continuous Improvement (CI) processes, to assist all parties in the prevention of a recurrence and to fulfil legislative requirements.

C101 Non-Conformance Reporting

A Non-Conformance Report documents the details of a non-conformance identified in a quality audit or other process review. The objective of the report is to make an unambiguous, defensible, clear and concise definition of the problem so that corrective action can and will be initiated by management.

All Non-Conformances, together with the proposed Corrective Actions, are to be reported to the Authority in accordance with Contractor procedures.

C102 Accident Book

An Accident Book must be available to every Vessel, Aircraft and RPAS team participating in the Project and in the Shore Offices. In practice this may be held in the Vessel, Aircraft, at the airfield, at the RPS, or in a RPAS support vehicle as most appropriate. The Accident Book is to be of an HSE approved format such as the UK HSE template at https://www.hse.gov.uk/pubns/books/accident-book.htm

All accidents involving injury, no matter how minor, must be recorded in the Accident Book. This includes all FAI, MTI, LDI and LTIs. On completion of the project, the accident book is to be retained by the Contractor for at least 3 years.

C103 First Aid Injury

First Aid Injuries (FAI) are injuries which require local treatment by a project First Aider which do not ordinarily require professional medical care. An injury which is treated by a medical professional (e.g. Doctor or EMT) but which could have been dealt with by a workplace First Aider remains an FAI.

FAIs are to be managed locally and internally reported in accordance with Contractor policy. They need not be specifically reported to the Authority, but they are to be statistically recorded in the DPR.

In the event of a FAI subsequently escalating and becoming a MTI, LDI or LTI, the situation is to be reported as an Incident as soon as practicable.

C104 Medical Treatment Injury

A Medical Treatment Injury (MTI) is a minor injury of a non-permanent nature requiring treatment by a doctor or other qualified medical professional including dentists. The employee can return to his/her normal work immediately on completion of treatment.

Or

Any occasion in which a prescription medicine is drawn from the Medicine Chest (C42) or Personal Medical Kit (C43) and administered under the remote supervision of a clinician or self-administered in accordance with previous instructions. (This does not include the routine self-administering of anti-malarial prophylaxis).

Or

Injuries to multiple individuals of a non-life threatening, non-permanent nature which require first aid only, i.e. multiple FAIs.

All MTIs are to be reported to the Authority as soon as reasonably practicable.

C105 Light Duty Injury

A Light Duty Injury (LDI) may exceptionally result from a FAI but is more commonly an MTI in which the injured employee additionally has work restrictions requiring assignment to other than his/her normal job or in which they cannot perform all aspect of his/her normal role unaided.

All LDIs are to be reported to the Authority as soon as reasonably practicable.

C106 Lost Time Injury

A Lost Time Injury (LTI) requires treatment by a doctor or other medical professional and the injured employee cannot return to work on his/her next scheduled working day because of the injuries received.

All LTIs are to be reported to the Authority as soon as reasonably practicable.

C107 Environmental Impact Statement

The Contractor must provide an Environmental Impact Statement (EIS). The EIS must be supplied to the Authority at least 4 weeks before commencing field work and at a minimum consider the following:

- Travel and transport (personnel & equipment)
- Reduction of noise and emissions
- Energy and Climate Change
- Minimisation of total energy/fuel consumption
- Air quality
- Minimisation of greenhouse gas emissions and pollution of air with gases and particulates
- Avoid harm and minimise disturbance or annoyance to people and wildlife caused by noise generated during survey activities
- Waste management (C109)
- Minimisation of waste production and promote reuse, recycling, and recovery
- Reduce total water consumption, maximise efficiency of use and encourage reuse whilst minimising the risks of water pollution
- Seabed and sediment
- Protection of seabed stability and features of geological interest
- Nature Conservation
- Conserve and prevent loss of biodiversity
- Mitigation of potential hazards to marine life
- Mitigation of potential hazards to terrestrial life including birds
- Impact upon and prevention of disturbance to maritime heritage
- Impact upon and prevention of disturbance to terrestrial historic and cultural sites, particularly sites of significant importance to indigenous peoples
- Communities and Social values
- Minimise disruption and nuisance to communities and local environments

C108 Carbon Footprint

In addition to the EIS, the Contractor must provide an estimate on tendering of the carbon footprint for all aspects of the projects including processing and delivery. Full details of the methodology and all aspects considered are to be included. The estimate is to be updated as required during the project and rendered as part of the final deliverables.

The Authority aspects of the project such as client representation are not to be included.

C109 Waste Management

So far as reasonably practicable, all vessels, aircraft, vehicles, and project facilities must operate a waste segregation system which separates and subsequently correctly/safely disposes (ashore) of recyclable material, non-recyclable domestic materials, biodegradable food waste, sanitary and medical waste, batteries, and industrial wastes including hazardous and flammable materials.

Notwithstanding the above, all industrial oily waste and hazardous waste, (including machinery lubricating oils, hydraulic fluids and filters, glues, and resins), must be segregated from ordinary domestic waste and must be disposed of in accordance with local applicable legislation.

Where local legislation does not specify and/or in practice provide for an appropriate means of disposal of segregated wastes, Contractor must identify and implement the locally available means of disposal which most closely conforms to current UK Environment Agency guidance. If this is the case it is to be reported to the Authority as a Non-Conformance, which must describe the issue and highlight the difference between the UK Environment Agency guidance and the locally achievable reality.

So far as reasonably practicable, disposal of any garbage from vessels at sea should not take place. If no alternative exists, (for example in the case of prolonged periods of Remote Working where waste generated exceeds storage capacity), disposal of garbage at sea must only take place in accordance with MARPOL and any locally applicable regulations.

Intentions for Waste Management are to be included as a section of the Environmental Impact Statement (C107).

Part D

General Requirements

Customs, Licenses, Consents and Permissions 117
Logistics 117
Fishing Industry 117
Additional Requirements for lidar Surveys 117
Scope 117
Progress Reports 118
Quality Control 119
Deliverables 119
Authority Provided Documentation 120
Survey Timings 120
Data Delivery Deadline 120
Data Delivery 120
H Forms and Templates 120
Report of Survey 121
File Conventions 122
Labelling of Records and Data 123
The Authority Appraisal Schedule 123
Data Ownership 123
Retention of Data 123

D1 Customs, Licences, Consents and Permissions

The Company must be responsible for arranging all licences, consents, customs clearance and permits, for access and radio communication clearance for all survey operations whether ashore, in the air or afloat to enable the survey to be conducted.

D2 Logistics

The Company must be responsible for ensuring all logistic arrangements including availability of correct fuel and engineering support are available in the area of operations.

D3 Fishing Industry

Liaison with, and compensation to, fishermen for loss/damage to fishing gear are matters which rest entirely with the Contractor. The Contractor is to liaise closely with local fisheries groups and the appropriate Local Fisheries Authorities well in advance of the commencement of fieldwork.

D4 Additional Requirements for lidar Surveys

When conducting a lidar Survey, the following items requiring the use of a seagoing Vessel may be specified in the HI but would not normally be expected:

- Acoustically collected bathymetry
- Water Clarity
- Tidal Stream Observations
- Seabed Sampling
- Views for Sailing Directions

D5 Scope

While every effort is made to ensure the Hydrographic Instruction provided at contract award is correct in extent, the Authority reserves the right to extend the scope of the requirement due to unforeseen circumstances following contract award. Renumeration for such work will be charged either at the provided daily rate, or at an agreed fixed price.

D6 Progress Reports

A Weekly Progress Report must be completed and e-mailed to the Authority throughout the duration of each HI. This must commence upon mobilisation of personnel and cease upon final demobilisation.

The specific email addresses to use for each project will be given at the Project Kick Off Meeting.

The report is to be with the UKHO addresses by 0800 (UTC) each Monday.

While this report may use the same format as internal Company project reporting, it must include:

› Associated vessel plans

› Any safety incidents and concerns

Operational

› A summary of activities over the previous 7 days

› Data collection progress to date

› Notable data collection challenges encountered

› Data processing progress to date

› Notable data processing challenges encountered

› A summary of activities planned for the next 7 days

› The predicted delivery dates for all final deliverables with any amendments to the original plan highlighted

Personnel

› The names of personnel in the field

› The names of personnel mobilised during the previous 7 days

› The names of personnel demobilised during the previous 7 days

D6 Progress Reports Continued

Equipment & Environment

› Weather downtime

› Equipment downtime

› Vessel downtime

Logistics

› Logistics forecast including downtime for routine Vessel, vehicle and Aircraft maintenance

QHSE

› Health and Safety summary drawn from the previous week's Daily Progress Reports

› Summary of any accidents and incidents

Other

› Any other issues or concerns

Any specific incidents, downtime that will affect delivery dates, or other concerns should be raised directly to the Authority as they occur.

The Authority reserves the right to increase the frequency of progress reports during a project if it requires additionally timely information. This may be by inclusion of Authority addressees in the email distribution of the Company Daily Operational Report (DOR)/Daily Progress Report (DPR) and may also require the inclusion of additional fields in that report form to satisfy specific information requirements.

D7 Quality Control

Robust quality control procedures must be provided and adhered to during processing of all data. These procedures must be provided to the Authority prior to survey operations commencing.

D8 Deliverables

The following deliverable milestones are detailed fully in the relevant ITT and HI:

1. Mobilisation
2. Raw Data
3. Demobilisation
4. Submission to Authority and passing of initial check
5. Final appraisal complete and survey accepted

Requirements for each milestone are detailed in the specific section of this specification for each data type.

D9 Authority Provided Documentation

The Authority will provide the following documentation:

Form/Document Number	Name
	Relevant Admiralty Sailing Directions
	Relevant GeoTIFFs of latest British Admiralty charts
	UKHO Electronic Navigation chart of the area where applicable/available
	UKHO Report of Survey Template
H102 (A/B)	Hydrographic Note Template
H143	Record of Tidal Observations (Fair)
H159	Description of Geodetic Control Station
H525	Report on Wreck Examination or Sweeping
H532	Levelling Reduction
H533	Transfer of Sounding Datum
H575	Record of Seabed Samples and Cores
H635	Oceanographic Observations

D10 Survey Timings

The Authority will endeavour to give the maximum time from award of HI to the final delivery deadline to allow the Contractor to optimise data collection in terms of weather and vessel availability. It should be noted that financial constraints often limit project timings to UK Financial Years (Apr-Mar).

D11 Data Delivery Deadline

All data and associated documents must be rendered to the Authority by the date stated in the HI. Any early submissions and payments must be agreed with the Authority.

D12 Data Delivery

Unless agreed otherwise, all data and reports are to be rendered via the UKHO FTP Site. Access details will be provided on contract award.

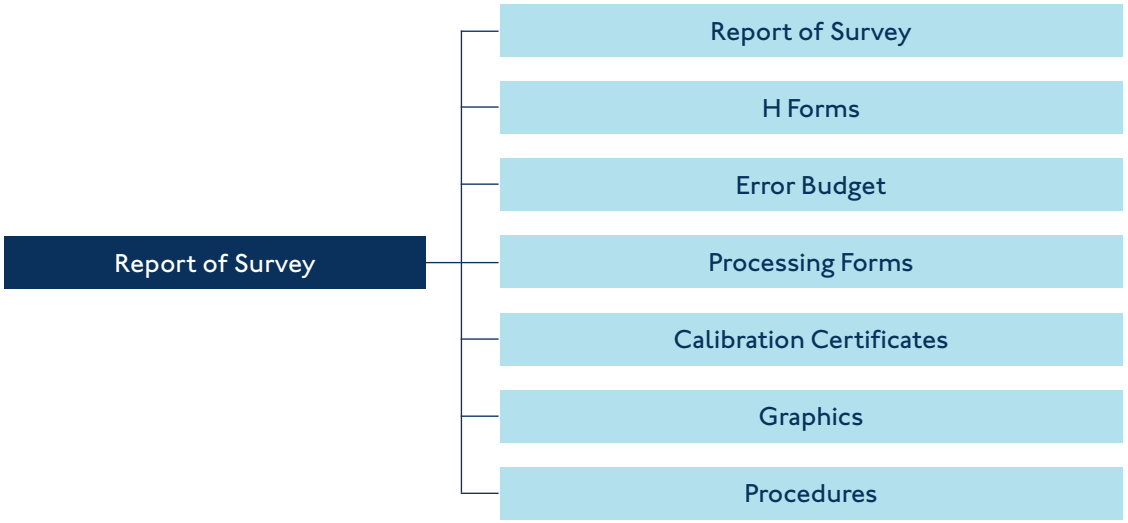
D13 H Forms and Templates

"H Forms" and Report Templates have been designed by the UKHO to facilitate checking and validation of rendered data. The Contractor shall always use the appropriate "H Form" where one exists for a process which is undertaken.

D14 Report of Survey

The Report of Survey along with the various H Forms provides the metadata required to both validate the data and correctly archive and distribute it for onward use. As such as much care should be taken over its completion as the data itself.

A separate folder should be forwarded with the data delivery using the following format:



D15 File Conventions

Naming Convention:

File naming used for each type of data 'product' will follow these conventions (unless otherwise stated in this specification):

- Filenames will contain a series of elements that give information about the file contents
- These elements will be separated by an underscore (_)
- Elements will contain only letters (AaBbCc etc…) and numbers (0123…)
- Filenames should not contain spaces. If required, 'CamelCase' (capitalising the first letter in each word) can be used to make concatenated words easier to read
- Filenames will finish with the conventional extensions (.jpg, .tif, .csv etc)

File naming for final products (e.g. image files, bathymetric surfaces) will adhere to the following convention. The use of elements within raw data and working files is encouraged, where appropriate, as 'good practice':

HInumber_Title_DataType_CoordSys_BinSize

Element	Description
HI number	The Hydrographic Instruction number for the survey.
Title	Abbreviated survey title as supplied by the Authority.
DataType	SBXYZ = ASCII XYZ of fully corrected Swathe bathymetry. SB = Swathe bathymetry GeoTIFF. SBFP = floating point GeoTIFF from Swathe bathymetry. SBSXYA = ASCII X, Y, Backscatter in decibels. SBS= Swathe backscatter GeoTIFF. SBSFP = floating point GeoTIFF from Swathe backscatter.
CoordSys	Datum and projection of the output data product. E.g. UTM29N, WGS84, ITRF2008.
BinSize	Grid resolution, in metres, for raster data and XYZ. Express as a decimal, but substitute the letter 'd' for the decimal point. 0d5 = 0.5 m , 1d0 = 1.0 m, 1d5 = 1.5 m etc. If Full density XYZ output use the abbreviation: FD.
Additional	Further information can be added if relevant. E.g. Tile1, V1.
Null values	Use NA (not applicable) to represent a null value for mandatory elements.

Example: GBR_HI1234_LittleHarbour_SBXYZ_UTM30N_2d0.

D16 Labelling of Records and Data

Project Name: As detailed in each HI.
Hydrographic Instruction Number: As detailed in each HI.
Hydrographic Instruction Name: As detailed in each HI.

All deliverables are to be named iaw the file conventions laid out in each relevant section of this specification.

Where appropriate, they are to carry the following official markings:

CROWN COPYRIGHT 2020*

Where appropriate, they are also to carry an official marking: As detailed in each HI.

*year as appropriate.

D17 The Authority Appraisal Schedule

The Authority intends to fully validate the deliverables within 30 working days* subject to the data passing a 5-day initial check. The 5-day check will commence on successful transfer of the entire data set to the Authorities systems.

If the data is delivered to the Authority earlier than described at D11, then the Authority will assign the survey to the next available slot in their programme. The validation timescales may increase but the Authority intend to not exceed 30 working days* past the Data Delivery Deadline (D11).

This assumes the deliverables are fully compliant with this specification.

* Working days are defined as: the days between and including Monday to Friday and do not include public/bank holidays and weekends in England.

D18 Data Ownership

All rights in intellectual property which are generated in the performance of work under the Contract shall vest in and be the property of the Authority. The Contractor shall take all necessary measures to secure that vesting.

D19 Retention of Data

All raw and processed digital records shall be retained and maintained by the Contractor for a period of 1 year from the date of the final contract payment in case of questions arising.

On completion of this 1 year period, the Contractor is to destroy/remove data from all systems and media and confirm to the Authority that this has been completed.

Part E

Positioning

Survey Geodesy 125
Geodetic Parameters Check 125
Horizontal Uncertainty 125
Positioning 125
Establishment of Survey Control 126
Optical Levelling 127
Geodetic Station Marking & Documentation 128
Geodetic Station Documentation 132
Dimensional Control 133
GNSS Static Positioning Check 134
Swath Bathymetry Vertical Offset Check 135
Swathe Bathymetry Calibration (Patch Test) 135
Swathe Bathymetry Repeatability Test 136
Lidar Calibration 136
Lidar Dynamic height check 136
Lidar Roof Test 137
Lidar Bathymetric Repeatability Test 137
Bathymetric Test Site 137
Lidar Strip Adjustments 137
USBL Positioning 137
USBL Error Budget 138
USBL Beacons 140
USBL Calibration 141
USBL Spin Check 142
USBL Z Check 142
USBL Position Check 142
Position Quality 143
Deliverables - General 143
Deliverables – Mobilisation 143
Deliverables – Delivery 143

E1 Survey Geodesy

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

Datum: ITRF2014

Spheroid: GRS '80

Projection: UTM Grid Zone: As specified in the HI

Geoid model: EGM08

Unless an alternative format is stipulated by a specific H-Form, all rendered positions must be quoted as geographical co-ordinates (i.e. in terms of Lat./Long) as decimal degrees to at least 8 decimal places. The realisation of ITRF used (i.e. 2014) should be clearly stated in the Report of Survey.

E2 Geodetic Parameters Check

If a datum other than ITRF is specified, a Geodetic Parameters Check should be conducted using the survey navigation system's inbuilt test feature to demonstrate the correct transformation of coordinates between ITRF and the survey datum. If this is required it will be specified in the HI, together with a specimen set of coordinates to use in the Check.

If a Geodetic Parameters Check is required, the result of the check must be reported in the Mobilisation and Calibration Report.

E3 Horizontal Uncertainty

The Horizontal Uncertainty of all soundings and positions shall be as stated at G5 or in the HI.

E4 Positioning

The Contractor must demonstrate that the method chosen for sounding positioning results in the overall horizontal and vertical uncertainty requirements for the Standard as stated in the HI being met.

The Contractor will state methodologies for positioning as a tender deliverable. This can be post-processed or real time.

E5 Establishment of Survey Control

- Three-dimensional position of any existing or newly established survey control must be determined by dual frequency carrier phase GNSS techniques, tied into a Continuously Operating Reference Station network
- Multiple reference stations are to be used where available and a full network adjustment carried out to ensure the positional accuracies are met as stated below
- Data should be logged at 15 second intervals
- Where the maximum baseline length does not exceed 715km, a minimum of twelve hours of observations are required per station
- The observation period should be divided into two sessions of equal duration. At the end of the first session the antenna should be physically moved away from the mark and then re-established over the mark (at an appreciably different antenna height) before commencing the 2nd observation session
- Where the maximum baseline length is greater than 715km the following formula should be used to calculate the minimum required duration of observations per station in minutes:
  - Baseline length (in km) + (recording interval (in secs) x 0.5)

The absolute uncertainty with respect to the coordinate system used (ITRF2014) for any existing or newly established survey control must not exceed 1cm + 0.1ppm in horizontal and 2 cm + 0.1ppm in vertical (at the 95% confidence level)

- When logging GNSS data care must be taken to use a suitable elevation mask (a minimum of 15°) and minimise the effects of multipath signals. This information must be included in the Report of Survey
- The height of the GNSS antenna should be measured before each logging session and clearly recorded and reported. If the height measured is a slope distance from the edge of the antenna, this must be appropriately corrected to obtain the true vertical offset
- The static GNSS antenna must be positioned directly over the control point using an optical plummet
- An orthometric height as described in the HI and appropriate UTM coordinate for each station must be computed. Where necessary, co-ordinate conversion must be conducted using appropriate (as agreed by the Authority) conversion programs and an estimated final uncertainty stated

The Authority will consider, but is not under any obligation to accept, alternative solutions to that described above. If the Contractor wishes to suggest an alternative solution, they must provide detailed technical evidence of their methodology and compliance with the absolute uncertainty requirements to the Authority within their tender.

E6 Optical Levelling

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

The correct practices for traditional optical Differential Levelling are to be adhered to. In particular:

- Prior to commencing a traverse, the correct calibration of the instrument is to be confirmed by performing a Two Peg Test. If required the instrument is to be adjusted and the test repeated to demonstrate that it meets the anticipated accuracy for the technique. The results of this test are to be recorded and presented as an attachment to the H532 Levelling Reduction Form
- Levelling is to be conducted between the 2 established control points, the tide pole and any existing benchmarks in the vicinity and provided in the HI. Levelling is to comprise a looped traverse, starting on the first known point and finishing on the second; no inter-sights shall be taken. Levels should be read and recorded to a precision of 0.001m. The maximum acceptable misclosure for a looped traverse is 0.02m. Any misclosure is to be in line with the apriori sounding budget
- The Authority recommend levelling is to be conducted using the Three Wire (top; middle and bottom of stadia) technique
- Levelling is to be conducted using *Foresights* and *Backsights* positioned at *Turning Points* in the traverse. The optical instrument is to be positioned at a point equidistant between the Foresight and Backsight with observations taken to both staffs
- If an area exists over which it is impossible to run differential levels with balanced sights, a new geodetic mark should be established in a location which eliminates this requirement. If this is impossible or impractical then the correct Reciprocal Levelling technique is to be employed to bridge the gap
- Every effort shall be made to ensure that the survey staffs are held vertically whilst observations are being taken. An appropriately mounted bubble Staff Level shall be employed for this purpose
- On soft or uneven ground, a Change Plate or similar is to be used to provide a footing for the survey staff at all Turning Points
- A Staff Baseplate with a pointed tip is to be used if geodetic marks used have a pronounced indentation at the measurement point
- Levelling shall be recorded using the H532 Levelling Reduction Form. Any levelling field records should also be supplied, including the results of the Two Peg Test. The calibration certificate for the optical level is to be appended

In some cases, this levelling requirement may be replaced by an entirely GNSS based redundant technique upon agreement with the Authority, should pre-existing control prove unsuitable or non-existent.

E7 Geodetic Station Marking & Documentation

All geodetic stations established during survey operations must be described, photographed, and permanently marked to enable their future recovery.

To enable the correct performance of level loops (when conducting optical levelling to a tide gauge), two geodetic stations must be established in each locality. These should be inter-visible, but sufficiently separated as to make it unlikely that any subsequent disruption would affect both marks. Stations should be suitably positioned for optimal GNSS observations; they should not be located close to possible sources of electromagnetic interference, or to buildings or topography which could obscure satellite visibility or cause multipath issues.

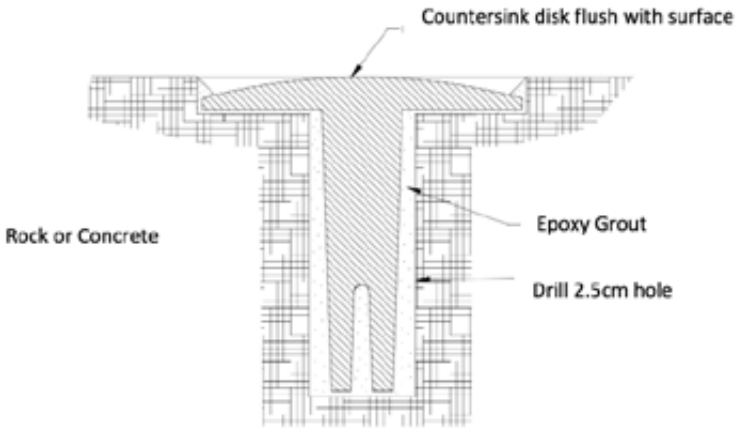
The proposed location for the geodetic stations must be fully described in the tender documentation and in the Project Execution Plan.

Appropriate permissions must be obtained by the Company prior to establishing any permanent marks.

Geodetic stations must be easily recoverable and installed on solid ground that is unlikely to move, be developed or be subject to change in the foreseeable future. For this reason, stations must not be established in tarmac. Stations should only be established on jetties or piers if these structures are assessed to be extremely stable, e.g. they are solid concrete or rock and concrete structures built directly on the underlying bedrock. Concrete or wood jetties or piers supported by piles would not normally be considered sufficiently stable; if however a Geodetic Station is established on such a structure, (for example facilitate levelling to an immediately adjacent tide gauge), the second station must be established on the shore.

The standard methods for installation of a geodetic station, using a standard 3.5"/8.9cm engraved brass or bronze marker with centre-punched datum point is illustrated below. Alternate methods for installation may be used but must be agreed with the Authority.

GNSS station mark – engraved brass or bronze disk in rock or precast concrete



E7 Geodetic Station Marking & Documentation Continued

GNSS station mark – detail of engraving

The marker and all installation equipment must be provided by the Company and engraved as illustrated above

The Year and Station Designation should be completed in accordance with the HI. This may be engraved or manually stamped using appropriately sized number and letter punches.

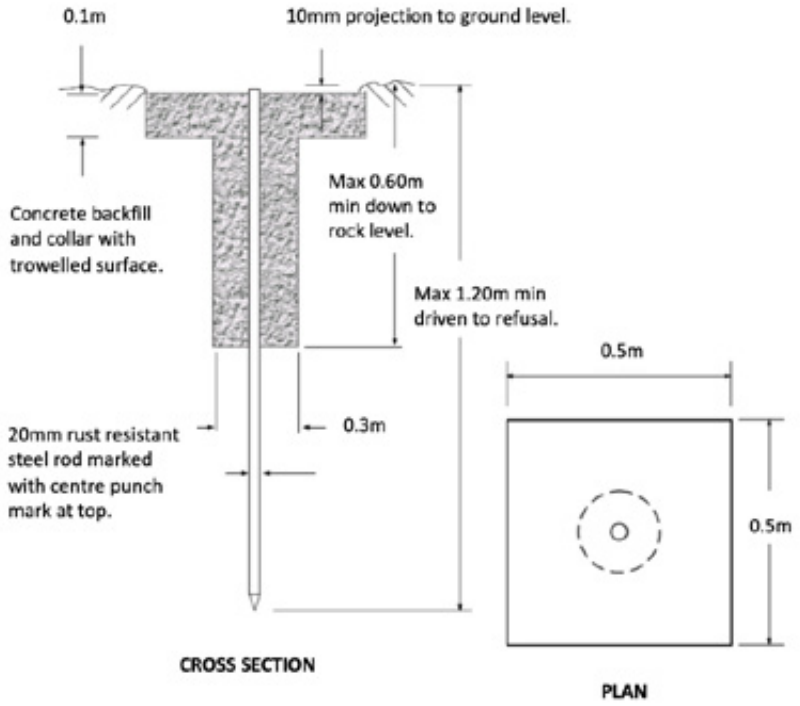
If a location or installation scenario conforming to these requirements is fundamentally not available in the vicinity of the required location, alternative methods of installation may be acceptable using rod or tube monuments. The use of Survey Nails/Survey Washers will not however normally be considered adequate for marking permanent GNSS stations; experience shows that they are insufficiently resistant to disturbance.

Stations deviating from the above requirements due to site conditions should be fully described in tender documentation and in the Project Execution Plan. These will only be permitted at the prior discretion of the Authority. The Authority will have the final say on geodetic station location suitability.

Representative examples of these are illustrated below. Wherever possible the rod or tube shown should be capped with a brass or bronze Station Mark, conforming to the above specification, which should be securely attached to the rod or tube. Where this is possible the end of the rod or the tube cap must be centre punched to precisely define the centre of the geodetic mark.

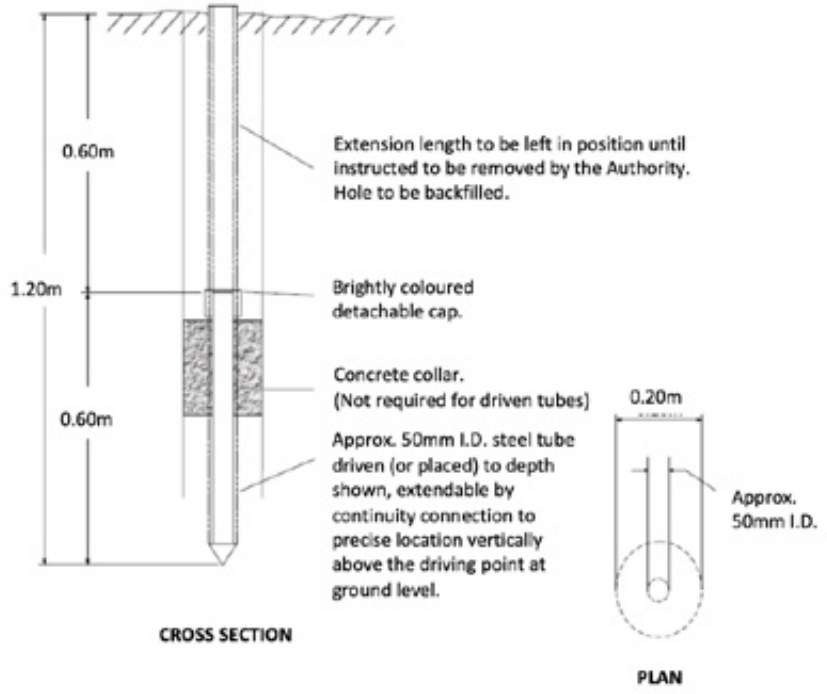
E7 Geodetic Station Marking & Documentation Continued

GNSS station mark – unpaved surfaces (non-agricultural sites)



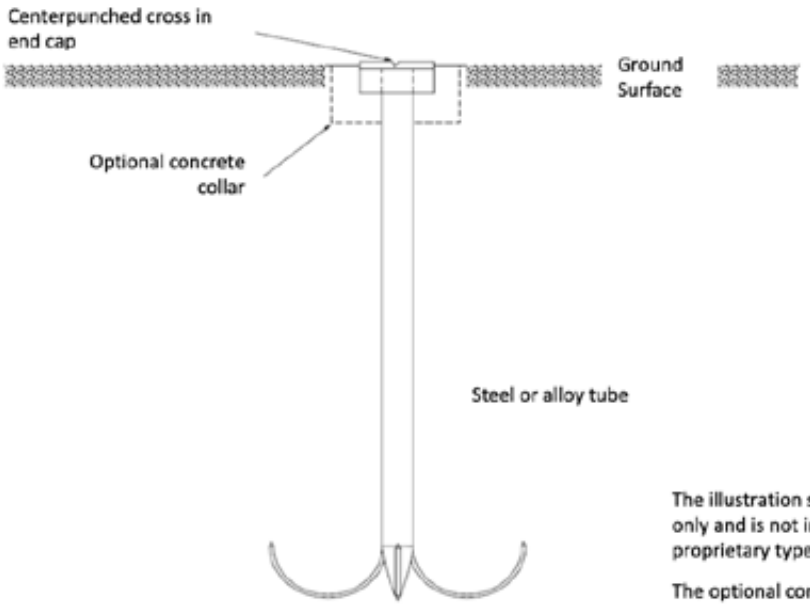
E7 Geodetic Station Marking & Documentation Continued

GNSS station mark – unpaved surfaces (agricultural sites)



E7 Geodetic Station Marking & Documentation Continued

GNSS station mark – soft surfaces (agricultural sites)



The illustration shown is diagrammatic only and is not intended to refer to any proprietary type.

The optional concrete collar should be included unless ground conditions prohibit this.

E8 Geodetic Station Documentation

A full station description must be recorded using the H159 Description of Geodetic Control Station Form, including photographs and diagrams to aid recovery.

All stations are to be described in terms of ITRF2014 position and the following height datums:

- ITRF ellipsoidal height
- Chart datum
- EGM08
- Local land datum (if known)

H159 Description of Geodetic Control Station Forms are to be appended to the Mobilisation and Calibration Report.

E9 Dimensional Control

An appropriate Dimensional Control Survey, (DimCon), of each Vessel, Vehicle or Aircraft, (the Survey Platform), utilised must have been conducted prior to commencement of data collection. Permanent and recoverable control points are to be established on each Survey Platform, coordinated to the reference frame to within a tolerance ±0.01m relative (at the 95% confidence level) in X, Y and Z.

All sensors must be established within the Survey Platform reference frame within a tolerance of ±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 must be initially determined by the DimCon to within ±0.2 degrees (at the 95% confidence level). If required, these values may be later adjusted during the sonar patch test or lidar repeatability test as appropriate.

For swath bathymetry surveys, the Centre of Gravity (CoG) of the vessel (rotation) must also be determined. In small vessels and workboats this may be by estimation. In larger vessels this should be by calculation and/or observation using the results of formal vessel stability observations if available. The position of the CoG and its location within the vessel reference frame and the method by which it was established must be clearly described in the Report of Survey.

A copy of the dimensional control report for each Survey Platform must be supplied with the Mobilisation and Calibration Report and referenced in the RoS for each HI.

Any deviation from the above must be discussed and agreed by the Authority.

The results of the Survey Platform Dimensional Control may be presented as a stand-alone document or, if conducted in the field, are to be included in the Mobilisation and Calibration Report.

E10 GNSS Static Positioning Check

A GNSS Static Positioning Check must be performed at the start of fieldwork for each HI and after changing out or significantly reconfiguring any GNSS sensor or antennae.

The positioning data to be compared must be derived using the same equipment and configurations which will subsequently be used to obtain all positions associated with the bathymetric data.

The Static Positioning Check must monitor either:

› The three-dimensional position of both the primary and secondary GNSS antennae, for a period of no less than 30 minutes at a 6 second resolution or

› The three-dimensional position of another appropriate point within the Survey Platform reference frame as calculated by navigation system computations from positions supplied by both the primary and secondary GNSS antennae and the heading sensor, for a period of no less than 30 minutes at a 6 second resolution

The Static Positioning Check report should separately state the computed statistical reliability of both the horizontal position and the height measured.

Any local survey control utilised in this procedure must be compliant with the requirements above in Establishment of Survey Control (E5).

The detail of the proposed methodology and analysis must be presented in the tender.

The results of the Static Positioning Check are to be included in the Mobilisation and Calibration Report.

E11 Swath Bathymetry Vertical Offset Check

A vertical offset gross error check shall be performed at the start of each HI; after changing out or significantly reconfiguring any survey sensor and regularly throughout the survey.

The detail of the proposed methodology and analysis shall be presented in the tender.

The check shall compare the physical measurements of the distance from the waterline to the seabed. This must be performed in one location, in a depth of water representative using a method entirely independent of the vessel's survey systems (e.g. level staff or lead line in a berth). These measurements shall be compared to data logged with respect to the waterline simultaneously in the same location using the vessel's survey system and software and, where available, the navigational echosounder. The results should be compared and detailed in the Report of Survey and included in the Mobilisation and Calibration Report.

E12 Swathe Bathymetry Calibration (Patch Test)

A calibration of the Swathe Bathymetry system and associated sensors (e.g. "Patch Test") must be performed at the start of field work for each HI or after changing out or significantly reconfiguring any survey sensor (methodology must be detailed in tender). Final post calibration repeatability must be proven by means of the Swathe Repeatability Test (E1.14).

The detail of the proposed methodology and analysis must be presented in the tender.

The results of the Patch Test are to be included in the Mobilisation and Calibration Report.

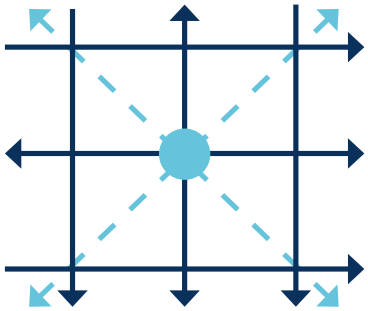
An MBES Boresight Calibration may be an acceptable alternative, but full details of the procedure would need to be included in the tender and agreed by the Authority.

E13 Swathe Bathymetry Repeatability Test

A Swathe Bathymetry Repeatability Test must be performed following all previous checks and calibrations:

This should be undertaken at the start of field work for each HI or after changing out or significantly reconfiguring any survey sensor (methodology shall be detailed in tender).

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.



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

The results of the Swath Bathymetry Repeatability Test are to be included in the Mobilisation and Calibration Report.

E14 Lidar Calibration

A calibration of the lidar system and associated sensors must be performed at the start of each survey, if there is significant change in the repeatability test and after changing out or significantly reconfiguring any survey sensor iaw E15-18.

Any deviation from the prescribed procedure must be proven to and agreed by the Authority.

E15 Lidar Dynamic height check

A test area no smaller than 10m2 is to be surveyed on land to an accuracy of 2cm in horizontal and 5cm in vertical (at the 95% confidence level) with a grid point every 1m. The system is then to be flown over this site in a number of directions and the resultant data used to confirm the calibration of the system. Full details are to be rendered as part of the final deliverables.

E16 Lidar Roof Test

A roof test is to be conducted where the system is to be flown over a building with a pitched roof from 4 directions 90o apart. The resultant data is to be used to demonstrate the correct calibration of the system. On completion of the roof test the system is to be flown overland to sea. A difference of no more than 0.1m is to be achieved at this crossover.

The aerial photography system is to be checked during the roof test to ensure that it is coincident with the lidar and detailed in the Report of Survey

E17 Lidar Bathymetric Repeatability Test

Unless a suitable feature is known (as detailed in the HI) a suitable underwater feature should be identified as early in the survey as possible to conduct a bathymetry repeatability test following calibration at the start of each survey, changing out or significantly reconfiguring any survey sensor and at the end of the survey (methodology must be detailed in tender). This test should be conducted after the dynamic height check stated above.

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

E18 Bathymetric Test Site

If available, the UKHO will provide the results of any recent acoustic survey to further inform the validation. If previous data is not available, the HI may specify that the Company conducts a small acoustic survey to act as a test site.

E19 Lidar Strip Adjustments

To achieve the data uncertainty noted at G5 and a seamless crossover between bathymetry and topography, a strip adjustment is to be conducted based on a number of Ground Control Points (GCPs) if necessary, on the topographic data, with full details of the process, adjustment and any final mismatch that is still evident are to be noted in the tender documentation and reported in the RoS.

GCPs are to be:

› Spread evenly throughout the survey area

› No more than 25km apart

Coincident with crosslines if this does not detract from the bathymetric quality control.

E20 USBL Positioning

Ultra-Short Baseline (USBL) positioning must be conducted using a fixed (i.e. pole or hull mounted) USBL transducer.
The use of 'dipping' type USBL transducers which are deployed by being lowered over the side of a vessel on a tether is not permissible.

E21 USBL Error Budget

In typical scenarios, USBL will be used to position an ROV which is being used as a platform for:

- General Visual Inspections (GVI)
- Close Visual Inspections (CVI)
- MBES surveys conducted in deeper water where higher order UKHO Survey Levels are required than could be achieved using an MBES mounted to a surface vessel

A specific Error Budget for the USBL positioning system will not normally be stated. (If a specific Error Budget for USBL positioning is required it will be stated in the HI). The requirement is that the overall horizontal and vertical positional accuracy of the entire survey system allows the specified THU and TVU, (and feature detection requirements if applicable), and specified UKHO Level of survey to be achieved. The equipment and methodology specified in the Project Execution Plan must be capable of meeting the specified UKHO Survey Level.

For example, if an ROV is being used for CVI during a Level 5 or Level 6 Wreck Investigation, to visually confirm the position of the shoalest point of a wreck during an IHO Order 1a survey, the overall system Error Budget must be such that the that the THU and TVU for the detection of the shoalest point is met. This will be the sum of surface vessel GNSS positioning errors, USBL system positioning errors and any additional positional uncertainty associated with visual observation of the shoalest point from a remote camera. This visual observation error could be minimised by, for example the use of a laser to accurately range the shoalest point from the known datum of the camera mount.

Alternatively, in operations where the ROV is being used as a platform for a MBES survey, the positional uncertainty of MBES soundings must meet the required UKHO Survey Level. This uncertainty will be the sum of rigorously assessed surface vessel GNSS positioning error, USBL positioning errors, (as suggested by the USBL Calibration (E23) and USBL Position Check (E26)), uncertainty in Sound Velocity Profiling, and the error budget associated with the MBES and INS system in use.

Potential sources of error to be considered during USBL positioning operations include but are not limited to:

E21 USBL Error Budget Continued

Source	Error	Effect
Surface Positioning	Surface positioning not of sufficient quality to meet given positional tolerances	Positions derived from surface positioning systems will be erroneous, or of a quality outside specification.
Acoustic Positioning	Incorrect application of offsets when referenced to surface positioning. Incorrect application of motion Incorrect application of Velocity of Sound data.	Subsea acoustic positioning erroneous or outside given system error budget.
Heading Reference	Incorrect latitude setting Incorrect speed setting Incorrect application of C-O corrections Incorrect installation of sensor on ROV/ROV tooling	Incorrect heading data reported. May not reflect true heading of structure or vessel. Position of USBL Beacon calculated incorrectly. Positions of other vessel offsets calculated incorrectly.
Inclination Sensors	Incorrect installation of motion sensor on vessel Incorrect application of C-O corrections Incorrect convention used to interpret data Incorrect calibration values of USBL system	Incorrect pitch and roll data reported. May not reflect true attitude of vessel. Position of CRP not correctly corrected for GNSS antenna motion.
Offsets	Incorrect measurement of vessel offsets Incorrect measurement of ROV offsets Incorrect convention used in local coordinate frame Incorrect calibration values of USBL system	Incorrect positioning of vessel/ROV. Possible incorrect installation of seabed infrastructure as a result.
Geodesy	Incorrect datum shift parameters Incorrect grid projection Incorrect calculation of convergence	Incorrect positioning on project coordinate system. When considering convergence, conversion from True to Grid heading may be erroneous.
Acoustic Noise	Degradation of acoustic signals used for subsea positioning. Degradation or failure of subsea data telemetry USBL positioned too near thrusters or propellers.	Transponder positions sporadic and/or erroneous. Data telemetry error and/or failure.
USBL acoustic Positional errors	Poor or inaccurate SVP observations. (Through refraction) Poor or inaccurate measuring of offsets. Low battery power	Position of subsea beacons may have accumulated errors which are not obvious to control. Can make positions intermittent and unreliable.

Note: An alternative use of USBL positioning techniques is as a positional input into the positioning system of a vessel operating on Dynamic Positioning (where USBL beacons are laid in tightly controlled positions on the seabed and used as fixed reference points in the navigational solution).

E22 USBL Beacons

USBL Beacons must be selected based on project requirements and the operational environment.

Directional beacons

Directional beacons have a focused acoustic transmission pattern allowing greater distance from the transceiver compared with an Omni Directional beacons, so long as the beacon is facing the transceiver. A typical application would be ROV operations in deep water where the beacon is mounted on the ROV facing upwards.

Omni Directional beacons

Omni directional beacons are used in circumstances where orientation in the general direction of the ship cannot be guaranteed, such as for longer ranges in shallow water.

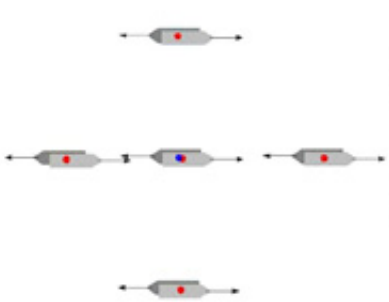
The Project Execution Plan must detail which beacon type/types will be used in specified survey areas and how their acoustic and physical characteristics are appropriate to the prevailing conditions and tasking.

E23 USBL Calibration

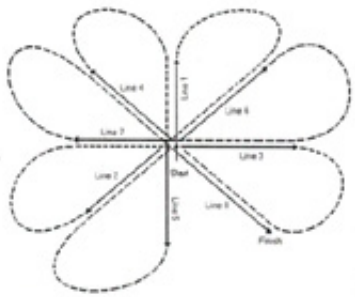
The objective of a USBL calibration is to accurately determine, by Least Squares adjustment the Scale Factor and relative Roll, Pitch and Heading alignment of the USBL transceiver with respect to the Motion Reference (MRU) and Heading systems installed on the vessel. A Dynamic USBL Calibration must be conducted. ('Static Calibrations' are unlikely to result in the required positional accuracy for hydrographic survey operations and are not to be used).

Depending upon the size of the vessel and prevailing conditions, an efficient and successful Dynamic Calibration may take 6 – 8 hours from deployment of transponder to recovery, including the calculation of calibration values. The importance of adequate time being allocated to the calibration phase of any USBL operation cannot be overstated; it is of the utmost importance to take the required time to calibrate successfully, as often later in project operations the opportunity is not present to re calibrate. Further, USBL calibration errors are likely to result in the collection of erroneous data which cannot subsequently be corrected. It is strongly recommended that USBL calibrations are conducted once, correctly and systematically regardless of the time taken. It is strongly recommended that at least 12 hrs be allocated to the activity during mobilisation. This allows for data acquisition to be repeated if necessary and considerable checks to be made throughout the procedure, particularly if personnel are comparatively unfamiliar with the procedure, vessel or with the systems onboard.

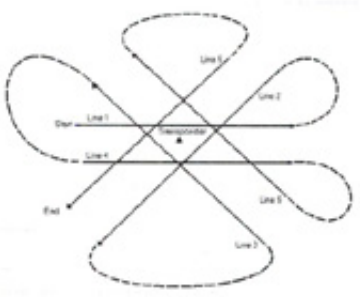
The USBL Calibration should be conducted in accordance with the instructions for the USBL system and/or USBL Calibration Utility in use. In general terms it would be expected that the Four-Quadrant Method would be employed for vessels fitted with Dynamic Positioning (DP), with a Clover Leaf pattern used for non-DP vessels, modified depending upon whether the transducer head is aft-looking or omnidirectional.



Four Quadrant Method (DP Vessels)



Clover Leaf Method (non-DP Vessels)
Aft-looking transducer head



Clover Leaf Method (non-DP Vessels)
Omni transducer head

Alternative patterns for non-DP vessels include navigating the vessel in a circle centred on the transducer position, potentially followed by the four-quadrant method with the vessel held as stationary as possible using manual control of propulsion and thrusters. These patterns should be used if specified for the USBL calibration utility in use.

The results of the USBL Calibration must be rendered as part of the Mobilisation Report.

E24 USBL Spin Check

On completion of the USBL Calibration and application of the calculated Heave, Pitch and Roll offsets to the survey system, a USBL Spin Check must be conducted to confirm that the calibrated values (scale factor, roll, pitch, and heave) are correct and have been correctly applied.

A USBL Spin Check should also be conducted at any time when the USBL system has not been used for a protracted period, and at any time when there is any uncertainty about the ongoing applicability of the calibration values. If on completion of the USBL Spin Check any uncertainty exists, the USBL Calibration must be repeated.

The results of the USBL Spin Check must be rendered as part of the Mobilisation Report.

E25 USBL Z Check

On completion of the USBL Spin Check, a USBL Z Check must be conducted. With the vessel positioned above the transponder, the vessel echosounder depth and the USBL Z reading should be observed simultaneously. This compares "Z" values read out of the USBL and depth readings from the echosounder to check the transducer offset from the vessel reference point in the Z-axis. (The assumption is made that the echosounder readings are correct values for depth and this must therefore be conducted after the Patch Test and other specified MBES depth checks). The USBL "Z" values are measured between the transducer and the receiver/transmitter element in the transponder. Depth values obtained from the echosounder record the vertical separation from either transducer to seabed, or sea surface to seabed, depending upon whether the reference plane set in the echosounder is the transducer or sea surface. The plane for depth reference used in the calibration program is the URP (USBL Reference Point). Therefore echosounder values that refer to sea surface must first be corrected for the draft of the transducer to yield "computed" depth values measured between echosounder transducer and seabed, and secondly, these values can then be referenced to the URP by entering the offset distance FROM the URP TO the echosounder transducer (+=Down).

One other correction needs to be made. Since USBL depth measurements are made between URP and the receiver/transmitter element of the transponder, and corrected echosounder values are given for the vertical separation from the vessel reference to seabed, a correction for the vertical separation FROM the transponder TO the seabed must be made. This distance is always positive (+=Down). In this way, echosounder measured depths and USBL measured depths can be compared directly.

The results of the Z Check must be included in the USBL Calibration Report.

E26 USBL Position Check

On completion of the USBL Calibration, Spin Test and Z Check, the accuracy of the USBL position must be checked by the ROV visiting a known and accurately positioned feature on the seabed in a representative depth of water, and confirming that the ROV tracks and positions correctly, in three dimensions, in the survey navigation system. For example, if the shoalest point on a wreck or obstruction has been accurately determined during a MBES wreck or obstruction investigation, the ROV should be positioned immediately adjacent to the shoalest point, and its position fixed in three dimensions. The depth returned by any pressure sensor carried by the ROV should also be compared. Any positional errors observed must be within the required horizontal and vertical position accuracy stated in the HI.

The results of the USBL Position Check must be included in the USBL Calibration Report.

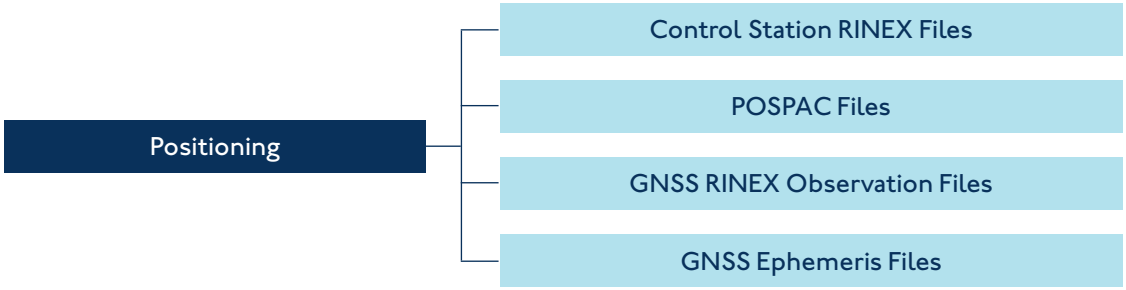
E27 Position Quality

The navigation display must be configured to provide a real-time indication of the 3D position and any received GNSS augmentation data.

Company must provide an indication of the continuous quality of the post-processed 3D position.

E28 Deliverables – General

Positioning data is to be rendered using the following structure:



E29 Deliverables – Mobilisation

› Dimensional Control/Calibration/Validation Report

E30 Deliverables – Delivery

› All logged survey control geodetic observation data and reference station data. All data must be in RINEX format

› All ephemeris data used for computations

› Baseline processing and network adjustment reports for all geodetic observations

Part F

Tides

Reduction of Soundings 145
Establishing Chart Datum 145
Establishment of Shore-Based and Offshore (Seabed Mounted) Tide Gauges 146
Continuously Operating Tide Gauge 147
GNSS Tide Buoys 148
Pole-to-Gauge Calibration 149
Separation Model 150
Tidal Stream Observations 151
Deliverables – General 152
Deliverables – Demobilisation 152
Deliverables – Delivery 152
Deliverables – Tidal Data Formats 153
Deliverables – Tidal Stream Data 154

F1 Reduction of Soundings

All soundings are to be reduced as per the following table:

	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Depth Range unless Specified in HI	600m+	200-600m	As detailed	As detailed	0-200m	As detailed	As detailed
Tidal Reduction	N/R	N/R unless within 12nm of land (then as per levels 3-7)	Real time tides, tidal model, or separation model				

In depths of 200m or less all soundings are to be reduced to Chart Datum as specified by the specific HI. This will usually be by one of two methods:

› Direct reduction from local tide observations collected for the duration of survey operations

› GNSS heighting using a spheroidal separation model

Where the majority of data falls within 200m, the HI will specify for all the soundings to be reduced using the same model.

Soundings are to be presented as depths below Chart Datum, as supplied by the Authority.

The Contractor shall demonstrate that the method chosen for sounding reduction results in the overall depth uncertainty requirements being met.

Alternate methods of sounding reduction may be approved by the authority in certain cases but must be fully outlined in individual survey tenders.

F2 Establishing Chart Datum

Where the Authority deems that Chart Datum within the extents of an HI area is not adequately defined by the current infrastructure or historical knowledge, the Contractor will establish a tide gauge(s) in accordance with F3 & F4. The location of the tide gauge(s) being agreed between the Authority and the Contractor.

The HI for a particular area will detail if the Contractor must undertake a Transfer of Tidal Datum iaw NP122 (Extract will be provided by the Authority if required) using form H533 or define a Sounding Datum for the survey in accordance with NP122.

In either case this data is to be forwarded to the Authority at the earliest opportunity to establish CD. The final value for CD will be passed back to the Contractor who is to use it for the final reduction of soundings.

F3 Establishment of Shore-Based and Offshore (Seabed Mounted) Tide Gauges

Onshore/offshore tidal stations may be required within the extents of an HI area. The HI will confirm local requirements.

Some HIs will require supplementary tidal stations, and some will require the use of locally available permanently installed gauges or sea level monitoring stations, e.g. local Port Authority or National Network tide gauges.

When requested in the HI, tidal heights will be measured throughout the survey period and for a minimum of 30 days using a temporary or 'continuously operating' tide gauge capable of meeting all the requirements stated below.

- Automatic tide gauges (both onshore and offshore) are to have a measurement accuracy of ±0.01m or better
- Gauge time is to be synchronised with UTC on set up and is to drift by no more than ±0.5 min in time over the course of the survey operation
- Longer term deployments of gauges are to include a mechanism (e.g. GNSS clocks or network time) to ensure the gauge remains aligned with UTC to with the required specification stated in the HI
- Gauges should be configured to take readings on the hour and at least 10-minute intervals thereafter
- Readings should be an average of the previous minute's readings
- On demobilisation of all gauges and during data downloads or tide gauge checks, gauge time is to be checked against UTC and recorded
- Heights must be recorded to at least 2 decimal places of precision and at sample intervals no longer than 10 minutes

Offshore (and non-vented) tide gauges must be corrected for atmospheric pressure. Temporary or permanent air pressure sensors for this purpose are to meet all of the following requirements:

- Pressure is to be recorded at a location representative of the survey area in terms of air pressure
- Pressure sensors are to measure an accuracy of ±0.5hPa or better
- Time is to be synchronised with UTC on set up and is to drift by no more than ±0.5 min in time over the course of the survey operation
- Pressure sensors are to be configured to take readings at the same time and interval as the corresponding tide gauge(s)

F4 Continuously Operating Tide Gauge

- Where a continuously operating tide gauge is required, the following requirements are to be met:
- Robust fittings capable of withstanding Category One (Saffir-Simpson Scale) hurricane force winds
- Enough power generation (solar/wind) and storage (batteries) to enable continuous operation in expected meteorological conditions
- A minimum of two separate gauges of different types (pressure/radar/float/acoustic)
- Communications equipment capable of uploading data to the GOES[1] system operated by NOAA[2] and/or FTP or other cloud site as stated in the HI

Additionally, the following may be requested in the HI, which will also need to be configured to be uploaded with the main tide level data:

- Atmospheric pressure sensor
- Continuous GNSS measurements
- Provision of a further real-time link for local and UKHO data viewing/download

Where systems are going to be integrated into the IOC's GLOSS or Tsunami Warning Systems the recording characteristics are to be amended as follows:

- Readings are to be taken every minute
- Upload to the GOES and/or FTP is to be conducted every 5 minutes

1 Geostationary Operational Environmental Satellite
2 National Oceanic and Atmospheric Administration

F5 GNSS Tide Buoys

Where a separation model is to be used, GNSS buoys may be specified in the HI or be acceptable as a tender response.
In such instances the following requirements are to be met:

- The buoy is to be established in an area agreed between the Authority, Contractor and Local Authorities
- The ground mooring is to be sufficiently secure to ensure the buoy does not drag
- The buoy is to have suitable battery or power generation to operate for the entire period of survey operations and for a minimum of 30 days in total
- Vertical measurements are to have a resolution of 0.01m or better
- Vertical measurements are to have an overall accuracy of 0.1m or better
- Vertical measurements must be recorded to at least 2 decimal places of precision
- Data may be real-time or post processed providing it achieves the required resolution and accuracy requirements
- All times are to be in UTC
- The buoy should be capable of uploading data to a satellite or other link and data flow checked at least daily during survey operations to ensure there is no data outages experienced

Additionally, the following may be requested in the HI:

- Atmospheric pressure sensor

F6 Pole-to-Gauge Calibration

Offshore seabed mounted gauges do not require pole to gauge but must be referenced to Chart Datum using methods described in F3.

All shore-based tide gauges must be calibrated by reference to independent readings using a tide pole/stilling well or other manual method (e.g. top-down air gap measurements using a weighted tape measure from a known survey mark, see sections E5, E6 & E7) which can be subsequently tied into the vertical control. The H143 spreadsheet must be used for this purpose. Readings are to be synchronised with the tide gauge and 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 in excess of 5m (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. All tide gauges installed by the Contractor require a minimum 25-hour period of manual observations.

The pole/stilling well is to be read to an accuracy of ± 0.025m, with the time of each reading recorded to within ± 5 seconds of UTC; the same applies for a 'top-down air gap' measurement technique.

Reports on the Pole to Gauge comparison are also to be made on Form H516 (Summary of Checks on Automatic Tide gauge).

The pole used must be levelled to at least two permanently mounted and documented control points which meet the requirements stated in Establishment of Survey Control (E5) and Station Marking and Documentation (E7).

The pole and subsequently the tide gauge should also be referenced to spheroidal height to allow the Spheroid separation to be established.

When a permanent / previously established tide gauge is used, a pole to gauge calibration is required to ensure the gauge is correctly calibrated (unless documented evidence can be provided in the Report of Survey that this check has been undertaken within the last 6 months by an appropriate authority). The HI will confirm local requirements.

F7 Separation Model

A separation model where used must make full use of all separation values measured during the survey and any additional values provided by the Authority.

Additionally, sea surface measurements are to be taken during flight lines that span the entire survey area. These lines are to:

- Be evenly spaced at no more than 25km intervals or as specified in the HI
- Be run over any tidal stations established during the survey
- Run in a direction as specified in the HI or as agreed by the Authority
- Be run in the most ideal environmental conditions (low swell, sea state)
- Be run as close to slack water as possible
- Be reduced using the final observed tides as approved by the Authority

Once separation values have been gained from these measurements they are to be used to supplement/check the tidal station separation values used.

The separation model is to be provided to the Authority along with check line data and a full explanation/report of its production prior to final data reduction to allow validation.

F8 Tidal Stream Observations

When required in the HI, tidal stream observations will be conducted in the locations listed using a seabed mounted ADCP, or continuously recorded from a ship mounted ADCP.

Tidal stream observations are not normally required for surveys conducted using lidar unless boat work is additionally specified.

Seabed Mounted:

These observations shall obtain the Tidal Stream in the "surface" layer of the water column, which is to be representative of a depth of 5m below MSL.

The ADCP should also record the stream movement throughout the water column at appropriate bin sizes in order to achieve, at the very minimum, a 'mid-column' and 'near seabed' stream rates and directions.

Bin size is to be set to 0.5m in water depths of ≤20m, and 1m in depths >20m.

If the ADCP is also capable of recording water level, this should also be enabled and the resulting data rendered.

Tidal stream data (and height data if available) is to be synchronised with UTC on set up and is to drift by no more than ±0.5 min in time over the course of the survey operation. Gauges should be configured to take readings on the hour and 10-minute intervals thereafter.

ADCPs will be deployed for tidal stream observations to enable a minimum of 30 days continuous data to be collected, unless stated differently in the HI.

Ship Mounted:

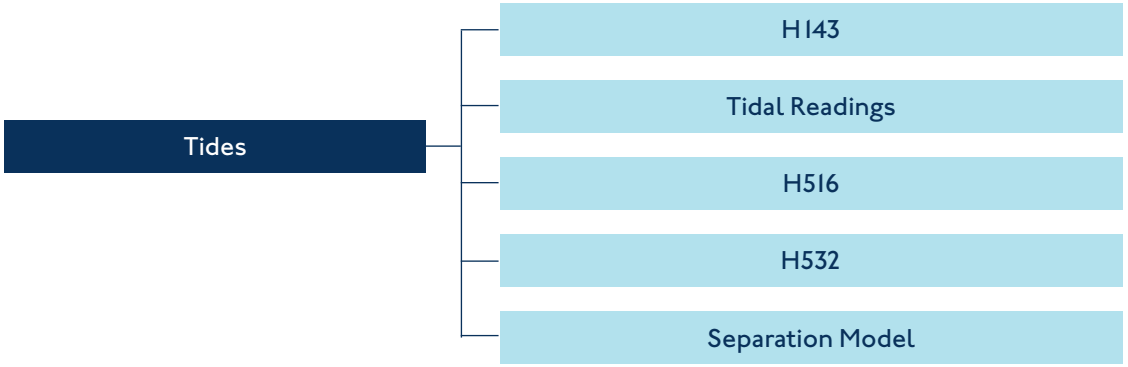
ADCP's should have frequencies optimised to provide the maximum resolution for the depth in question. It is expected that these would be split into two main systems; high frequency for continental shelf operations (<200m) and low frequency for deeper ocean operations (200m – 1000m). Careful consideration should be given to ensuring that this system doesn't interfere with the main bathymetric echo sounder.

Bin sizes for high frequency systems should be no greater than 5m and for low frequency systems 20m.

Full details of the systems to be used, frequencies to be operated and bin sizes to be provided are to be stated in the tender document.

F9 Deliverables – General

Tidal data is to be rendered using the following structure:



F10 Deliverables – Demobilisation

- H143 for all tidal stations, including GNSS buoys
- Tidal records
- Tidal stream records (if applicable)

F11 Deliverables – Delivery

- Separation model (if applicable)
- Final analysis of Tidal Stream Data (if applicable)

F12 Deliverables – Tidal Data Formats

Tide gauge records, including raw tide heights (not just pressure readings) and metadata, are to be submitted in .csv file format or Microsoft Excel format (.xlsx) as follows:

dd/mm/yyyy,hh:mm:ss,m.mm

For example:

13/01/2018,02:00:00,1.08

13/01/2018,02:10:00,1.07

13/01/2018,02:20:00,1.06…etc.

The following metadata must be included in the Report of Survey and H143:

I. Tidal Instrument Type, Make & Model

II. Position of Tide Gauge Horizontal Datum (degrees, minutes and decimal minutes, dddmm.mm)

III. Coordinate type

IV. Projection (if applicable)

V. Height above Chart Datum

VI. GNSS Height of the gauge zero

VII. Data format of supplied file(s) preferably .csv (see above paragraph for details)

VIII. Tidal Observations Start Date, Time and Time Zone (in the format: yyyy-mm-ddThh:mm:ss±hh:mm) and Tidal Observations End Date, Time and Time Zone (in the format: yyyy-mm-ddThh:mm:ss±hh:mm)

F12 Deliverables – Tidal Data Formats Continued

IX. If there are any data gaps in the record, enter the gap date range in the format yyyy-mm-ddThh:mm:ss±hh:mm to yyyy-mm-ddThh:mm:ss±hh:mm

(Note: for the above two bullet points the hyphens are required, as is the "T" character between the date & time fields. The "±hh:mm" refers to the Time Zone of the observations (so for GMT this would be +00:00 [positive east and negative west of Greenwich Meridian)

X. Time Zone of the supplied data (UTC)

XI. Time interval of the tidal records (e.g. 1, 6, 10 minutes etc.)

XII. Any calibration or saltwater density factors used during gauges setup

XIII. Note any specific details regarding the tidal data record submission, i.e. surge, noisy data etc, or if the data been adjusted or manipulated in any way (i.e. differs to the original instrument raw data, a vertical datum adjustment part-way through, etc.)

The tide gauge observations must be rendered in metres and not solely in pressure readings on a H143.

F13 Deliverables – Tidal Stream Data

ADCP Tidal Stream data (and if applicable tidal heights combined, see above) should be supplied in a netCDF format or directly in Excel spreadsheet format. The tidal stream data must be available for each bin recorded and show either:

› the 'departures East and North' (i.e. the rates of the stream in both the Easterly and Northerly direction), and/or

› the resultant Magnitude and Degrees (true) which themselves are derived from the Departures East and North

An Excel spreadsheet containing the following meta-data about the deployment should be supplied, and include: -

I. Position of instrument

II. Depth of water at the deployment site

III. Height of instrument above the seabed

IV. Start/ End of deployment time and date

V. Time zone

VI. Units of stream rates

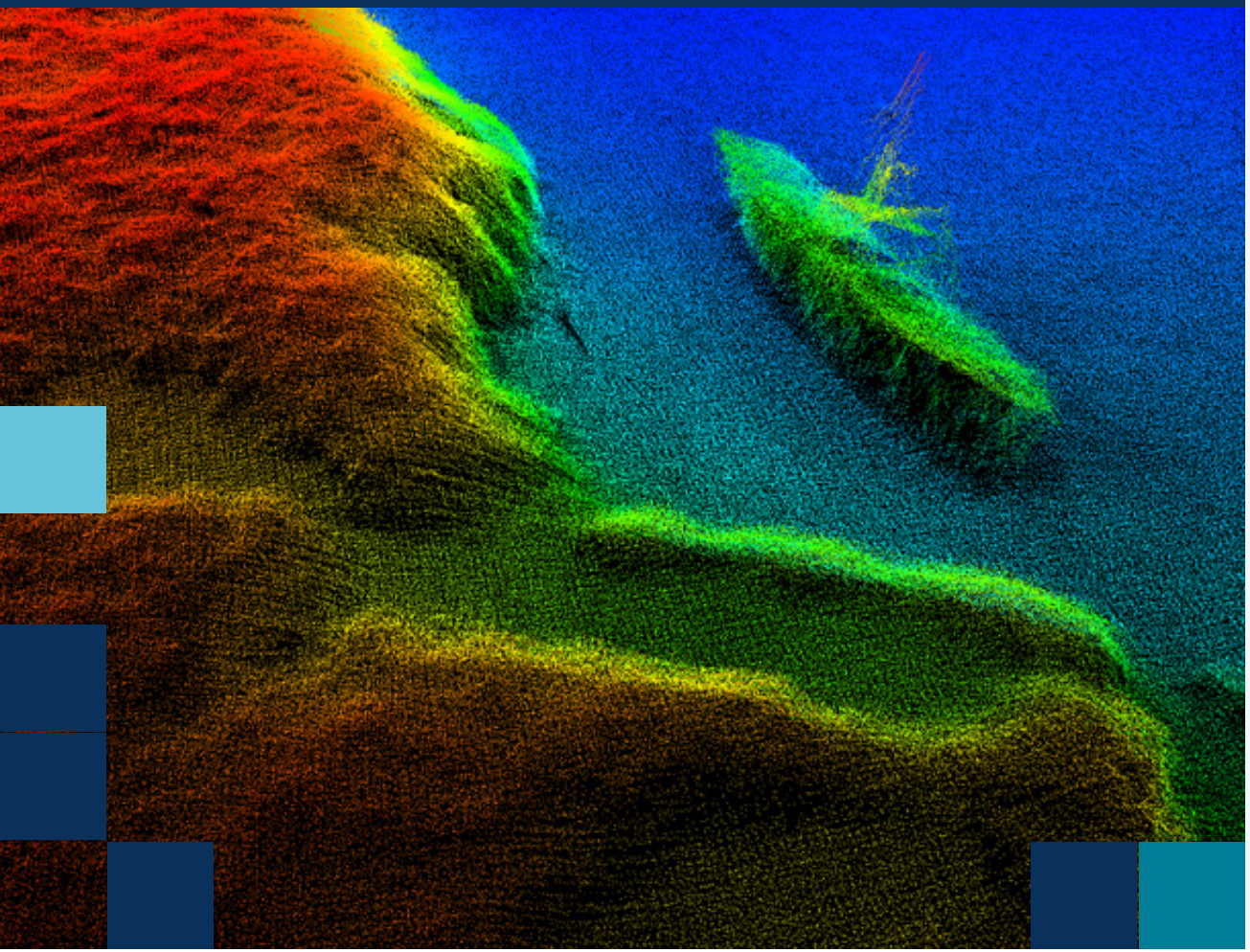
VII. Any general notes of use pertaining to the deployment (e.g. any tilt unable to resolve, missing data)

VIII. Local variable parameters:

Magnetic Variation, Mean Water Density and Barometric Pressure

Part G

Bathymetry



Bathymetry 156
Primary Depth Sensor 156
Secondary Depth Sensor 156
Bathymetric Data Quality Measures 157
Uncertainty 157
Uncertainty Model 157
Sounding Density 158
Coverage 159
Feature Detection 159
Crosslines 159
Draught Measurements 160
Sound Speed Check 160
Single Beam Echosounder Bathymetry 161
Investigations of Wrecks 162
Investigation of Obstructions 163
H525 – Investigation Form 163
Swathe Bathymetry Water Column Data (WCD) 164
Side Scan Sonar Box Search 164
ROV Inspections 164
Magnetometer 165
Leading Lines, Tracks, Dredged Channels and anchorages 165
Depth Data Precision 165
Quality Control 166
Data Cleaning 166
Data Cleaning Guidance – Notes layer 166
Data Cleaning Guidance – Manmade Features 167
Acoustic Bathymetric Data Attribution 168
Non-Acoustic Point Clouds 168
Processing Software 168
Data Blocks 169
Deliverables – General 169
Data Structure 169
Deliverables – Hydrographic Notes 170
Deliverables – Mobilisation 170
Deliverables – Raw Data 170
Deliverables – Prior to Demobilisation 170
Deliverables – Submission 171
Deliverables – Final Acceptance 171
Deliverables – Fixed and Floating Aids to Navigation 171
Deliverables – Comparison with Published Chart 171

G1 Bathymetry

Depths will be measured throughout the survey area using single or combination of systems that are capable of meeting the requirements stated in these parts.

Iaw IHO S44 Section 3.2.1 depth is understood as reduced depths.

Optically clear water is understood as waters where the seabed is visible vertically from the air.

The Company must provide empirical evidence of each system's ability to meet the stated requirement to the Authority as a tender deliverable.

G2 Primary Depth Sensor

It is the aim of this specification to be system agnostic; however, it is understood that the different levels and the likely HI area requirements are still going to be best achieved using a specific type of equipment whether that is acoustic, lidar and/or imagery methods especially where feature detection is concerned. As such it is still necessary to distinguish requirements for these types of systems.

Acoustic systems used for depth measurements are to be of a swathe design capable of meeting the requirements stated in this part (with the sole exceptions of Paras G3 and G13 which uniquely apply to Single Beam Echosounder bathymetry).

Lidar systems or combinations of systems should as a minimum be capable of achieving the requirements of this part to a depth of 45m in optimum water and environmental conditions. The expected maximum depth of the proposed system for any specific project should be detailed in the Company's tender documentation and that achieved noted in the RoS.

UKHO Level 4 as described in this part is the minimum requirement for bathymetric data collected using lidar systems, noting the additional feature detection requirements in 'shallow' water. Additional requirements to meet this standard are detailed in this part. The ability of the proposed system to achieve these additional requirements is to be detailed in the Company's tender documentation and where achieved noted in the RoS.

G3 Secondary Depth Sensor

Notwithstanding the requirements for the Primary Depth Sensor (Para 2G), 'Open Spaced' survey lines may on occasion be specified in the HI without the intention of providing full seafloor coverage. This technique will typically be specified in areas of highly mobile shallow and inter-tidal banks where the object of the survey is change detection over time and/or to permit the extents of the mobile area to be adequately described on navigational products. In this case, sounding using a Single Beam Echo Sounder (SBES) may be specified. In practice the use of a swath bathymetry system will also be acceptable for this purpose, but without the requirement to achieve overlap between adjacent swaths.

Where Open Spaced survey lines are specified using a SBES, the requirements of Section G13 must be adhered to.

G4 Bathymetric Data Quality Measures

Bathymetric quality reporting is to be based upon the following criteria:

› Individual Sounding Uncertainty

› Sounding Density

› Coverage

While these are based on the IHO S44 Edition 6 Standard they have in a number of areas been expanded and/or tightened to allow for a wider range of usage across the maritime domain.

G5 Uncertainty

Systems or combinations of systems are to be capable of achieving sounding uncertainty (in three dimensions) in accordance with the levels detailed at Annex A to this part and as specified in the HI.

G6 Uncertainty Model

The Company must provide a fully developed A Priori uncertainty model to the Authority prior to survey operations commencing. The model must state all component uncertainties, as well as the combined total uncertainty for all elements of the survey.

The model(s) is/are to include an estimate of seabed footprint size and expected spreading with an indication when this exceeds the IHO Order 1A feature detection for a 2m object. This should be taken as a spot with a radius greater than 1.414 m.

Details from this model as well as real time factors should be entered into the processing system to ensure all soundings are attributed with realistic TPU values. For acoustic surveys these values are to be visible/reproduced in the final Caris project. For lidar and other methods where individual point attribution of uncertainty is not possible in current software and delivery formats, the tender is to specify how uncertainty values will be demonstrated in the final delivery.

G7 Sounding Density

Each Feature as described in Feature Detection (G9) is to be detected by at least 3 valid soundings in the along-track direction and 3 valid soundings in the across-track direction, forming a minimum 3x3 grid of 9 soundings.

After processing/cleaning these valid soundings should be evenly distributed across each grid cell in the processing surface. A collection of soundings in one corner of the grid cell with the bulk of the grid cell empty is not acceptable.

Grid cell size is to be equal to the size of object required to be detected as specified in the HI.

Additionally, for surveys specified at Level 5 or above, there are to be 2 valid soundings in a grid size which is equal to ¼ of the feature detection requirement. For example, for 2m objects there is to be two valid soundings in every 1x1m grid cell.

The following requirements are to be met with regards to compliance to the above:

- 99.99% of all bins are to achieve the above requirement
- No bin is to have less than 5 hits
- There are to be no more than 2 conjoined bins where density is less than the requirement
- There are to be no bins that do not meet the density requirement over wrecks or other obstructions

At all times the Authority's decision on any infill requirements is final.

Companies proposing a phase measuring bathymetric sonar must submit a proposal when tendering stating how individual samples will be aggregated into a sounding for a given part of the acoustic footprint. Single interferometric samples will not be considered as a sounding unless they can be proven to meet the uncertainty requirements without any form of aggregation. For example, samples could be aggregated into a fixed across track bin size or binned by number of samples.

Where initial density does not meet the required specification and subsequent lines are run, they must be at least 45° off the main line direction to ensure different scan geometry is achieved. No more than 3 different passes are to be used to achieve the required density for order 1A. The Authority's decision on the requirement for re-flights is final.

3 Each sounding can only contribute to 1 bin

G8 Coverage

Full seafloor coverage shall be achieved to the limits of the supplied bounding polygon or the defined depth contours whichever is specified in the HI.

Extinction depth

In order to ensure safety of navigation throughout the defined polygon areas, full coverage is to be achieved even where depths extend deeper than the extinction depth of the system in use. This is to ensure that any isolated features shoaler than the minimum required extinction depth as stated in the HI will be detected.

Intertidal area/Very Shoal Water

Where a survey block lies adjacent to the coastline, data coverage (meeting the above requirements), must extend into the 2m CD depth contour unless specified differently in the HI.

All effort is to be made to gain valid depths throughout the survey area along coastlines and over shoal rocks and obstructions. This may be achieved by either using the topographic lidar at low water or the bathymetric lidar at high water. Methodology is to be fully described and justified in the Report of Survey.

Lidar Specific

Where possible, the Company is to collect data during periods of low turbidity (calm weather & low swell). Any gaps in coverage or density should be re-flown under different conditions.

Where gaps in coverage still exist that are not delineated by the extinction depth cut off, the Company is to provide full details including 'no bottom detection' soundings, photography, swell, and persistent low cloud, before commencing demobilisation. While it is accepted that gaps may remain, the Authority's decision on any infill requirements is final. Any remaining gaps must be similarly detailed in the Report of Survey and on the .hob file.

G9 Feature Detection

For all parts of the survey area the minimum size of feature detected shall be in accordance with the levels at Annex A or as stated in the HI.

Along with the density requirement (G7) this is to be achieved by ensuring the seabed footprint of the system in use does not exceed the size of the feature.

G10 Crosslines

Crosslines are to be run at a minimum spacing of 5km with a minimum of 3 being run per survey block.

Crosslines shall be at approximately equally spaced and be approximately perpendicular to the typical mainline orientation in that block.

Crosslines shall be rendered in folders separate from the mainline data structure but may be used in the final dataset and therefore should be cleaned as per Data Cleaning (G24) to allow for analysis.

An analysis between crosslines and the main data set against compliancy with IHO depth accuracies is to be given in the Report of Survey.

G11 Draught Measurements

A full understanding of the effect of draught is to be maintained and used to ensure vertical measurements remain within the proposed sounding error budget.

In smaller vessels and workboats (where limited changes in draught would be anticipated) it may be appropriate to manually measure draught at a regular interval whilst the vessel is alongside. In larger vessels, (where larger daily changes in draught would be anticipated and where the vessel may remain at sea overnight), the tender must indicate the method by which changes in draught are to be detected and recorded. The use of automatic draught recording systems is encouraged.

G12 Sound Speed Check

Prior to commencing survey operations, the correct function of all sound speed sensors and profilers shall be confirmed by conducting a comparative check, in a representative body of water. This check should include sound speed and depth.

The results of the Sound Speed Check are to be included in the Mobilisation and Calibration Report.

G13 Single Beam Echosounder Bathymetry

Where open spaced Single Beam Echosounder (SBES) lines are specified (Para G3), depth will be measured using a SBES which must meet the following requirements:

G14.1	Depth Sensor	The lines detailed in the HI are to be collected using a SBES system which meets the specifications of this Section. Alternatively, an acoustic swath bathymetry system agreed by the Authority may be used. If an acoustic swath bathymetry system is used, all data must be fully cleaned and processed in accordance with the normal requirements for this system.
G14.2	Uncertainty	Depth and position of sounding uncertainty shall be in accordance with Level 3b requirements from the table at Annex A to this part.
G14.3	Frequency	The acoustic frequency of the SBES shall be between 100kHz and 300kHz. Only one frequency channel is required. The frequency of the transducer shall be clearly stated in the RoS.
G14.4	Beamwidth	The major axis of the beamwidth of the SBES transducer shall be no more than 8°. The beam width of the transducer utilised shall be clearly stated in the RoS.
G14.5	Calibration	The SBES utilised shall be corrected for draft offset (from the GNSS antenna or water line as appropriate) and sound speed to ensure the depth and position uncertainty requirements are met throughout.
		Company must supply details of the SBES calibration procedure as a tender deliverable.
G14.6	Sounding Density	The along track distance between valid soundings must not exceed 5m.
G14.7	Wreck Investigations	All wrecks should have additional lines run as detailed in G14 if safety of the vessel permits.
G14.8	Survey Line Spacing	25m or 3x Line Spacing whichever is the greater or as specified in the HI.
G14.9	Cross Line Spacing	As per G10 or as specified in the HI.
G14.10	Deviation from planned survey lines	The maximum deviation offline from the planned survey lines will be 20m, except in areas where an obstruction exists. Where an obstruction exists, Company must follow the route around the obstruction which offers the least deviation from the planned survey line.
G14.11	Heave Compensation	The effect of heave must be minimised in the depth data by use of either a heave compensator or by GNSS smoothing techniques. Company shall supply details of the method to be used for countering the effect of heave as a tender deliverable.
G14.12	Data Cleaning	All accepted soundings within the final bathymetric dataset must fall within the uncertainty allowance for a level 3 survey as defined at Annex A to this part. All systematic errors and obvious outliers shall be rejected from the bathymetric data. Data points falling within the level 3 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.

G14 Investigations of Wrecks

All suspected wrecks (including those stranded at any state of tide) located during the survey must be reported on form H525.

Wrecks are to be investigated iaw the standards table at Annex A.

Further Investigation

For Level 3 Surveys an additional line is to be run, over the centre of the wreck and orientated along the major axis. The line is to be run at slow speed, and any adjustments made to the system to maximise sounding density in the area.

For level 4 surveys a wreck/obstruction investigation is to be run for all located or suspected wrecks (unless it uncovers and the shoalest point is captured by topographic/imagery data) consisting of running at least one additional line at approximately 90 degrees to the main line direction over the centre of the wreck/obstruction position. Speed and altitude are to be kept as low as practicable for the Aircraft type in use to maximise sounding density.

Detailed Investigation

For level 5 and above surveys all investigations are to be conducted by running one survey line, centred over the centre of the wreck, and orientated along the major axis, followed by two further parallel lines offset either side from the major axis. Sufficient lines run at right angles to the first to cover the entire length shall also be run. All investigation lines are to be run at as slow a speed as is possible and appropriate adjustments made to the swathe angle if possible, to maximise the sounding density in the area.

Company must clearly indicate within the Report of Survey whether the least depth for each wreck has been determined by the real-time bottom detect, by analysis of swathe bathymetry water column data, or by other means if previously agreed by the Authority.

The H525 shall include at a minimum 4 x representative images of the wreck and any associated debris field and area of scour. The images shall be viewed from the bow, stern, and the port and starboard beam. MBES data is to be presented as fully cleaned point clouds at full data density. The part of the structure identified as the shoalest point/least depth is to be annotated.

Exceptionally, (typically only in the case of very recent/intact and uncharted wrecks), additional views should be presented as will best represent any evidence of isolated anomalies including cracks, apertures, and structural collapse, e.g. collision damage or other structural failure.

For levels 6 & 7, the shoalest point of the wreck and additional details as requested in the HI are to be confirmed by use of either side scan sonar (G18) or an ROV (G20).

The HI may state also request the use of a Magnetometer (G20) during investigations.

All uncharted wrecks detected during the survey should be reported to UHKO within 48 hrs, using the H102 Hydrographic Note.

Where a mixture of survey methods are used during a survey, unless otherwise specified in the HI, any investigations are to be conducted using the system capable of achieving the highest level survey.

G15 Investigation of Obstructions

All Obstructions located during the survey must be reported using form H525, Report of Wrecks and Obstructions.

The list of Obstructions should include but not be limited to Anomalous Features and the obstructions as defined in IHO S57 Feature Object Attributes.

The investigation appropriate to a given Obstruction will vary depending upon the nature of the feature and should be agreed between the Party Chief and the UHKO Client Representative or Survey Manager. This will ensure that the agreed investigation is appropriate and will allow the data to pass Validation to the required standard.

Factors to consider will generally be the same as for Wreck Investigations, namely position, orientation, extent and least depth. Typically using the same line pattern as described above in G14.

Investigations of obstructions shall be run as per G14 above.

Any Obstructions that do not require investigation will be listed in the HI. This will typically apply to Obstructions the location of which are already fully known and charted, for example oil and gas and offshore renewables infrastructure including pipelines, wellheads, and cables.

If, however the mainline bathymetry indicates that these Obstructions may now be shoaler than charted, the Authority should be informed, and an investigation should be undertaken.

All uncharted Obstructions detected during the survey should be reported to UHKO within 24 hrs, using the H102 Hydrographic Note.

G16 H525 – Investigation Form

This should include as much information as feasible. Imagery where suitable is to be used to augment the bathymetry and assist in the overall description of the wreck/obstruction.

The H525 includes fields for the Name of the wreck (where known) and a Description. Every effort is to be made in the field to ascertain as much detail about the wreck as possible to add value to the H525 report. This should draw upon local knowledge where possible (e.g. fisherman, divers, and harbour authorities) and include basic internet research where applicable. The provenance of the information should be stated.

G17 Swathe Bathymetry Water Column Data (WCD)

Swathe bathymetry Water Column Data (WCD) shall be logged for further analysis during all wreck investigations.

By default, WCD shall also be logged for all Obstruction investigations where it would also be logged for wreck investigation lines. In some Obstruction Investigations however, the logging of WCD may not be required, for example when investigating a cable or pipeline laid on the seabed which, due to engineering realities will be of relatively consistent and predictable height above the seabed along the entire length of the engineered feature. In this case the Charge Surveyor should discuss the requirement with the Authority's Client Representative or Survey Manager. This will ensure that the agreed investigation is appropriate and will allow the data to pass Validation to the required standard.

The WCD shall be analysed in an appropriate software package to compare the data digitised in real time by the swathe bathymetry with other features present in the water column. The water column data must be visible in the final CARIS HIPS project. The surveyor shall have the ability to re-pick fully geo-referenced depths from the water column data for inclusion in the final sounding data if a shoaler depth over a given feature has been found within the water column data. These depths must be visible in the final CARIS HIPS data structure and be fully corrected for sound speed and tide.

Company must supply details of the procedure, software and file formats to be utilised for swathe bathymetry water column data interpretation prior to survey operations commencing.

If a phase measuring bathymetric sonar is proposed, Company must clearly indicate how they intend to meet this water column requirement as a tender deliverable.

G18 Side Scan Sonar Box Search

Where an SSS is used for a level 6 or 7 survey investigation the wreck or obstruction is to be boxed in by running four lines (2 x perpendicular and 2 along the length) such that the wreck or obstruction falls approximately halfway along the range scale in use.

The range scale used should be the shortest possible such that all aspects of the wreck and any shadow cast are visible. This may require additional lines being run if additional features are found extending above the wreck than that seen on the mainlines.

The side scan should be flown at a depth approximately 10% of the range scale in use above the seabed.

G19 ROV Inspections

Where requested in the HI, ROV Inspections may be conducted. These will typically utilise hand launched Mini and Micro observation class ROVs (IMCA Class 1[4]) – larger ROVs requiring a LARS or davit for deployment may be used but will not be specified.

ROV inspections will typically be specified for designated wrecks and obstructions listed in the HI but may include wider inspections of debris in sensitive areas or of areas with local environmental or fisheries interest.

4 IMCA R 004 Rev. 3 Code of practice for the safe and efficient operation of remotely operated vehicles

G20 Magnetometer

Where a magnetometer is specified for investigations it is to achieve one of the two following minimum characteristics:

Level 1

› The magnetometer shall be capable of detecting deflections of 10 nano-Teslars from the background noise

Level 2

› 0.1nT absolute accuracy

› 0.02nT sensor sensitivity

› 0.01nT counter sensitivity

A minimum of two lines are required, one centred over the centre of the wreck and orientated along the major axis, and the second run at right angles to the first across the minor axis.

Full details and screenshots are to be included in the H525.

G21 Leading Lines, Tracks, Dredged Channels and anchorages

The leading lines and recommended/dredged tracks along channels and into harbours and anchorages must be very carefully examined and are to be given priority over other areas when planning optimum times for data capture.

An additional survey line is to be run along the course of the lines, track and channels as early in the survey as practicable. If navigationally significant differences between physical features and their depiction on the current Admiralty nautical charts and publications are detected, then this should be immediately reported to the relevant Port Authority and the Authority using form H102 or H Note Application.

Where no channel limits are shown on the largest scale BA Chart, 25m or the width of a single swath of lidar data (flown at an altitude and with sensor settings as per the tender) should be taken as the limits of the channel. Where local restrictions make this impracticable, it should be stated in the tender or the Authority is to be made aware immediately it becomes apparent once in the field.

G22 Depth Data Precision

Depth data recorded must be logged and processed to at least two decimal places of a metre. Processing systems should be set to round down all values to give a shoaler depth than measured.

G23 Quality Control

Robust quality control procedures must be provided and adhered to during processing of all data. These procedures must be required at tender or are to be provided to the Authority prior to survey operations commencing.

G24 Data Cleaning

All accepted soundings within the final bathymetric dataset must fall within the uncertainty allowance for the IHO S44 Order as stated in the HI.

All systematic errors and obvious outliers must be rejected or classified as noise from the bathymetric data. Soundings falling within the uncertainty allowance, but still numerically distant from the main dataset, will be regarded as outliers and should be flagged as rejected in the Caris project or classified as noise in the LAS point cloud.

All transient features (for example boats, mooring lines, birds and marine life) are to be rejected from the dataset or classified as noise.

G25 Data Cleaning Guidance – Notes layer

A CARIS 'notes' .hob layer or SHAPE file is to be used to bring attention to items of specific interest in the dataset as well as noting them in the RoS. The list of objects to be outlined includes but is not limited to:

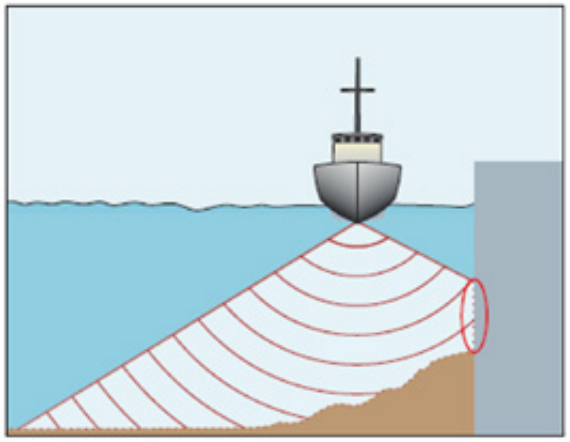
- Pipelines
- Bottom tackle for buoys or other floating objects
- Areas identified by local contacts as dump or dredge areas
- Areas identified as areas containing fishing equipment such as traps or (semi-) permanent nets
- Buoys and other floating aids to navigation

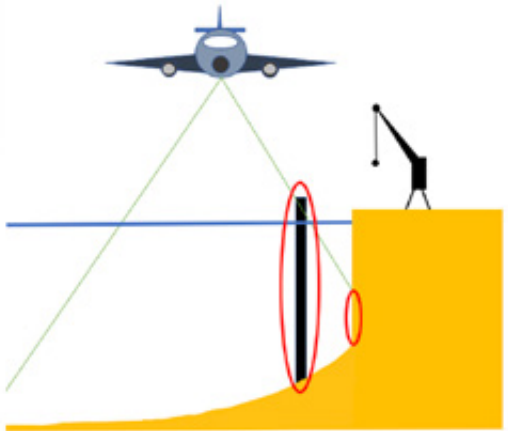
G26 Data Cleaning Guidance – Manmade Features

All manmade vertical structures that extend above the waterline and are dry at all states of tide (for example quay walls, Jetties and Windfarm structures) are to be rejected from the dataset back to the valid seabed soundings, i.e. sediment build-up or rock armour.

Types of features to look for:

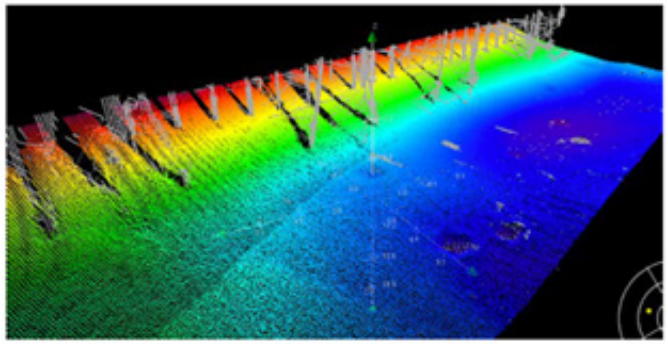
Data that should be rejected:





G26 Data Cleaning Guidance – Manmade Features Continued

Data can also be collected underneath structures. In these situations, the vertical dry structures are to be rejected and the seabed left in as described above.



G27 Acoustic Bathymetric Data Attribution

Processed bathymetric data must contain the following attributes for each sounding as a minimum: position and depth backscatter; 95% statistical uncertainty estimation for position; 95% statistical uncertainty estimate for depth. Files must be full density (i.e. not "thinned") with rejected soundings flagged but not deleted from the data set.

G28 Non-Acoustic Point Clouds

Lidar bathymetric point clouds are to be provided in LAS 1.4 – R15 Point record format 9 or 10 depending on Imagery requirements as described at Annex B.

G29 Processing Software

Data may be processed in any software as long as it achieves the requirements of this section and allows for the deliverables at G31-G40.

All acoustic data is to be rendered as a CARIS HIPS project. The CARIS HIPS software version must be up to date at time of rendering and at least version 11.

CARIS HIPS Projects must not be indexed. The data must be converted to full HDCS format.

The version of Caris HIPS used is to be agreed with the Authority prior to commencement of work. The Authority has final say over the version used.

All lidar data is to be rendered as a series of LAS files.

Any additional bathymetric data collected via non acoustic/lidar systems are to be rendered as a separate Caris HIPS project as outlined for acoustic delivery.

G30 Data Blocks

While the HI will detail the number of bathymetric survey blocks in terms of priority and level requirements, the Company may propose an alternate rendering strategy dependent on final data volumes. The Authority's decision is final.

G31 Deliverables – General

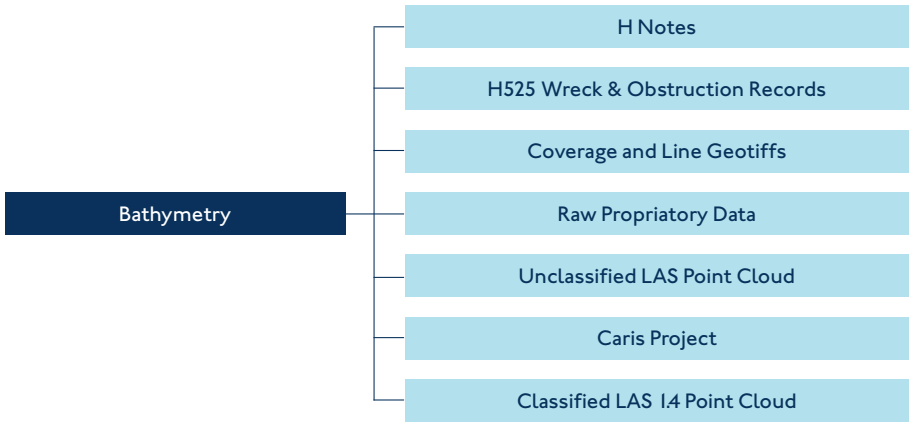
The following deliverables are required for bathymetric data:

- Raw data (proprietary format) containing full backscatter record
- Unclassified LAS Point Cloud (raw LAS file before processing)
- Trajectory files as either SBETs, txt or other binary format if used in the final bathymetric solution
- Raw data (proprietary format) and the processed files of the gathered positional data, including all data used to process
- Processed (cleaned) sounding data in a CARIS HIPS Project including all accepted, rejected depths & water column data, structured by vessel, and including cleaned crosslines in separate folders. The CARIS HIPS software version shall be up to date at time of rendering. Projects delivered using CARIS HIPS v11 (and later) must not be indexed and the user must select "carry over raw data" during import. The data must be converted to full HDCS format
- Raw and processed Water Column Data from wreck and obstruction investigations
- Fully classified LAS files

The HI may request additional deliverables or reduce the requirement of those deliverables detailed.

G32 Data Structure

Bathymetric data is to be rendered using the following structure:



G32 Data Structure Continued	Any projects should have the mainline, crosslines and investigation lines split into separate projects or folders. LAS point clouds should have files split into separate folders so crosslines and investigations can be easily identified.
G33 Deliverables – Hydrographic Notes	Reports of any newly discovered dangers to surface navigation must be passed immediately (within 24 hours) to the Authority and relevant local maritime authorities using the H102 Hydrographic Note form or UKHO H Note Application. Guidance on H Notes is given at Annex C.
G34 Deliverables – Mobilisation	› Mobilisation and Calibration Report (C22)
G35 Deliverables – Raw Data	› Geotiff showing coverage achieved to date based on a grid equating to the feature detection requirements › Raw Data (proprietary format) of the gathered positional data, including all data required to process › Raw data (proprietary format) containing full backscatter record › Raw Water Column Data from wreck investigations › Raw data (proprietary format) containing full reflectance and waveform record › Unclassified/unfiltered LAS files with sufficient metadata to allow import into GIS software to allow visualisation of collected data
G36 Deliverables – Prior to Demobilisation	› Geotiff showing final coverage achieved and statement of reasoning behind any areas not achieved. This must show either depths relating to CD or ellipsoidal heights of all areas based on a grid equating to the feature detection requirements › Geotiff showing all survey lines undertaken › Demobilisation report confirming completion of all planned survey lines and completion of data gathering to the required specification

G37 Deliverables – Submission

- Processed (cleaned) sounding data in a CARIS HIPS Project including all accepted and rejected depths, structured by Aircraft/Vessel, and including cleaned crosslines in separate folders
- Notes layer to accompany Caris Project (G25)
- If requested in the HI, Magnetometer data. This must be processed and mosaicked and presented as a GeoTiff showing the signal strength variations across the survey area at a resolution suitable for distinguishing wreck-like features
- All lidar point cloud data in fully compliant LAS 1.4 or later (as agreed by the Authority) Point Record files. This is to be level 1 classification (Annex B6) as a minimum although the HI may specify level 2
- HOB or Shape file outlining areas that have achieved standards in line with the specification
- Additional lidar point clouds with specific features removed as required by the HI

G38 Deliverables – Final Acceptance

The Authority will request further details and data rework as required during the validation process using a H628a Survey Validation Query Form. Any delay in the return of the relevant information or data may result in the validation process being delayed along with final payment. Similarly, on completion of validation a H628 Appraisal Form will be sent to the company with any final remaining queries and feedback. The survey will not be complete and final payment made until all queries have been satisfactorily answered.

G39 Deliverables – Fixed and Floating Aids to Navigation

The positions and characteristics of all fixed and floating aids to navigation visible from the survey area do not need to be specifically reported. However, if navigationally significant differences between physical features and their depiction on the current Admiralty nautical charts and publications are detected, then this should be immediately reported to the relevant Port Authority and UKHO using the H102 form or app.

The final classified LAS point cloud should have all such objects classified as 44.

G40 Deliverables – Comparison with Published Chart

The sounding detail shown on the largest scale published Authority chart of the survey area is to be critically examined and any significant differences reported. A comment is required for any charted dangers that were not discovered during the survey, or where the least depth found over a danger during the survey is deeper than charted. Any other errors, ambiguities or other defects must be reported.

Part H

Topography (lidar)

Topographic Coverage 173
Lidar Flight Lines 173
Lidar Crosslines 173
Point Density 173
Topographic Data Uncertainty 173
Uncertainty Model 173
Height Data Precision 173
Data Cleaning 174
Data Blocks 174
Deliverables - General 174
Deliverables - Mobilisation 174
Deliverables – Demobilisation 174
Deliverables – Raw Data 175
Deliverables – Delivery 175
LAS Classification Scheme 175

H1 Topographic Coverage

Heights will be measured on all land adjacent to the bathymetric survey area to a minimum of the 15m height contour based on the defined Chart Datum. Additional requirements may be included in the HI for individual projects.

All effort is to be made to gain valid topography throughout the survey area along coastlines and over exposed rocks and obstructions. This may be achieved by either using the topographic lidar at low water or the bathymetric lidar at high water. Methodology is to be fully described and justified in the Report of Survey.

The HI may detail additional topographic requirements or horizontal coverage limits.

H2 Lidar Flight Lines

Flight lines used to gather topographic data may be extensions of bathymetric lines but are to be optimised to ensure maximum coverage of all topographic features.

A minimum of 20% overlap is to be planned for data coverage.

H3 Lidar Crosslines

A minimum one every 25km are to run with at least 2 per block. Crosslines must be approximately perpendicular to the typical mainline orientation in that block.

Crosslines may be used in the final dataset and therefore should be cleaned as per Data Cleaning (H8) to allow for analysis.

An analysis between crosslines and the main data set against compliancy with the required accuracies is to be given in the Report of Survey.

H4 Point Density

A minimum of 10 accepted data points are to be achieved per $1m^2$

H5 Topographic Data Uncertainty

Topographic data should conform to the following uncertainties:

- +/-0.20m vertically at 95% confidence level
- +/-0.50m horizontally at 95% confidence level

H6 Uncertainty Model

The Company must provide a fully developed uncertainty model to the Authority prior to survey operations commencing. The model must state all component uncertainties, as well as the combined total uncertainty.

The uncertainty is to be quoted in terms of 95% confidence levels as described in (G6) and in terms of RMSE.

H7 Height Data Precision

Height data recorded must be logged to at least two decimal places of a metre.

H8 Data Cleaning

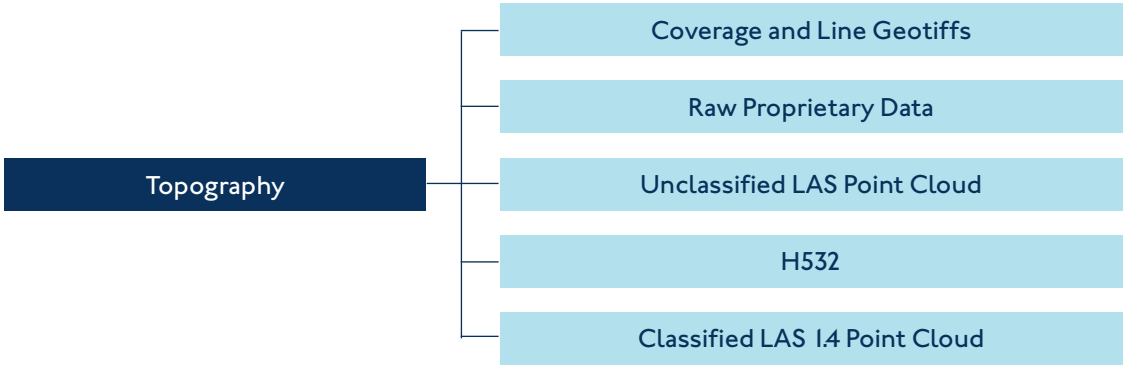
All systematic errors and obvious outliers must be rejected from the topographic data. Data points falling within the accuracy requirements at G6 but still numerically distant from the main dataset are to be regarded as outliers and rejected.

H9 Data Blocks

Data should be split into manageable data blocks as agreed with the Authority. These may be in line with areas in the HI or created to best manage data in terms of flight lines or processing. The Authorities decision is final.

H10 Deliverables – General

Topographic data is to be rendered using the following structure:



The HI may request additional deliverables or reduce the requirement of those deliverables detailed below.

H11 Deliverables – Mobilisation

- All setup and calibrations complete
- Acceptance of Mobilisation and Calibration Report (C24)
- Commencement of Data Collection

H12 Deliverables – Demobilisation

- Geotiff showing final coverage achieved and statement of reasoning behind any areas not achieved. This must show ellipsoidal heights of all areas based on a grid equating to the density requirements ($1m^2$)
- Geotiff showing all flight lines undertaken and individual swath coverage
- Demobilisation report confirming completion of all planned flight lines and completion of data gathering to the required specification

H13 Deliverables – Raw Data

- RAW [5] unclassified LAS files with sufficient metadata to allow import into GIS software to allow visualisation of collected data
- All raw data files in native format

H14 Deliverables – Delivery

- Processing workflow for classification, 'cleaning' and quality control
- Fully cleaned and classified LAS 1.4 Point Cloud on the ellipsoid at the classification level detailed in the HI
- Additional LAS 1.4 Point Clouds reduced to Chart Datum or other land datum may be specified in the HI
- A DSM[6] of first returns is to be provided at a 1m resolution or as specified in the HI
- Additional 'products' such as raster DEMs and DTMs[7] (for example Bare Earth) may be specified in the HI

H15 LAS Classification Scheme

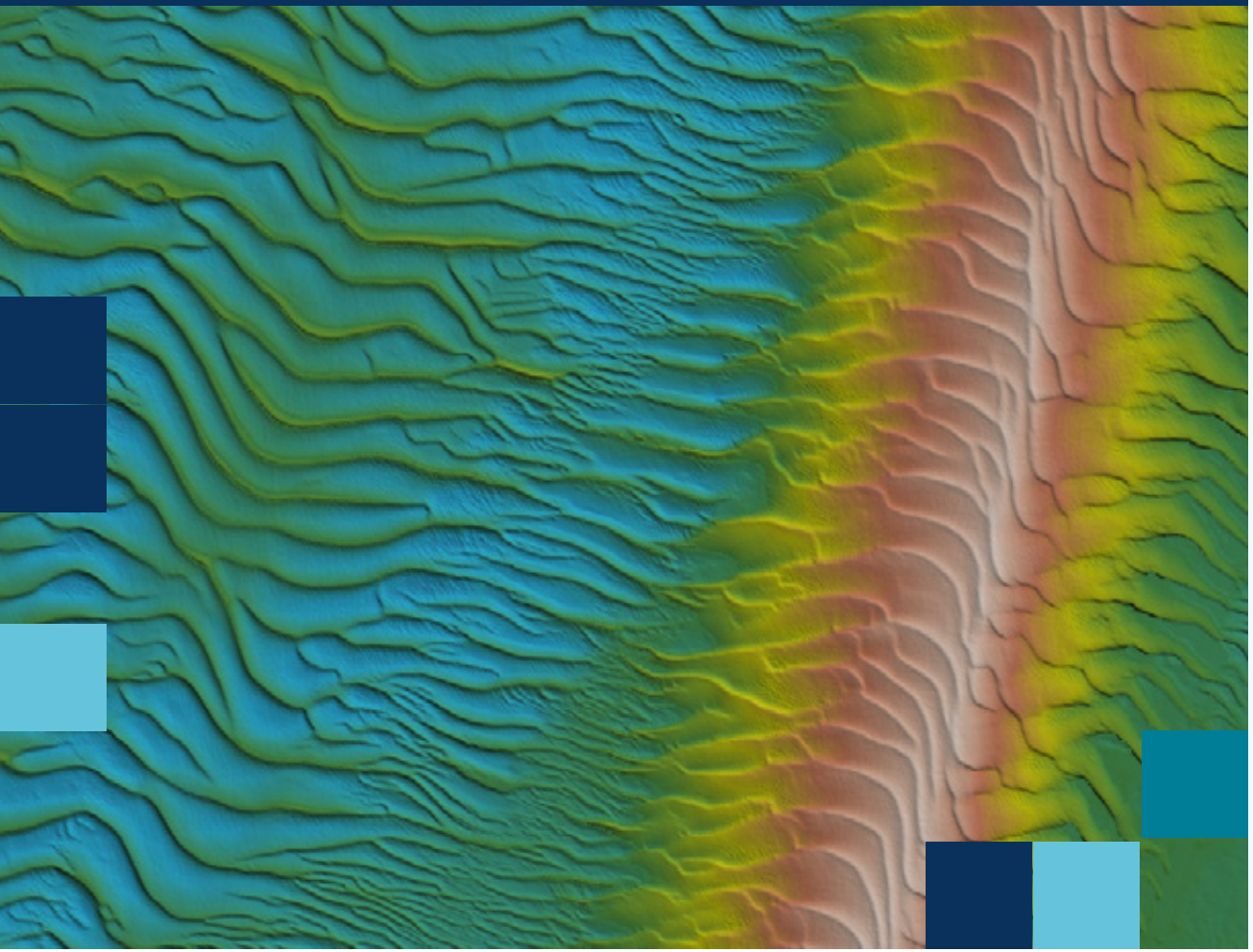
All accepted points must adhere to the modified ASPRS-LAS classification scheme at Annex B. Additional classes may be included as deemed suitable by the Company to best define the data and assist in data cleaning and product creation.

Unless specified in the HI, point data record formats 6 through 10 may be used for topographic point clouds to allow the addition of classification values 40 to 45 when combined with bathymetric data as defined in the ASPRS LAS Topo-Bathy lidar Domain Profile.

5 Unfiltered
6 Digital Surface Model (a DEM that represents surface objects, such as buildings and vegetation, as well as open terrain.)
7 Digital Elevation Model (a representation of a continuous surface of elevation values in a digital format, usually as a raster grid). Digital Terrain Model (a DEM that represents "bare-earth" terrain.)

Part I

Seabed



Requirement 177
Backscatter (Acoustic) 177
Reflectivity (lidar) 177
Seabed Sampling 178
Seabed Sampling – Remote Imaging 178
Seabed Sampling – Physical 179
Deliverables – General 180
Deliverables – Lidar 180
Data Blocks 180
Deliverables – Mobilisation 180
Deliverables – Raw Data 180
Deliverables – Demobilisation 180
Deliverables – Submission 181
Deliverables – Return Intensity Mosaic 181
Deliverables – Seabed Samples 182
Deliverables – Seabed Classification 182
Shape Files or Feature classes within a Geodatabase 183
Texture Area 184
Sediment Texture Codes 184
Textural Description (H575) 185
Categories of Landforms, general morphology and anthropogenic features 186
Ridge 187
Ripple 187
Shoal_Reef 188
Mound 188
Mountain 188
Groove_Gully 189
Channel 189
Valley (includes: Canyon) 189
Depression 190
Slope (includes: lobe, apron, escarpment) 190
Plane (includes: platform, terrace, sheet) 190
Vegetation Areas 191
Scour Areas 191
Cable 191
Pipeline 191
Geological interpretation 192
Seabed Sample 192

11 Requirement

Interpretation of collected data to provide an indication of seabed (geo)morphology is required for all surveys unless specified otherwise in the HI. For acoustic surveys and where specified for lidar, this is to be supplemented with seabed sampling or imagery.

12 Backscatter (Acoustic)

High resolution, geo-referenced swathe backscatter data must be collected at all times that bathymetry is being collected.

The Contractor shall ensure that systemic variations to backscatter intensity are kept to a minimum and that system changes which affect backscatter (e.g. gain, pulse length) are minimised during data acquisition.

Attention must be paid to settings that can automatically change without operator intervention. Changes affecting backscatter intensity within a single data file are to be kept to an absolute minimum, and ideally changes will only be made during line turns. Any user changes affecting backscatter intensity must be noted in the Report of Survey, including exact date, time (to the nearest 5 seconds), filename and nature of the change. Where site conditions require the use of different settings throughout the survey area, the Authority is to be informed and the survey area may need to be divided in blocks of similar settings as agreed with the Authority.

The number of vessels or swathe systems used to collect data at a survey site will be kept to a minimum. This will minimise differences in backscatter intensity collected from different vessels. Where multiple vessels or swathe echo sounders are used within a single survey area, the Contractor will ensure that:

1. Data from different vessels or systems will be collected in separate blocks.
2. An inter-calibration between the backscatter intensity values from the different vessels or systems is undertaken. A single repeat survey line for each system in the same direction may be sufficient to meet this requirement.

The survey area is to be crossed prior to main data collection to obtain an understanding of the range of seabed types and backscatter responses. Optimal system settings are to be derived and applied to minimise changes in settings affecting backscatter responses during the survey.

During the mobilisation the ability to acquire high quality backscatter data may be verified by the Authorities representative. Alternatively, a sample of processed backscatter data may be requested during main data collection.

Processes to assess and maintain the quality of backscatter data during the survey are to be in place and agreed with the Authority.

13 Reflectivity (lidar)

High resolution, geo-referenced reflectivity data must be collected to inform on seabed textural change. The Company must endeavour to ensure that systemic variations to reflectivity intensity are kept to a minimum and any changes to system settings that will affect the homogeneity of the reflectivity are minimised during data acquisition or accounted for during processing.

During the mobilisation the ability to acquire high quality reflectivity data may be verified by the Authorities representative. Alternatively, a sample of processed reflectivity data may be requested during main data collection. Processes to assess and maintain the quality of reflectivity data during the survey are to be in place and agreed with the Authority.

14 Seabed Sampling

Where requested in the HI, Seabed sampling is to be conducted with at least one sample being taken in each major textural area identified. In water deeper then 80m a major textural area is typically defined as a polygon with area greater than 10km^2. In water shoaler than 80m a major textural area is to be taken as any area which can be determined from the backscatter (or SSS) data.

Unless otherwise stated, seabed sampling is to be limited to the continental shelf.

Remote Sensing techniques are to be used in preference to physical sampling unless otherwise specified in the HI to reduce the environmental impact of the project.

15 Seabed Sampling – Remote Imaging

Remote sensing techniques (ROV) are to be used to achieve images taken by any appropriate technique capable of achieving a clear high-resolution colour image down to at least a depth of 100m. Images should be included as a supplement to the H575.

Where requested in the HI; remotely sensed images taken of the seabed must include a scale within the image, taken in situ, to assistance in differentiating between grain sizes and are to be colour corrected for light absorption or ambient light from additional light sources.

Seabed Sampling by Remote Imaging would normally only be required during Swath Bathymetry surveys; it would only be anticipated during lidar surveys if boat work is already specified as part of the project.Sampling must not be conducted until all bathymetry and backscatter (or reflectivity) collection and analysis for a given block or HI is complete, to inform the required positions for samples within the major textural areas. A major textural area is typically defined as a polygon with area greater than 10km^2.

At least one sample should also be taken in all charted anchorage areas.

Before demobilisation, the Client Representative is to be appraised on the samples taken in relation to the identified textural areas to ensure sufficient samples have been taken.

Remote Imaging techniques may include:

- Drop camera with high resolution colour video and/or high-resolution colour still photo capability
- Towed camera system with high resolution colour video and/or high-resolution colour still photo capability
- Remotely Operated Vehicle (typically Micro or Mini Observation Class) fitted with high resolution colour video and/or high-resolution colour still photo capability
- Autonomous vehicle with high resolution colour video and/or high-resolution colour still photo capability

ROVs will typically be free-swimming, although benthic crawlers/a free swimming ROV fitted with a crawler skid may be appropriate in some circumstances at the discretion of the Authority.

Additionally, Remotely Operated Vehicles (typically Micro or Mini Observation Class) may be fitted with tooling suitable for physical sampling. The Authority's decision on sampling requirements is final.

16 Seabed Sampling – Physical

Physical Seabed Sampling would normally only be required during Acoustic Bathymetry surveys; it would only be anticipated during lidar surveys if boat work is already specified as part of the project.

Physical samples may be taken by any appropriate technique including grab sampling, box coring and ROV mounted tooling suitable for physical sampling; undisturbed samples are not however required unless specifically specified in the HI.

Sampling must not be conducted until all bathymetry and backscatter (or reflectivity) collection and analysis for a given block or HI is complete, to inform the required positions for samples within the major textural areas. A major textural area is typically defined as a polygon with area greater than 10km2.

At least one sample should also be taken in all charted anchorage areas.

Before demobilisation, the Client Representative is to be appraised on the samples taken in relation to the identified textural areas to ensure sufficient samples have been taken.

A high-resolution colour close-up image should be taken immediately after the sample is brought to the surface. The sample should be placed on a plain white surface and include a millimetric scale and relevant Munsell Rock-Colour Chart.

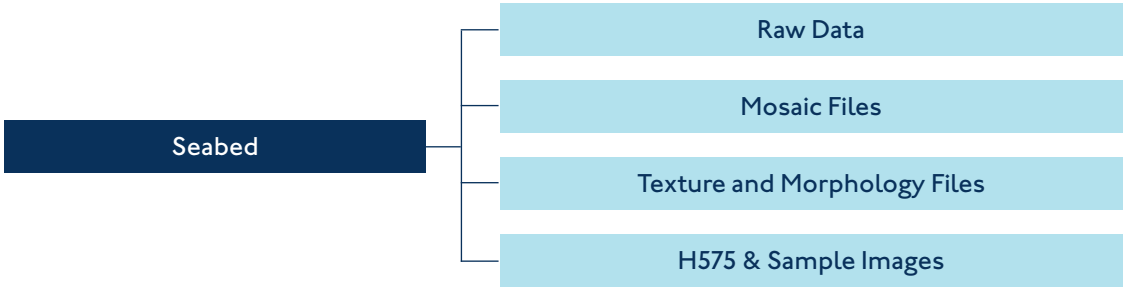
Samples must be retained for the period of the survey operations. On demobilisation they may be disposed of unless:

- Their retention is requested by local authorities in which case they may be provided to the local authority
- Their retention is requested by a local NGO or environmental interest group. In this case permission must be obtained from the Authority prior to providing samples to the interest group
- Their retention is specified in the HI. In this case samples are to be forwarded to the relevant organisation and logged on a H575 with images named and tagged suitably to cross reference with the sample serial number on the H575 form. Plastic screw top containers are to be used to preserve the samples. The use of polythene bags for preserving retained samples is not acceptable

The Authority's decision on sampling requirements is final.

I7 Deliverables – General

Seabed sampling and textural data is to be rendered using the following structure.



I8 Deliverables – Lidar

Seabed textural information should where possible match the LAS classification of the rendered point cloud, specifically with points classified iaw Annex B Numbers 43,44 and 46.

I9 Data Blocks

While the HI may detail the number of survey blocks required, the Company may propose an alternate rendering strategy dependent on final data volumes.

Where site conditions require the use of different settings throughout the survey area, the Authority is to be informed and the survey area may need to be divided in blocks of similar settings as agreed with the Authority.

I10 Deliverables – Mobilisation

Details in the Mobilisation and Calibration Report (C24) of any calibration/checks between multiple systems in use.

I11 Deliverables – Raw Data

- The bathymetric raw data (in proprietary format) containing full backscatter record
- The bathymetric raw data (in proprietary format) containing full reflectivity record
- Initial mosaic of data gathered to give indication of coverage and quality

I12 Deliverables – Demobilisation

- Initial mosaic showing complete coverage of HI area

113 Deliverables – Submission

The final deliverables required with be specified fully in the HI but will include some or all of the following:

› Final processed return Intensity Mosaic (114)

› Seabed Sample Form (H575), sample pots and Shape File (115)

› Seabed Imagery

› Seabed Classification .mxd file

114 Deliverables – Return Intensity Mosaic

The backscatter/reflectivity mosaic(s) should be a representation of the system return intensity across the HI area. The return data derived from the survey system will be processed using any software package that uses an industry standard backscatter engine (eg Geocoder[8]).

The intensity data derived will be processed so that any artefacts and reflectivity changes within homogenous areas are corrected for.

Where blocks of data were collected using different settings, separate outputs will be generated for each block. Calibration and crosslines will not be included in the backscatter deliverable.

Outputs will be provided as an internally referenced 32-bit Floating Point GeoTIFF images (which preserves actual backscatter/reflectivity decibel levels, rather than just greyscale values) or a GeoTIFF image with separate ASCII text file (at same resolution as GeoTIFF) containing the following information:

› Latitude/Longitude or Easting/Northing

› Corrected backscatter intensity in dB

The resolution of the backscatter mosaics will be a minimum of:

› 0.5 m in water less than 20 m

› 1 m in water less than 50 m

› 2 m in water depths more than 50 m

A full description of the processing workflow (including data assessment and cleaning steps), software (including name and version) and settings (including software specific settings used during processing, e.g. overlapping data blending mode, algorithm options selected, etc.) will be included in the Report of Survey. Where corrective action was taken to produce a high-quality mosaic, the report will detail how this was resolved.

8 Developed at Centre for Coastal and Ocean Mapping, University of New Hampshire by Luciano Fonseca
Fonseca, L. and Calder, B. (2005) Geocoder: an efficient backscatter map constructor. Proceedings of the US Hydrographic Conference 2005, San Diego, 9pp

115 Deliverables – Seabed Samples

Seabed sampling records (H575) and associated Shapefile (117).

High resolution colour images of all samples (14 and 15)

If requested in the HI, any physical samples are to be forwarded in sample pots labelled with the HI Number, Date and Serial Number as recorded on the H575.

116 Deliverables – Seabed Classification

Where required a seabed classification will be requested in the HI. Dependent on individual locational requirements, this deliverable will be segmented into three levels of complexity. The level(s) required will be specified in the HI.

The Contractor must interpret seabed textural changes across their respective HIs using a combination of the bathymetry, system return intensity interpretation and if specified by the HI, ground-truthing from seabed sampling. This is to be rendered as an ESRI MXD and include all area, point and line feature classes. An MXD is a file extension for a map document used by ArcMap and contain a map description, map layout, and embedded objects saved in the map. The Contractor must also provide details of the procedures and software to be employed as a tender deliverable.

Sediment textures based on categorisation of grain size – These are to be delivered in a singular feature class containing underlying sediment texture using the categories supplied in 118.

Landforms, morphology and anthropogenic features – Each feature is to be rendered as their own feature class (121).
Eg: - All Ridges are to be rendered in a singular feature class with each ridge delineated as a single part feature.

Geological interpretation – Each geological feature is to be rendered as their own feature class. The level of this requirement will be specified in the HI (137) e.g.: - All Channel deposits are to be rendered in a singular feature class with each Channel deposit delineated as a single part feature.

For each seabed classification deliverable there shall be no gaps or overlaps between adjacent polygons within that individual a shapefile or feature class.

117 Shape Files or Feature classes within a Geodatabase

- May only hold features with the same geometry, which is defined as; point, line, or polygon
- Must be of polygon type (not polygon ZM or other type)
- For each shapefile or feature class deliverable, there must be no gaps or overlaps between adjacent polygons within that individual a shapefile or feature class
- Must have the appropriate assigned coordinate system
- Contain all specified attributes, even if the field is left blank
- Meta data must follow ESRI ISO 19115-1:2014 and must be fully populated including geospatial information
- Each Shapefile/Feature Class must only contain singlepart polygons e.g.: - Individual polygons within a feature class can be individually selected, see below for an example

1 Multipart Feature

4 Singlepart Features

118 Texture Area

Attributes:

Field Name	Field Alias	Field type	Example
Code	Texture Code	Short Integer	2
Code Descr	Code Description	Text	Sandy mud and muddy sand
Descript	Textural Description	Text	fS.M.Sh.Wd
Comments	Comments	Text	

This Feature Class must encompass the entire survey area (as detailed in each Hydrographic Instruction) such that no gaps or overlaps must remain.

119 Sediment Texture Codes

All Sediment Texture information is to be held together in a Single shapefile or Feature Class containing a continuous representation of Seabed sediment. These must be single part polygons that do not overlap or have gaps.

Any additions to the below table are to be approved by the authority before submission.

Texture Code	Texture Description
0	Rock/Sediment Absent
1	Mud
2	Sandy mud and muddy sand
3	Sand
4	Mixed
5	Coarse sediment
6	Cobbles and Boulders (with or without finer sediment)

120 Textural Description (H575)

Descriptions are to be classified with the largest composition by weight followed subsequently by the next using terms form the below table. Any additions to the below table are to be approved by the authority before submission.

Main Terms	Symbol	Secondary Terms	Symbol	Qualifying Terms	Symbol	
Sand	S	Ooze	Oz	Fine	f	Only to be used for sand
Mud	M	Marl	Ml	Medium	m	
Clay	Cy	Shingle	Sn	Coarse	c	
Silt	Si	Chalk	Ck	Broken	bk	
Stones	St	Quartz	Qz	Sticky	sy	
gravel	G	Madrepore	Md	Soft	so	
Pebbles	P	Basalt	Ba	Stiff	sf	
Cobbles	Cb	Lava	Lv	Volcanic	v	
Rock, Rocky	R	Pumice	Pm	Calcareous	ca	
Boulders	Bo	Tufa	T	Hard	h	
Coral	Co	Scoriae	Sc	Small	sm	
Shells	Sh	Cinders	Cn	Large	l	
Weed (including kelp)	Wd	Manganese	Mn	glacial	ga	
Two Layers e.g Sand over Mud	S/M	Glauconite Oysters	Gc Oy	Speckled White	sk w	
Mixed: main constituent is given first, e.g. fine Sand with Mud and Shells	fS.M.Sh	Mussels Sponge Algae Foraminifera	Ms Sp Al Fr	Black Blue Green Yellow	bl b gn y	
		Globigerina	Gl	Red	rd	
		Diatoms	Di	Brown	br	
		Radiolaria	Rd	Chocolate	ch	
		Pteropods	Pt	Grey	gy	
		Polyzoa	Po	Light	lt	
				Dark	d	

121 Categories of Landforms, general morphology and anthropogenic features

The following requirements, listed in respect of their geometry, describe the typical types of features to be included for Seabed Texture deliverables. Each survey is unique and as such not all the features may be found in an individual survey. Additional features may be requested in individual HI. The Report of Survey should detail the types of Seabed Texture information that has been found and delivered.

Each type of Seabed Texture feature has several attributes that must be included. The attributes listed are based on information required by the Authority and are not absolute – extra features and/or attributes may be added at the discretion of the surveyor. Each Landforms, general morphological or anthropogenic feature is to be rendered as their own shapefile or as an additional feature class within the Geodatabase. Features can be classified as only one of the following; point, line, or polygon, depending of the feature's physical representation. Where there are multiple features in an area, features should be grouped into singlepart area features.

Any additions to the above table are to be approved by the authority before submission.

Each feature class must contain all instances of that feature type. For example:

› All Seabed Samples are held together in a single point Feature Class

› All Cables are held together in a single line Feature Class

› All Texture Areas are held together in a single polygon Feature Class

1	Ridge (includes: bank, dune, wave)
2	Ripple
3	Shoal/reef
4	Mound
5	Mountain (e.g. seamounts)
6	Groove or gully
7	Channel
8	Valley (includes: canyon)
9	Depression
10	Slope (includes: lobe, apron, escarpment)
11	Plane (includes: platform, terrace, sheet)
12	Vegetation areas
13	Scour Areas
14	Cable
15	Pipeline

122 Ridge

Feature Class Name: Ridge

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Aspect	Aspect	Text	Asymmetric or Symmetric	N/A	Symmetric
Height	Height (m)	Double	Metres	1 decimal place	2.7
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	155
Wavelength	Wavelength (m)	Double	Metres	1 decimal place	25.0
Comments	Comments	Text			

Where many Ridges occur in groups these must be classed as a Ridge Area. The values given for Aspect, Height, Orientation and Wavelength must be chosen to give a general description of the features found in this area. Where one or more of these values changes a new polygon must be created.

A ridge is defined as having a height greater than 1 metre. Features smaller than this must be classed as ripples.

123 Ripple

Feature Class Name: Ripple

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Height	Height (m)	Double	Metres	1 decimal place	0.7
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Wavelength	Wavelength (m)	Double	Metres	1 decimal place	57.6
Comments	Comments	Text			

Where many ripples occur in groups these must be classed as a Ripple Area. The values given for Height, Orientation and Wavelength must be chosen to give a general description of the ripples found in this area. Where one or more of these values changes a new polygon must be created.

A ripple is defined as having a height less than 1 metre. Features greater than this must be classed as ridges.

I24 Shoal_Reef

Feature Class Name: Shoal_Reef

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text		N/A	Coral Reef
Diameter	Diameter (m)	Double	Metres	1 decimal place	210.7
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Comments	Comments	Text			

I25 Mound

Feature Class Name: Mound

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Diameter	Diameter (m)	Double	Metres	1 decimal place	2.7
Height	Height (m)	Double	Metres	1 decimal place	3.5
Comments	Comments	Text			

I26 Mountain

Feature Class Name: Mountain

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text			Thermal vent
Diameter	Diameter (m)	Double	Metres	1 decimal place	210.7
Height	Height (m)	Double	Metres	1 decimal place	340.5
Comments	Comments	Text			

127 Groove_Gully

Feature Class Name: Groove_Gully

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text			Gully
Length	Length (m)	Double	Metres	1 decimal place	210.7
Width	Width (m)	Double	Metres	1 decimal place	30.4
Depth	Depth (m)	Double	Metres	1 decimal place	4.8
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Comments	Comments	Text			

128 Channel

Feature Class Name: Channel

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Length	Length (m)	Double	Metres	1 decimal place	1528.4
Width	Width (m)	Double	Metres	1 decimal place	300.2
Depth	Depth (m)	Double	Metres	1 decimal place	60.8
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Comments	Comments	Text			

129 Valley (includes: canyon)

Feature Class Name: Valley

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text			Canyon
Length	Length (m)	Double	Metres	1 decimal place	1260.5
Width	Width (m)	Double	Metres	1 decimal place	420.7
Depth	Depth (m)	Double	Metres	1 decimal place	80.9
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Comments	Comments	Text			

130 Depression

Feature Class Name: Depression

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Width	Width (m)	Double	Metres	1 decimal place	80.6
Depth	Depth (m)	Double	Metres	1 decimal place	4.8
Comments	Comments	Text			

131 Slope (includes: lobe, apron, escarpment)

Feature Class Name: Slope

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text			Lobe
Length	Length (m)	Double	Metres	1 decimal place	210.7
Width	Width (m)	Double	Metres	1 decimal place	30.4
Depth	Depth (m)	Double	Metres	1 decimal place	4.8
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Slope Angle	Angle (degrees)	Short integer	Degrees	Whole number	30
Comments	Comments	Text			

132 Plane (includes: platform, terrace, sheet)

Feature Class Name: Plane

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text			Platform
Length	Length (m)	Double	Metres	1 decimal place	210.7
Width	Width (m)	Double	Metres	1 decimal place	30.4
Depth	Depth (m)	Double	Metres	1 decimal place	4.8
Orient	Orientation (degrees)	Short Integer	Degrees	Whole number	270
Comments	Comments	Text			

133 Vegetation Areas

Feature Class Name: Vegetation_Area

Attributes:

Field Name	Field Alias	Field Type	Units	Accuracy	Example
Type	Type	Text			Sea Grass
Height	Height from Seabed (m)	Double	Metres	To nearest 0.5 metre	4.5
Comments	Comments	Text			

134 Scour Areas

Feature Class Name: Scour_Area

Attributes:

Field Name	Field Alias	Field Type	Units	Example
Type	Type	Text	Hydrodynamic, Dredging, Ice or Trawl	Trawl
Comments	Comments	Text		

135 Cable

Feature Class Name: Cable

Attributes:

Field Name	Field Alias	Field Type	Units	Example
Type	Type	Text	Power or Telecommunications	Power
Comments	Comments	Text		

136 Pipeline

Feature Class Name: Pipeline

Attributes:

Field Name	Field Alias	Field Type	Units	Example
Type	Type	Text	Oil or Gas	Oil
Comments	Comments	Text		

137 Geological interpretation

Below is a non-exclusive list of the anticipated Geological features. As each survey area is unique, the HI will provide a list along with expected attribution.

Class	Simplified geological description	Explanation
1	Bedrock	Including any kind of rocky outcrop, escarpment, dyke etc.
2	Lag deposit	Sediment consisting of sand, gravel and/or coarser material left behind when smaller particles are washed away by waves or currents
3	Biogenic reef (including coral)	Rock outcrops that are produced by the action of living organisms
4	Current-induced landform	Active or relict sediment landforms produced by the action of currents as waves or tides. It includes ripples, megaripples, sandwaves, dunes, bars etc.
5	Glaciogenic landform or deposit	Bedform or sediment deposit produced by the action of glaciers. It includes moraines (curved ridge deposited in front of glacier), eskers (linear glacifluvial ridges), till covers etc.
6	Fluid-escape feature	Landforms created by the actions of fluids escaping from the seabed (e.g. pockmarks)
7	Mass-wasting deposit	Cover of sediments deposited by mass movements such as submarine slides, debris flows or turbidite currents. It can form lobes, mounds or sheets
8	Channel deposit	Sediments deposited in a channel
9	Suspension deposits	Fine grained sediments (usually clay and silt) transported by and deposited from suspension, it includes pelagic oozes or suspension-settling from glaciers
10	Unspecified landform or deposit	If it does not fall in any of the previous

Each Geological feature is to be rendered as their own feature class.

138 Seabed Sample

Feature Class Name: Seabed_Sample

Attributes

Copy of H575 attributes.

The H575.xls form has been designed in such a way that it can be directly brought into ArcGIS and converted into a Feature Class.

Part J

Aerial Photography (lidar)

Requirement 194
Inclusion 194
Coverage 194
Collection 194
Resolution 195
Spectral Range 195
Spatial Accuracy 195
Orthorectification 195
Colour Balancing 195
Mosaicking 196
Time & Date 196
Deliverables – General 196
Deliverables – Milestone 2 196
Deliverables – Milestone 3 196

J1 Requirement

This section is regarding full lidar surveys conducted from an aircraft or RPAS.

Aerial photography is split into two levels of complexity as detailed below:

1. Basic level for use in processing and quality control of lidar data
2. Product level photography for use in feature extraction and other application

Level 1 will be required for all lidar surveys, whereas level 2 may be requested in the Hydrographic Instruction and will be dependent on cost.

J2 Inclusion

Level 1 georeferenced photography of the entire survey area is to be taken coincidentally with lidar data capture.

Level 2 georeferenced photography will be dependent on cost and impact on lidar data acquisition and will be fully detailed in the HI.

J3 Coverage

There is to be no gaps in photography between adjacent flight lines.

Level 1 - The entire area defined within the HI.

Level 2 – All topography, coastline out to approx. 10m contour (or as otherwise stated in the HI) and all features, manmade or otherwise, that uncover at any state of tide.

J4 Collection

Level 1 - The collection of aerial photography is to be secondary to the collection of lidar data. Whilst atmospheric conditions should be considered when planning optimum flight times for photography it should not do so at the expense of lidar data capture.

Any data capture during hours of darkness is not to be conducted over areas of seabed that would be visible during daylight under current water clarity conditions or over land.

Level 2 – The final rendered mosaics should be taken from flight lines that are specifically planned for that requirements which may be separate to the main lidar collection and run with different flight path characteristics as required to best meet the requirements of this specification and the HI.

All rendered mosaicked photography is to be taken in daylight.

Images as far as possible are to be free of clouds, shadows from clouds, smoke and significant haze. The Authorities decision on the requirement for re-flights is final.

J5 Resolution

Aerial photography is to be acquired and processed to the following minimum resolution (Ground Sample Distance).

Level 1 – 0.5m.

Level 2 – Up to 0.1m resolution depending on specific requirements detailed in the HI.

J6 Spectral Range

Level 1 – Three band; RGB.

Level 2 – Multi-spectral (RGBN) may be specified in the HI.

Level 3 – Hyper-spectral may also be specified in the HI for specific purposes with exact parameters.

Data values for all photographic products should be set to the range 1-254 (not 0-255). This is to reserve the values 0 and 255 for null image data.

All null values are to be a single value (0 or 255) to allow viewing of overlapping cells

J7 Spatial Accuracy

Level 1 – +/- 2m at 95% confidence level.

Level 2 – +/- 1m at 95% confidence level or as specified in the HI.

J8 Orthorectification

Level 1 – While it is not necessary to produce a 'true orthophoto' that corrects for building lean, seamlines are to be placed to avoid bisecting jetties, buildings or other manmade objects projecting above the bare earth terrain model.

Level 2 – True orthophoto where 3D elevation data (resolution of which is to be equal to the image resolution) for buildings in addition to the bare earth model are to be used to orthorectify imagery. Additionally, pixels from adjacent frames are to be used to fill in the ground that has been obscured by building 'lean' seen in the original frames.

J9 Colour Balancing

Level 1 – Whilst it is not necessary to provide a completely seamless fully colour-balanced photo mosaic, care should be taken with photographic exposure and mosaicking to ensure that the imagery is suitable for processing and validation of bathymetric datasets.

Level 2 – Colour balancing and colour matching between frames must be performed to achieve a homogeneous image. Contrast and brightness of each image should be adjusted to minimize variations between images.

J10 Mosaicking

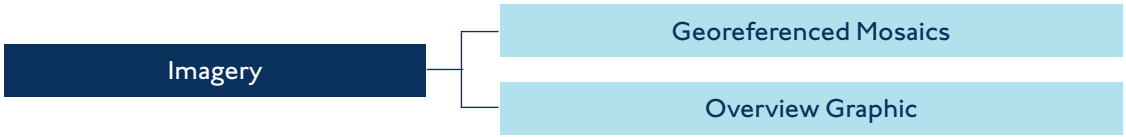
Photography should be orthorectified and mosaicked and provided as 1km square blocks in the specified georeferenced image file formats that do not affect null value representation. Individual blocks are to be named as a derivative of the UTM Coordinate System specified in the HI. For example, a tile with lower-left UTM coordinates 372,000E, 1,937,000N is to be named 372000-1937000. An index diagram (GeoTIFF) or Shape file to allow easy cross-referencing during validation is to be provided in a format agreed by the Authority.

J11 Time & Date

Time and date of photography should be supplied to enable subsequent cross referencing between photographed state of tide and actual recorded state of tide.

J12 Deliverables – General

Imagery data is to be rendered using the following structure:



The HI may request additional deliverables or reduce the requirement of those deliverables detailed below.

J13 Deliverables – Milestone 2

All raw images are to be provided for the highest level required by the HI.

J14 Deliverables – Milestone 3

Level 1

- Georeferenced 8-bit RGB image mosaics of the most appropriate images that cover the entire survey area. Provided in both ECW and LZW GeoTIFF
- Index diagrams/Shape file to include a mosaicking seamline vector file
- The Report of Survey is to include details of the camera model, lense(s) fitted and a workflow for image processing and mosaicking process

Level 2

- Separate georeferenced 8-bit RGBN image mosaics at the specified GSD of all topography, coastline, and all features, manmade or otherwise, that uncover at any state of tide. Provided in both ECW and LZW GeoTIFF
- Additional products as required by the HI including Structure from Motion (SfM) renderings of specific areas

Part K

Vegetation Mapping

Requirement 198
Inclusion 198
Imagery 198
Ground Truthing 198
Deliverables – General 198
Data Blocks 198
Deliverables Vegetation Classification 199
Shape Files or Feature classes within a Geodatabase 199
Vegetation Ground Truth Data 200
Vegetation Areas 200
Vegetation Depth 200
Vegetation Density 201
Sea Surface Conditions 201

K1 Requirement

The requirement for vegetation mapping will be dependent on the area and may include areas of mangrove, macro-algae (kelp), seagrass or other marine vegetation visible from the air.

Areas for vegetation mapping will be indicated either in the HI or by the Client representative during survey work.

K2 Inclusion

Vegetation Mapping will be dependent on cost and impact on other survey data acquisition.

K3 Imagery

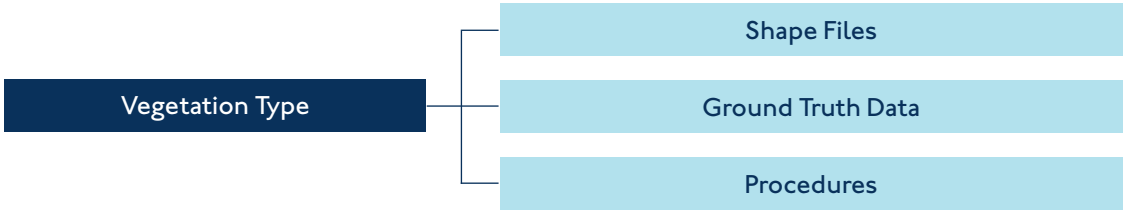
The imagery collected during bathymetric data collection is to be used unless specified otherwise in the HI.

K4 Ground Truthing

Ground Truthing may be required if suitable small craft are available and can be safely deployed. All ground truth data including close up photographs should be logged and provided as part of the rendered data.

K5 Deliverables – General

Vegetation data is to be rendered using the following structure:



K6 Data Blocks

While the HI may detail the number of survey blocks required, the Company may propose an alternate rendering strategy dependent on final data volumes.

Where site conditions require the use of different settings throughout the survey area, the Authority is to be informed and the survey area may need to be divided in blocks of similar settings as agreed with the Authority.

K7 Deliverables Vegetation Classification

The Company shall interpret imagery and any ground truth data to provide details of vegetation in the survey areas.

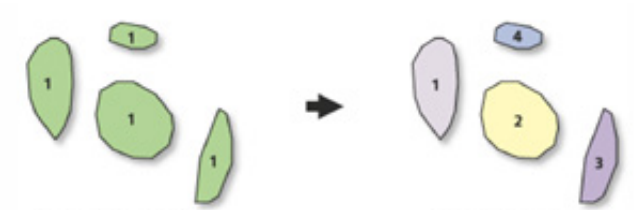
This is to be rendered as an ESRI MXD or individual Shape Files. The Company shall also provide details of the procedures and software to be employed as a tender deliverable.

The vegetation classification will include the following:

- Point features for each ground truth data point taken
- Area features for each vegetation type
- Area features for surface/subsurface vegetation
- Area features for vegetation density
- Area features for sea surface conditions at time of survey

K8 Shape Files or Feature classes within a Geodatabase

- May only hold features with the same geometry, which is defined as; point, line, or polygon
- Must be of polygon type (not polygon ZM or other type)
- For each shapefile or feature class deliverable, there shall be no gaps or overlaps between adjacent polygons within that individual a shapefile or feature class
- Must have the appropriate assigned coordinate system
- Contain all specified attributes, even if the field is left blank
- Meta data must follow ESRI ISO 19115-1:2014 and shall be fully populated including geospatial information
- Each Shapefile/Feature Class must only contain single part polygons e.g.: - Individual polygons within a feature class can be individually selected, see below for an example



1 Multipart Feature 4 Singlepart Features

The tables in I9 to I12 have been completed for macroalgae but should be amended for each vegetation type being mapped.

K9 Vegetation Ground Truth Data

Feature Class Name: Macroalgae_Sample

Attributes:

Field Name	Field Alias	Field Type	Accuracy	Example
Date	Date			01/12/2019 12:15:00 PM
Family	Type	Text		Laminariaceae
Genus	Genus	Text		Macrocystis
Species	Species	Text		Macrocystis pyrifera
Depth below Surface	Depth	Double	To nearest 0.5 metre	0.2
Comments	Comments	Text		

K10 Vegetation Areas

Feature Class Name: Macroalgae_Area

Attributes:

Field Name	Field Alias	Field Type	Accuracy	Example
Family	Type	Text		Durvillaeaceae
Genus	Genus	Text		Durvillaea
Species	Species	Text		Antarctica
Comments	Comments	Text		

K11 Vegetation Depth

Feature Class Name: Macroalgae_Depth

Attributes:

Field Name	Field Alias	Field Type	Units	Example
Depth below Surface	Depth	Float	To nearest 0.5 metre	0.2

K12 Vegetation Density

Feature Class Name: Macroalgae_Density

Attributes:

Field Name	Field Alias	Field Type	Example
Density	Density	Float	Medium

A simple low/medium/high scale is to be used for estimations of density. Any further descriptions of density values used should be included in the Report of Survey.

K13 Sea Surface Conditions

Feature Class Name: Sea_Surface_Conditions

Attributes:

Field Name	Field Alias	Field Type	Example
Sea Surface Conditions	Sea Surface	Text	2

The Beaufort wind scale should be used.

Part L

Shoreline Mapping and Imagery

Scope 203
Inclusion of Shoreline Mapping 203
Topographic Mapping 203
Safety 203
Coverage 203
Topographic Data Uncertainty 203
Panoramic Views 204
Positioning 204
Stabilisation and image quality 204
Comply with UK data protection laws 204
Deliverables – Milestone 4 204

L1 Scope

This section concerns the collection of non-vertical imagery and mapping, such as that taken from a surface vessel mounted lidar and/or camera system.

L2 Inclusion of Shoreline Mapping

Topographic data and georeferenced imagery of the shoreline may be required for some surveys. The HI will give full details if required.

L3 Topographic Mapping

If requested, georeferenced data of the shoreline and manmade structures both at sea and ashore are to be collected using a mobile lidar system that provides accurate georeferenced ranging to the following standards.

L4 Safety

The following additional safety considerations are to be adhered to when using lidar systems:

› All systems utilised for this purpose are to be classified as eye safe

› All staff onboard are to be fully briefed as to any additional safety requirements required when using lidar equipment

While it is expected that systems will generally be collocating on the afloat vessel, proposals for systems flown from RPAS will be considered if the safety requirements noted in Section C are followed and systems flown will have to comply with any local legislation.

L5 Coverage

Ranges are to be measured to all land and structures adjacent to the survey as well as any offshore structures.
The system utilised is to have:

› A minimum range of 200m at 10% reflectivity

› A minimum scan frequency of 300 lines/second

L6 Topographic Data Uncertainty

Topographic data should conform to the following uncertainties:

› +/-0.25m vertically at 95% confidence level

› +/-1.0m horizontally at 95% confidence level

The lidar unit may utilise the same positioning system as the bathymetric system or may be separate.

L7 Panoramic Views

Where requested 360° georeferenced images of the coastline and offshore structures are to be taken. This requirement will be specified in the HI, if at all, and comprises of three tiers.

Tier 1 – Still colour images taken from a specified location(s) with the subject occupying as much of the photograph as possible.

Tier 2 – Continuous colour imagery taken along a specified stretch of coastline, stitched together to form an interactive virtual tour, enabling users to view and navigate through 360° horizontal and 290° vertical panoramic images at vessel level.

Tier 3 – Lidar and continuous colour georeferenced imagery. The lidar point cloud is to be used as a DTM to drape over the imagery to provide enhanced 3D image analysis.

Systems for tiers 2 and 3 must capture an image at least one every second at normal survey speeds (4-5 knots) so that any post-processing and image stitching is not affected. Images are to be captured at an appropriate distance from the shore/object so that the subject occupies as much of the photograph as possible with some sea and sky included.

Alternate methods using Structure from Motion (SfM) from RPAS may be considered for tier 3 providing the products comply with all requirements of this part. Where SfM is the Company preferred method, compliance to the specification must be proven prior to tender/contract award.

L8 Positioning

All images are to be georeferenced with embedded GNSS position in the image metadata. For Tier 3, all geo-referencing between images and lidar are to be coherent, in the same horizontal co-ordinate system and vertical datum, using the same accuracy level.

L9 Stabilisation and image quality

Image stabilisation must be such that vessel movement in all axis is compensated for in order to provide an image that is in focus, sharp and with good contrast. Images need to be captured to at least 12 Megapixels with an appropriate aspect ratio for the chosen data processing software.

L10 Comply with UK data protection laws

Any images taken must comply with UK Data Protection Act 2018. In order to protect people's privacy and limit privacy intrusion personal data shall be removed from any images, e.g.: the blurring of faces and vehicle number plates.

L11 Deliverables – Milestone 4

The final output of the shoreline mapping system is a point cloud georeferenced to the same datum as the bathymetric data set as described in the HI.

Images are to be captured as JPEG or RAW files types only, using a standard naming convention using only standard ASCII characters in the filename (examples of characters not allowed: ü, á, e etc.) and shall at the very least include basic metadata such as time, date, position, collecting organising, HI Number, HI Name and all camera descriptors used in taking the image.

All deliverables for tiers 2 and 3 are to be provided in an appropriate platform that allows a restricted list of viewers to interact with the virtual tour or DTM. A specified software platform may be provided in the HI but will in general be left to the Company's discretion.

Part M

Ancillary Observations

Scope 206
Cetaceans & Marine Mammals 206
Eddies and Over-falls 206
Sound Speed 206
Water Clarity 206
Views for Sailing Directions 207
Amendments to Sailing Directions and Port Approach Guides 207
Fixed and Floating Aids to Navigation 207
Additional Ancillary Observations 208
Marine Life & Seabirds 208
Magnetic Anomalies 208
Sub-Bottom Profiling 208
Sub-Bottom Deliverables – Milestone 4 208
Neutron Backscatter 209

M1 Scope

The following Ancillary Observations are required during all surveys where boat work is required.

They may additionally be specified for any survey, i.e. lidar surveys. Details will be given in the HI if this is required.

M2 Cetaceans & Marine Mammals

A Cetacean & Marine Mammal Sighting Log is to be kept on the bridge or other suitable place that has an open view of the sea. This is to be completed for every sighting and the data rendered on form H637.

Where Cetaceans and Marine Mammals are seen in lidar imagery they must be reported on a H637 form and rendered with the RoS.

M3 Eddies and Over-falls

Observations of any eddies or over falls which may be significant to small craft are to be rendered in the Report of Survey, stating the approximate geographic extents of such features, and how they relate to tidal and weather conditions.

All previously charted eddies and over-falls must be reported on, even if just to state that the current charted information is correct.

M4 Sound Speed

Sound speed profiles must be observed at an interval consistent with the proposed error budget. All valid profiles are to be rendered with the RoS on form H635 or as an electronic file (ASCII or CARIS.svp). In all cases the header information is to be completed and a full decode provided.

Expendable SV probes while acceptable in areas where their use is permitted by local law, are discouraged due to their environmental impact. Where they are used, profiles are to be extended to the full seabed depth using tables or equations that are accepted by the UKHO as being suitable.

Where the UKHO holds suitable values for such use, it will be described in the HI and provided as part of the Government Furnished Data at the commencement of survey.

In all instances, the SV accuracy should be reflected in the Sounding Error Budget.

M5 Water Clarity

The Contractor shall provide an indication of the water clarity in term of secchi disc depths throughout the survey area. Observations are to be made on an approximate 5km grid with at least one observation being given for each major area of noticeably different clarity.

Other methods of obtaining water clarity may be used but all measurements must be reported in terms of secchi disk depths unless otherwise agreed with the Authority.

Data is to be rendered on form H631 (part of the Oceanographic H Form Spreadsheet).

M6 Views for Sailing Directions

Where requested in the HI, photographs required to update existing views in the relevant Admiralty Pilot will be detailed in each HI. Views shall be supported by appropriate records in accordance with NP100. New photography shall be in colour and prepared in accordance with NP100. Digital cameras shall be used and must be either Single Lens Reflex or described by their manufacturer as a "Bridge" or "Bridging" camera and shall have at least 6M pixel resolution.

M7 Amendments to Sailing Directions and Port Approach Guides

The relevant Admiralty Pilot and Port Approach Guide (if applicable) shall be checked in the field and appropriate amendments rendered. Particular attention shall be paid to any recommended approach routes and anchorages within or adjacent to the survey area. If no changes to the relevant Admiralty Pilot are thought to be required by the Contractor, this should also be recorded in the Report of Survey.

M8 Fixed and Floating Aids to Navigation

The positions and characteristics of all fixed and floating aids to navigation visible from the survey area should be checked to ensure that they are as charted and as stated in the Admiralty List of Lights. Nil returns are not required, i.e. specific details do not need to be reported where no changes are noted. There must however be a positive statement in the Report of Survey indicating that fixed and floating aids to navigation were observed to be correct as charted and stated in the publications and that no additional uncharted aids to navigation were observed.

Where differences in the positions or characteristic of marks are noted, local authorities should be asked whether the changes are permanent. Discrepancies are to be noted in the Report of Survey or by Hydrographic Note if more urgent, e.g. safety of navigation is directly and immediately affected due to a buoy being out of its charted position or unlit.

Any marks found to have significantly modified characteristics are also to be reported immediately to the Authority by Hydrographic Note. To avoid ambiguity, the Light List publication and the International Number of the light are always to be quoted when reference is made to a listed light.

Where it is apparent that floating navigational marks, including lightships, lightfloats and buoys are out of position or newly installed/uncharted they are to be fixed in position. This should be the centre of the feature in both its flood and ebb positions thereby determining the range of movement (i.e. the 'scope' of the mark. The mean position and the limits of the scope of the mark should be stated in the Report of Survey together with any light and sound signals observed. Initial fixing of the aid to navigation should be to within the following accuracies, although it is understood that the final mean position will potentially have higher inaccuracies.

	Level 1 – 600m+	Level 2 – 200-600m	Levels 3, 5,6 & 7 – 0-200m
Position of Floating aids to navigation/buoys	20m	10m	0 - 50m – 2m 50 -200m – 5m

For lidar (air or boat mounted), the final classified LAS point cloud should have all such objects classified as 44 (G40).

M9 Additional Ancillary Observations

The following Additional Ancillary Observations may be specified for any survey.

Details will be given in the HI if this is required.

M10 Marine Life & Seabirds

Where requested in the HI, in addition to the mandatory reporting of Cetaceans & Marine Mammals, sightings of other specified marine life and seabirds are to be recorded. Any ornithological observations are to rendered on form H634.

M11 Magnetic Anomalies

Where requested in the HI, charted, or newly discovered magnetic anomalies are to be investigated.

The ship should be steamed slowly in a wide octagon shape centred on the charted anomaly, both to port and starboard, made with the standard magnetic compass on 8 equidistant points during each turn. The ship should be steadied on each heading for at least a minute before the observation to allow the sub permanent magnetism resulting from the last course, to disappear. On each leg of the octagon, both magnetic and GNSS derived headings shall be logged and compared.

Any anomaly found, or not found, shall be reported in the Report of Survey, including the extent and magnitude of local variations.

M12 Sub-Bottom Profiling

Sub-Bottom Profiling may be requested in the HI to inform planning where there is the potential for near or offshore engineering works or to assist in environmental management.

Any such work will be defined in the HI based on three tiers:

Tier 1 – Individual measurements from a hand launched free fall penetrometer.

Tier 2 – A full mapping of the survey area using a shallow penetration 'pinger' or 'chirper' system to give penetration of at least 10m and vertical accuracies of better than 0.3m.

Tier 3 – Specific collection using larger towed systems. Full requirements will be detailed in the HI.

M13 Sub-Bottom Deliverables – Milestone 4

Raw data in proprietary format. Details to be given in Report of Survey.

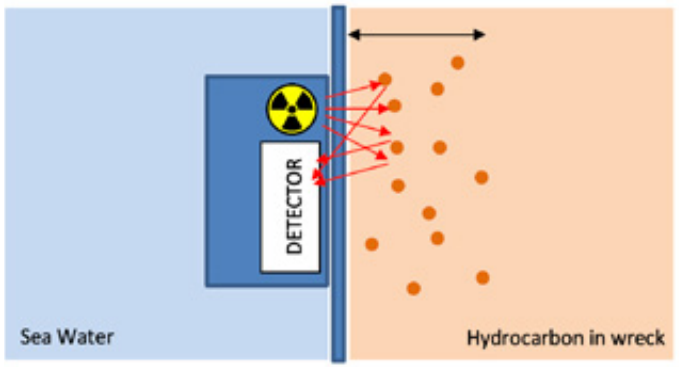
Processed data in SEG-Y.

A full report based on the specific requirement detailed in the HI along with relevant cross-sectional graphics and SHAPE files as required.

M14 Neutron Backscatter

During the conduct of Wreck Investigations, a Neutron Backscatter survey may additionally be specified, using a Neutron Backscatter Unit (NBU). This provides a non-destructive assessment of the contents of the space behind a bulkhead, side shell or external cargo tank wall of a wreck. The technique may assist in determining the location of oil in tanks of the wreck, as well as estimating the volume, and possibly oil properties, whist minimising unnecessary disturbance of the wreck.

A neutron backscatter survey is performed by using a source of high-energy "fast" neutrons and a detector that is sensitive to low-energy "slow" neutrons. The neutron source is held against the side of the vessel once concretions have been removed and moved up and down over the surface by a diver and or an ROV. This is shown in the schematic below.



Neutrons from radioactive source collide with hydrogen atoms in hydrocarbon and are backscattered to the detector

Schematic of Neutron Backscatter Unit – Principal of Operation

Fast neutrons from the source penetrate the vessel walls and interact with the medium inside. If the medium is hydrogenous, neutrons are slowed by collisions with the hydrogen nuclei. The slow neutrons are reflected back out of the vessel and are detected by the sensor. The detector functions to measure the hydrogen concentration of the material adjacent to the detector. When the detector moves across a liquid/vapour interface a large change in detector response is observed. At interfaces between liquids of different hydrogen richness (such as oil and water), a smaller change in detector response is observed. The higher the concentration of hydrogen nuclei, the greater the magnitude of the sensor's response will be.

For oil detection in a wreck, the system requires calibration with hull thickness, which can be achieved by Ultrasonic Thickness (UT) hull gauging. The suspected oil type also needs to be calibrated to interpret the results. For accurate results, there needs to be proper detector placement, survey area accessibility, good hull surface conditions, and line of sight visibility. Rust, concretions, and any encrusting marine life must be removed, mechanically or by jetting, so that the device can attach to a clean surface. When conditions are right, using neutron backscatter allows for the location of oil on a wreck and the limits the need for more time consuming, complex, and costly hull tapping operations for taking samples.

If a Neutron Backscatter survey is required, full details, together with required sampling points, will be specified in the HI.

Annex A

UKHO Bathymetry Standard Table

UKHO Level	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Depth Range unless Specified in HI	600m+	200-600m	As detailed in HI	As detailed in HI	0-200m	As detailed in HI	As detailed in HI
IHO Equivalent Order (S44 Matrix)[1]	2	2	2	1b	1a	Spec	Exclusive
CATZOC Equivalency	B	B	B	B	A1	A1	A1
Example Equipment[2]	MBES	MBES	SBES	Lidar	MBES	MBES	MBES
THU (σ 5%)	±5m +5% depth	±5m +5% depth	±5m +5% depth	±5m +5% depth	±5m +5% depth	2m	1m
TVU (σ 95%)	a = 1.0	a = 0.5	a = 0.5	a = 0.5	a = 0.5	a = 0.25	a = 0.15
	b = 0.020	b = 0.015	b = 0.013	b = 0.013	b = 0.01	b = 0.0075	b = 0.0075
Bathymetric Coverage	100%	100%	25m or 3x depth line spacing[3]	100%	100%	100%	200%
Feature Detection[5][6]	10% of Depth	10m +5% of Depth	Not required	Optically clear – 2m Cube OC to 40m – 6m Cube	2m Cube to 40m then 5% of Depth	1m Cube	0.5m Cube
Wreck/ Obstruction Investigation[5]	Not Required	As specified in HI	Further Investigation	Further Investigation	Detailed Investigation	To include SSS or ROV imagery	To include SSS or ROV imagery

[1]While general equivalencies are noted here, it should be noted that the UKHO Specification is in several areas more stringent than IHO S44 to take account of potential non SOLAS data requirements.

[2]While these examples give an indication of the UKHO's perceived optimum equipment at time of writing, it should not be seen as a limiting statement on potential equipment used for a project which remains a commercial decision and may change as new equipment becomes available.

[3]Whichever is the greater.

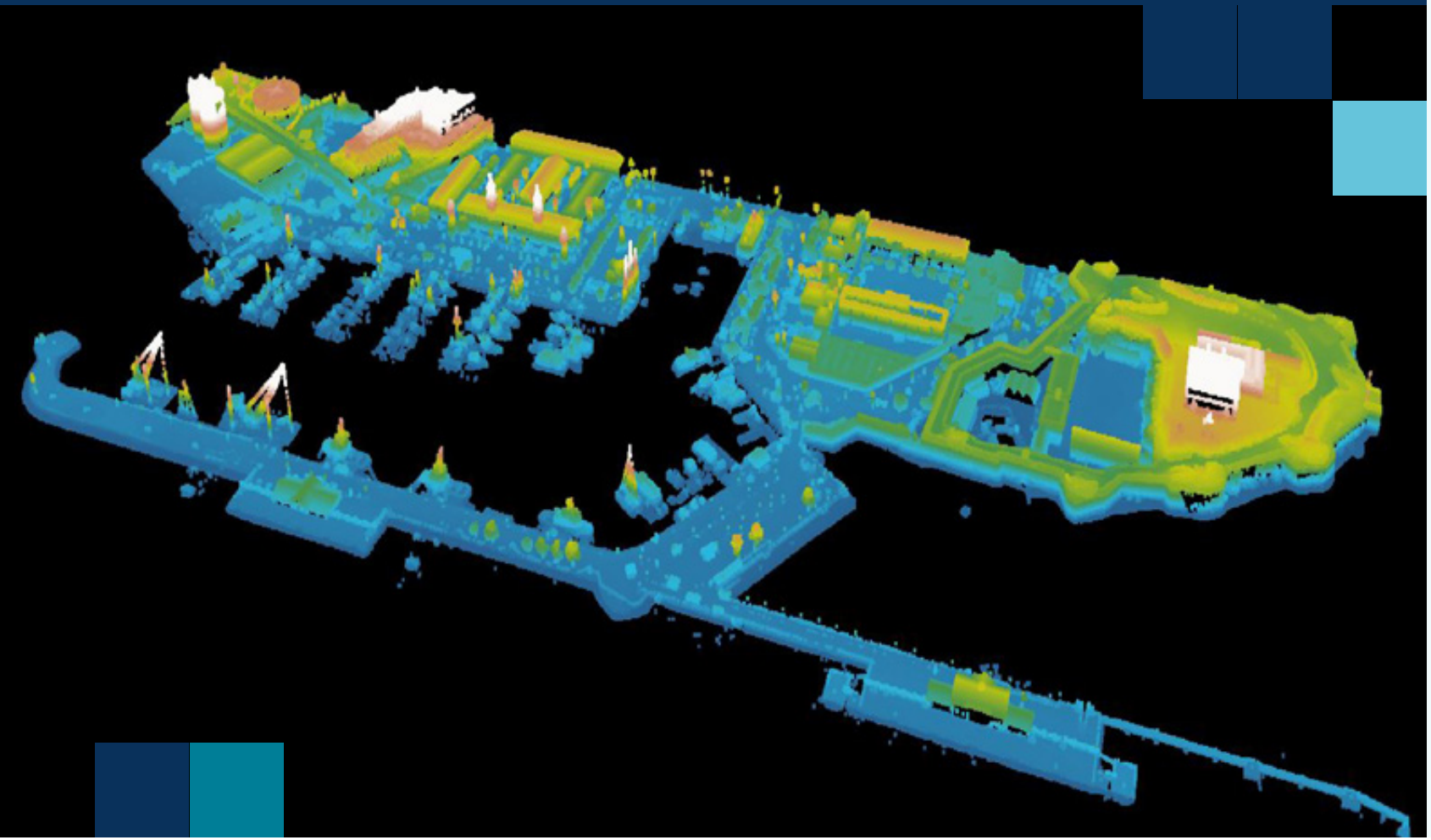
[4]For Level 3 Investigation criteria see G14.

[5]For Level 3 Object Detection criteria see G15.

[6]2m3 Object Detection is required where optically clear water is encountered, and reflectance levels are moderate to good.

Annex B

ASPRS – LAS Classification Scheme



LAS Version 213
Lidar Point Cloud Classification Levels 213
Classification Accuracy 213
Classification Consistency 213
LAS Point Record 213
ASPRS LAS Classification 213
ASPRS LAS Classification Codes 214

B1 LAS Version

LAS Version 1.4-R15 utilising the LAS Domain Profile for Topo-Bathy Lidar (dated 17/07/2013) should be used for all deliverables. Newer versions may be used with the explicit approval of the Authority.

B2 Lidar Point Cloud Classification Levels

One of three levels as defined below and detailed at A7 will be required by the HI:

- **Level 0 – Undefined:** All points classified as 0 or 1 by the lidar processing software with no classification algorithms applied
- **Level 1 – (Semi) Automated Classification:** Processing of the validated point cloud into basic classes
- Any anomalies of >2m in the classification levels must be corrected during QA/QC
- **Level 2 – Detailed Classification and Correction:** The further classification of points to include the classes not mentioned in Level 1 classification

B3 Classification Accuracy

It is expected that due diligence in the classification process will produce datasets that meet the required classification accuracies according to A5. The data set will be accepted if it meets the following:

- No gross errors are present in the data
- Errors of omission must not exceed 2% of all points per class
- Errors of commission must not exceed 2% of all points per class

B4 Classification Consistency

Point classification is to be consistent across the entire project.

Noticeable variations in the character, texture, or quality of the classification between tiles, swaths, flight lines, or other non-natural divisions may lead to the entire deliverable being returned for rework or rejected entirely.

B5 LAS Point Record

Point data record format 9 is to be used unless specified otherwise in the HI with the addition of classification values 40 to 45 when combined with bathymetric data.

B6 ASPRS LAS Classification

ASPRS LAS Topo-Bathy Lidar Domain Profile values 40 to 45 as defined in the LAS Domain Profile Description, dated July 17, 2013 are to be used in addition to the standard classifications.

Additional classes (50-255) may also be included as deemed suitable by the Company to best define the data and assist in data cleaning and product creation. Classification 46 should be used for all submerged vegetation in the dataset as shown in the table at B7.

B7 ASPRS LAS Classification Codes

Number	Class	Level	Description
0	Never Classified	0	Created but not subjected to a classification process
1	Unclassified	0	Default – undergone classification process but emerged as undefined. Includes non-ground points from simple ground/non
2	Ground	1	Bare Ground.
3	Low Vegetation	2	0-0.3m
4	Medium vegetation	2	0.3-2m
5	High Vegetation	2	>2m
6	Building	2	Includes walls and fences. Also includes jetties and wharves that extend over the sea but not floating pontoons
7	Low Point	1	Spurious returns (unusable)
8	Reserved		Reserved for model key points only
9	Water	2	Any point in water (see Number 41)
10	Rail	2	
11	Road Surface	2	
12	Reserved		Reserved for overlap data
13	Wire – Guard (Shield)	2	
14	Wire – Conductor (Phase)	2	
15	Transmission Tower	2	
16	Wire-structure Connector	2	E.g. insulator
17	Bridge	2	
18	High Noise	1	Spurious returns (unusable)
19	Overhead Structure	2	E.g. conveyors, mining equipment, traffic lights
20	Ignored Ground	2	E.g. breakline proximity
21	Snow	2	
22	Temporal Exclusion	2	Features excluded due to changes over time between data sources – e.g. water levels, landslides, permafrost
23	Transient Objects	2	All objects such as cars, people and boats that could move at any time

B7 ASPRS LAS Classification Codes

Number	Class	Level	Description
40	Bathymetric point	1	Seafloor or riverbed (submerged topography)
41	Water surface	0	Sea/river/lake surface from bathymetric or topographic bathymetric lidar. Distinct from Point class 9, which is used in topographic only lidar and only designates water not water surface
42	Derived water surface	0	Synthetic water surface location used in computing refraction at water surface)
43	Submerged Object	2	Not otherwise specified (e.g. wreck, rock, submerged piling)
44	S-57 Object	2	International Hydrographic Organisation (IHO) S-57 object, not otherwise specified
45	No bottom found	1	Bathymetric lidar point for which no detectable bottom return was received
46	Submerged vegetation	2	E.g. Kelp
47	Floating Offshore	2	Any objects at sea that while not permanently attached to the seabed are connected to the seabed and are not expected to move within at least a year. Including offshore oil, gas and renewables
50-255	User Definable		As required to better define dataset. Any use of these class definitions is to be clearly noted in the Report of Survey

Annex C

Hydrographic Note Guidance for Survey Contractors

Introduction 217
Why are Hydrographic Notes Needed 217
Requirements 217
How the UKHO does it 218
Using Decision Trees 219
Decision Tree for Depths in 31m or less 220
Decision Tree for depths of over 31m and under 800m 221
Decision Tree for wrecks, rocks, obstructions, and aquaculture in 800m or less 222
Critical and Controlling Depths 223
What is Navigationally Significant 224
Hazardous Features 225
Depth Selection 225
Contours 227
Additional reporting Requirements 228
How to Report 228
H102 Example 228
Example 1 232
Example 2 233
Example 3 234
Example 4 235
Example 5 236
Example 6 237
Example 7 238
Glossary 239

C1 Introduction

The purpose of this guidance is to facilitate and assist survey contractors with identifying navigationally significant features to be submitted by Hydrographic Note (H102) during surveys.

The aim is to clarify the UKHO requirements for H102's to reduce unnecessary work for contractors and the UKHO in preparing and processing Hydrographic Notes.

Throughout this guidance the Hydrographic Note will also be referred to as H102.

At the end of this guidance there is a glossary of acronyms and terms, and translations of key words.

This guidance is to be followed by all UKHO contractors but can be considered best practice for all other survey work commissioned by other organisations.

C2 Why are Hydrographic Notes Needed

Safety of Navigation

It is important that safety critical information identified during a survey is reported as soon as possible so that products can be updated to ensure safety at sea.

Timeliness

There may be occasions where there is a delay to surveying or processing data. H102's ensure that navigationally significant data can be published by Notices to Mariners without delay. If new information is known but not reported it could lead to an avoidable marine incident.

C3 Requirements

Compare as the Survey Proceeds:

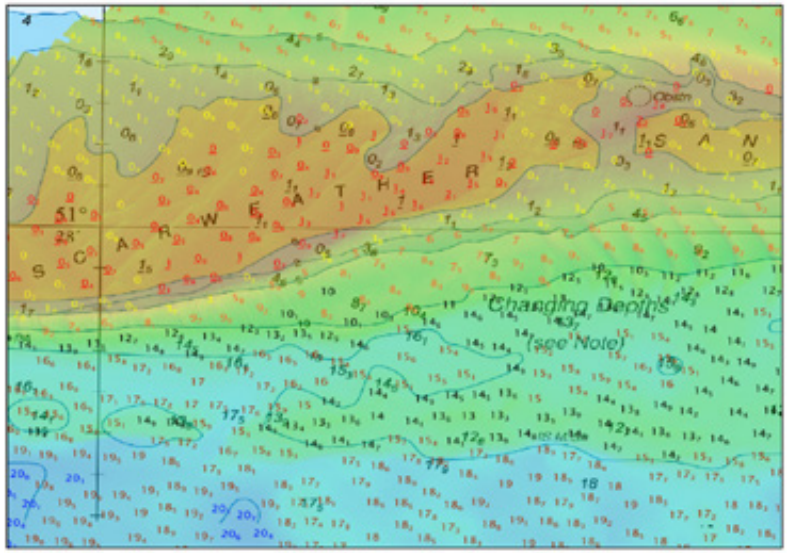
Comparison between the largest scale[12] (and up to date) published chart or ENC and the data collected should be carried out as the survey proceeds. Ensure that the latest edition of the chart or ENC is used and all NM's have been applied.

- The process consists of assessing the depth changes and deciding what is navigationally significant
- When examining depths for rocks, wrecks, obstructions, and aquaculture, H102's can be submitted if necessary, for new and shoaler features as they are identified
- When determining the least depth over a bank or in an area, it is better to survey the whole feature before doing a chart comparison to identify the least depth over the shoal
- Hydrographic Notes should be sent as the survey progresses, however, if further navigationally significant differences are identified after survey field work is completed, they should be rendered within the same timelines noted at G33 of this specification

12 The largest scale chart shows the maximum possible detail for the area. (eg: 1:25000 scale is larger than 1:50000 scale).

C4 How the UKHO does it

When assessing survey data for the purpose of assessing the requirement for Notice to Mariners the UKHO uses a display of the survey surface with a shoal biased sounding selection overlaid digitally on the chart:



Using transparency and a colour banded sounding selection, the shoals and the depths over them can be more easily identified displayed against the latest published chart.

If the depths are shoaler than charted, use the Decision Trees and guidance on depth selection below to decide if an H102 is required.

C5 Using Decision Trees

"Decision Trees" are flow diagrams to assist in deciding whether navigationally significant changes to charted depth information should be reported to the UKHO by H102. They are intended to provide a visual reference guide to aid the decision-making process.

The following decision trees are available in the guidance:

› H102 Guidance for drying heights and depths in 31m or less

› H102 Guidance for depths of over 31m and under 600m

› H102 Guidance for reporting new or amended wrecks, rocks, obstructions, and aquaculture in 800m or less

It is important that the correct decision tree is used for the depth range being examined as the requirements will be different.

The decision trees work like any flow diagram. Simply follow the arrows starting at the top of the decision tree to decide if an H102 is required for the selected feature.

Important:

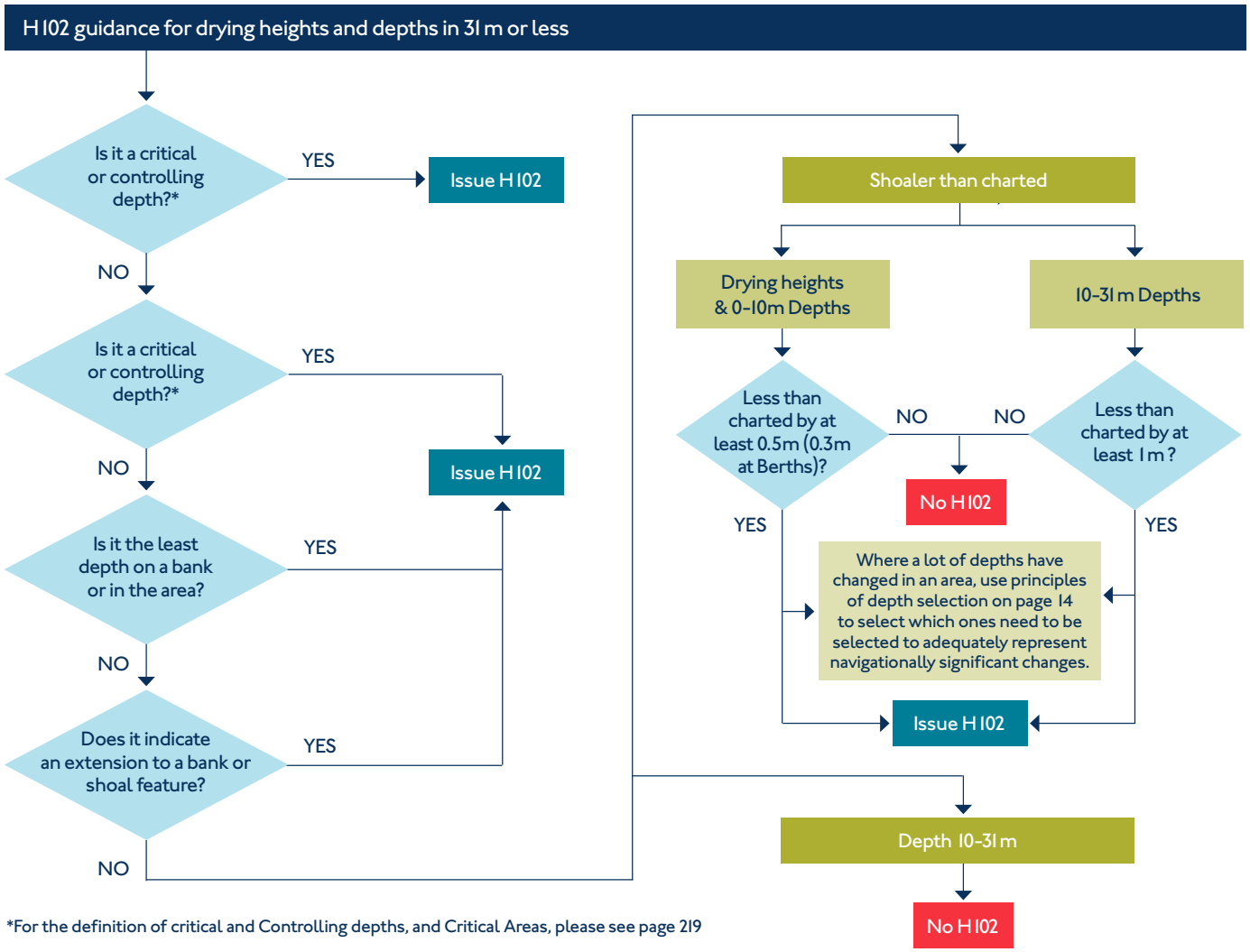
› The UKHO does not require H102's for depths and wrecks which are deeper than charted

› All new wrecks must be reported by H102, including non-dangerous wrecks

› In high-risk areas with minimum under-keel clearance, any shoaling of critical or controlling depths must be reported by H102 (eg: within Deep Water Routes and Traffic Separation Schemes)

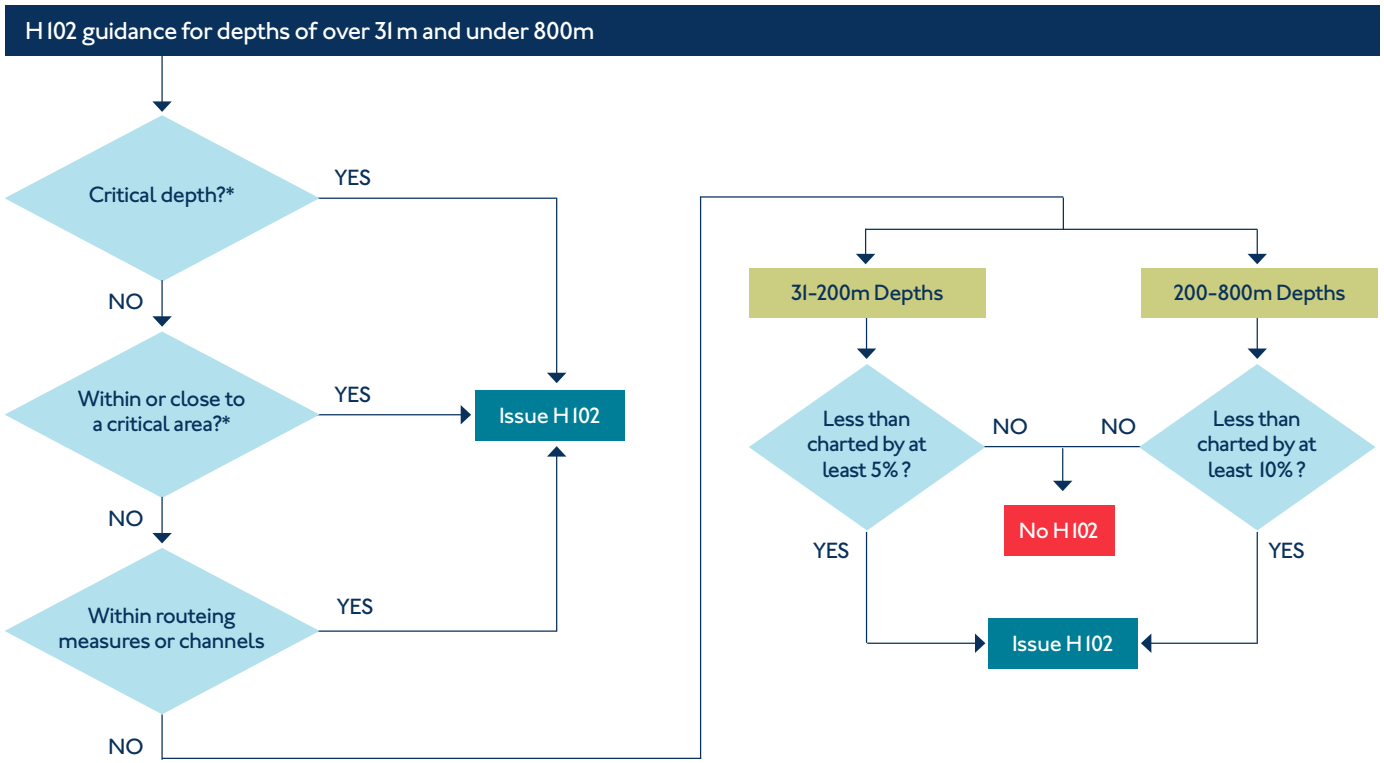
› IF IN DOUBT REPORT IT

C6 Decision Tree for Depths in 31m or less

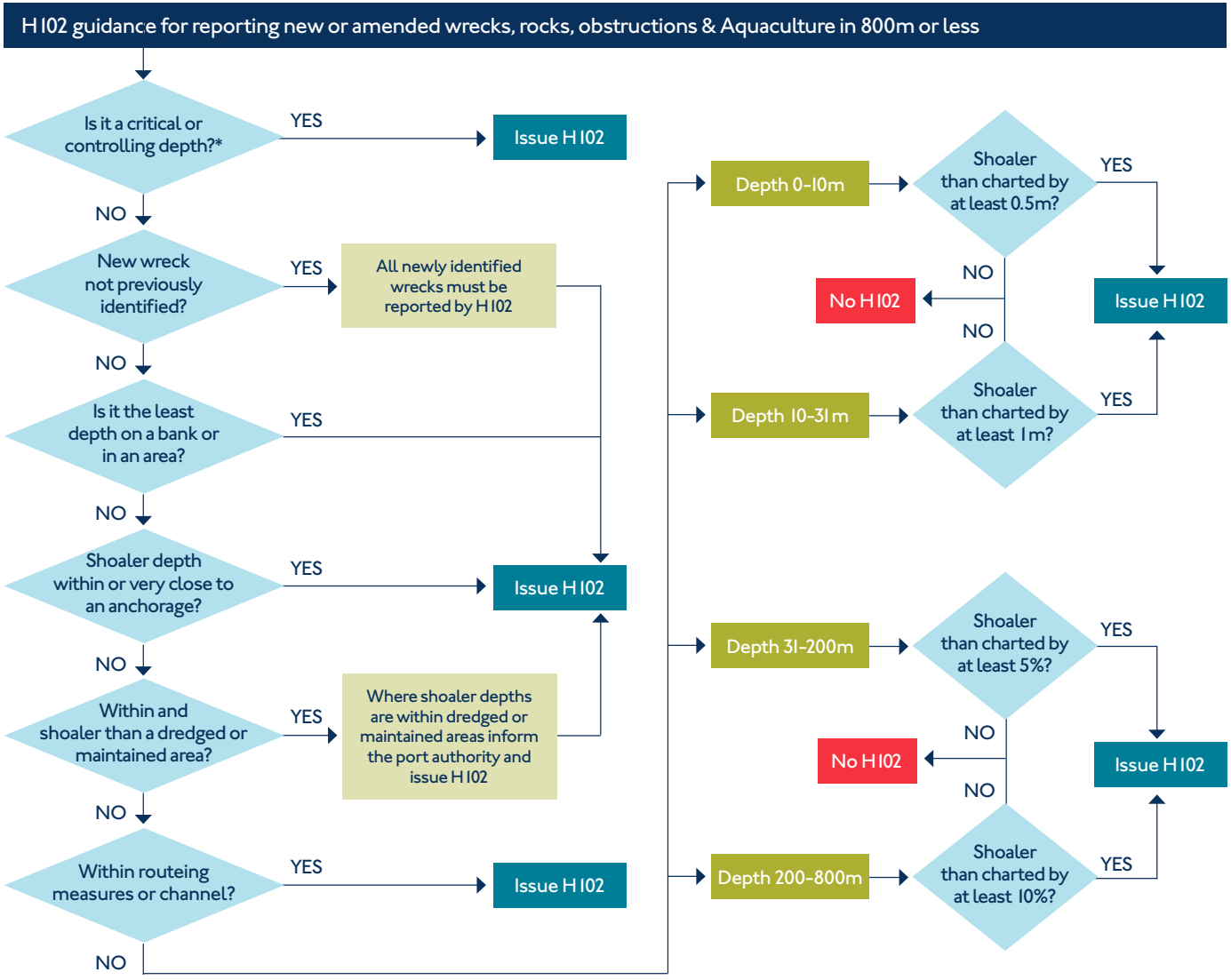


*For the definition of critical and Controlling depths, and Critical Areas, please see page 219

C7 Decision Tree for depths of over 31m and under 800m



C8 Decision Tree for wrecks, rocks, obstructions, and aquaculture in 800m or less



C9 Critical and Controlling Depths

Controlling depth:

The least depth which vessels cannot avoid when navigating through a channel. This will generally be towards the centre of the channel (see Example 1 on page 23). However, in busy channels where vessels travel in both directions, two controlling depths may be present – one on each side of the centre line. With under-keel clearance the controlling depth restricts the safe use of the channel to draughts of less than that depth at a particular time/state of tide. Controlling depths are only applicable to surface navigation, so not relevant to depths over 31m.

Also defined as: 'The least depth in the approach or channel to an area, such as a port or anchorage, governing the maximum draft of vessels that can enter.'

Critical Depths:

Depths outside a channel or harbour approach are therefore not strictly 'controlling depths'. In an uneven area, where there is no clear channel, it may be necessary to select the least depths over several heads, i.e. the 'critical depths'.

Even where there is a clear ship channel, the surveyor needs to consider the needs of other vessels that may not be constrained by, and may even avoid, the ship channel.

Critical depths are therefore those depths in the wider area which are critical to the safe navigation of any vessel likely to be in the area. A critical depth is defined as the least depth in proximity to a known or potential navigational route. Critical depths can be any depth.

Critical areas include:

- Deep water routes and TSS
- Leading Lines
- Fairways and recommended tracks
- Anchorage areas
- Alongside jetties
- Quays and berths
- Entrances to harbours and basins
- Dredged and maintained areas

C10 What is Navigationally Significant

In high-risk areas with minimum under-keel clearance, such as Deep-Water Routes and Traffic Separation Schemes, any shoaling of critical or controlling depths needs to be reported by H102.

Least depth reductions over wrecks, rocks, obstructions, and aquaculture (according to the decision tree).

The least depth over shoals and banks, and over bars in navigable channels should be reported if less than charted. Note that any shoaling of the least depth in these areas should be reported, as indicated on the decision trees. Depth reductions which indicate an extension to a bank or feature, especially near channels, are also navigationally significant.

The typical maximum draught of vessels is 24m, but deeper depth changes are navigationally significant to sub surface navigation and fishing vessels and therefore need to be considered.

Particular attention should also be paid to depths in other critical areas, for example:

- On or adjacent to leading lines
- Controlling depths in fairways and along recommended tracks
- In anchorages
- Alongside jetties
- Quays and berths
- Entrances to harbours and basins
- Dredged and maintained areas
- In areas where only leisure craft sail, only depth changes within the 10m contour are significant
- It is important to consider the location and context of the depth in relation to charted features. For example, a smaller reduction to a deeper depth near a traffic lane may be more significant than a greater depth reduction further away

Remember that although depth changes in critical areas are more significant, other areas should also be examined in detail for differences.

C11 Hazardous Features

A hazardous feature is any feature where, if the information was missing or incorrect on the chart or ENC, it could lead to a marine accident serious enough to put lives at risk or cause serious environmental damage.

If the least depth is reduced, the position has changed, or the feature is wrongly depicted or missing on the chart, then this should be reported by H102.

These features will be in high transit areas such as:

› Anchorage Areas/Anchorages

› Port Approaches

› Recommended Routes and Tracks, TSS

C12 Depth Selection

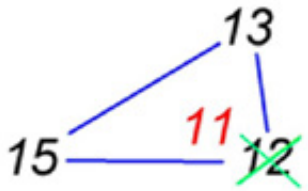
The UKHO criteria for depths which are considered for Notices to Mariners (NM) are:

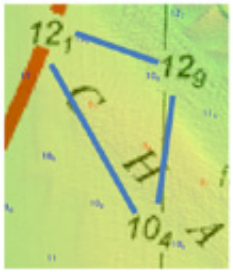
Depth range	Depth difference for NM action
Drying heights and 0-10m	>0.5m less than charted (0.3m at berths)
10-31m	>1m less than charted
31-200m	>5% less than charted
200-800m	>10% less than charted

It is important to consider the depth range of the selected depth and compare to the table above to see if the difference is significant for H102 action.

Where several depths have changed in an area, use principles of sounding selection below to select which depths are significant.

Depth selection is made easier by using the triangular method of sounding selection:

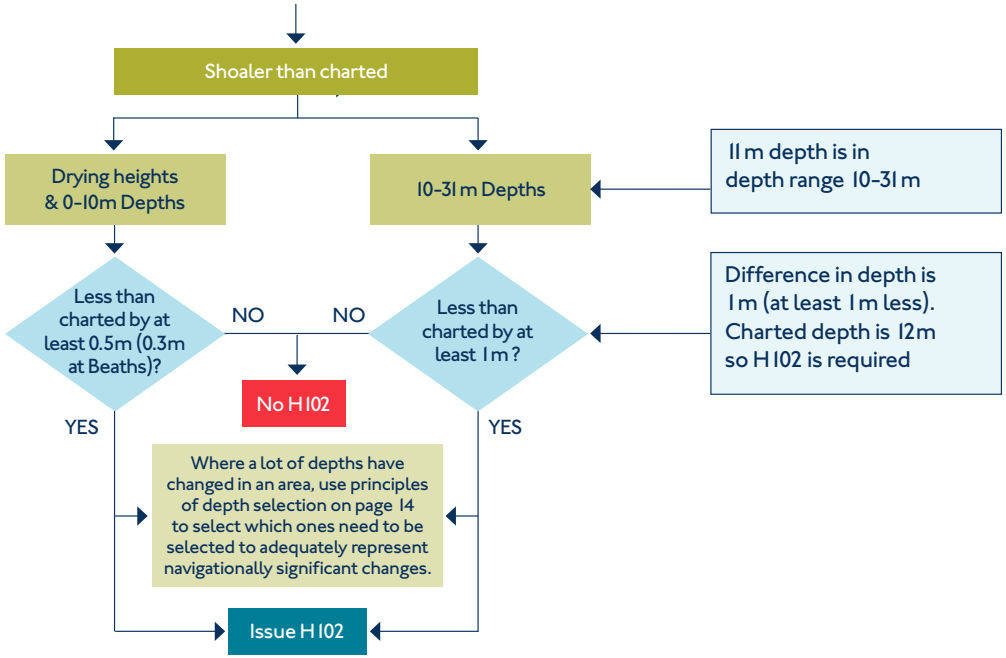




C12 Depth Selection Continued

The black numbers in the images above represent the charted depths. No depths on the sounding selection within the triangle should be less than the charted depths at the edges of the triangle. If there are shoaler depths within the triangle than charted, use the decision trees to identify significant depths and issue an H102 if appropriate. Note that depth reductions between adjacent depths (along the edges of the triangle) are also significant.

In the first image above, the red 11m depth is 1m less than the 12m depth so will need to be reported by H102 as it is at least 1m shoaler within the depth range of 10m-31m (see the extract from the H102 decision tree for depths between 10m and 31m below). Always select the least depth within the triangle.



Important:

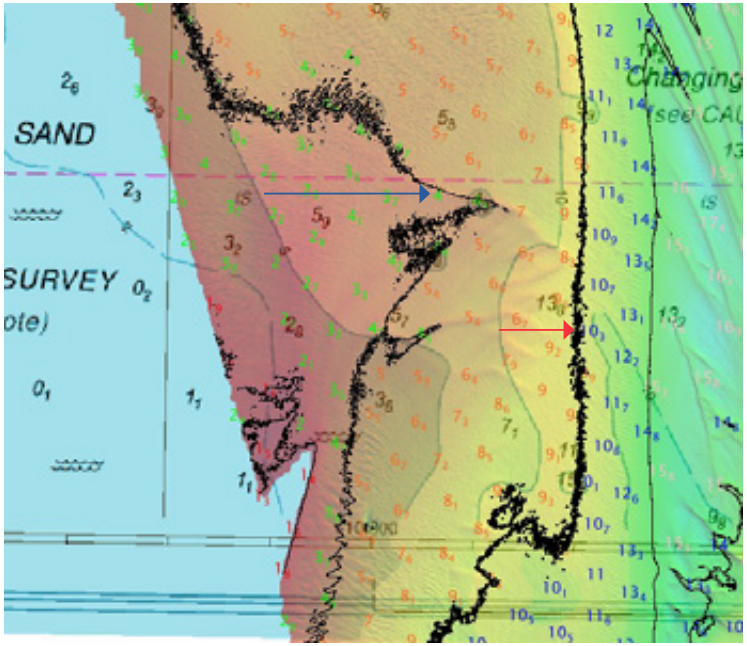
The most significant shoal depths which need to be reported may not be located directly over the charted depths. When the guidance advises to report "depths less than charted", consider the shoalest depth in the vicinity of the charted depths, not necessarily the survey depth in the same position as the charted depth.

C13 Contours

Use the charted contours to determine the movement of banks or shoals, especially into channels. If the shoaler depth indicates a movement of the contour over a wider area, consider including other depths along the contour which may be of interest which more clearly demonstrate the change.

If the software is available, it may be useful to create contours digitally from the survey data and compare to the charted contours to more easily identify sediment migration.

Example:



Key

Easterly migration of 5m contour.

Easterly migration of 10m contour.

C14 Additional reporting Requirements

Fixed and Floating Aids to Navigation

The positions and characteristics of fixed and floating Aids to Navigation in the survey area do not need to be reported if they are as charted. However, if navigationally significant differences between physical features and their depiction on the current Admiralty nautical charts and publications are identified, then this should be immediately reported to the local port and lighthouse authorities using the H102 form. The local maritime authority (MCA in the UK) and UKHO should be copied in to all correspondence of this kind.

Leading Lines and Tracks

The leading lines and recommended tracks along channels and into harbours and anchorages marked by lights or fixed daymarks must be very carefully examined. If navigationally significant differences between physical features and their depictions on the current Admiralty nautical charts and publications are identified, then this should be immediately reported to the local port and lighthouse authorities using the H102 form. The local maritime authority (MCA in the UK) and UKHO should be copied in to all correspondence of this type.

C15 How to Report

UKHO need a reduced depth and a position for each navigationally significant depth to issue a Notice to Mariners. If final tidal/ellipsoidal reduction values aren't available, an initial figure or predicted tides should be used and noted as such on the H102.

Additional graphics are useful to show the context of the depth being submitted. However, the UKHO cannot use graphics showing changes to contours without depths and positions. Please ensure that the depths and positions are supplied.

Where numerous depths (>10) are considered navigationally significant in an area, consider including a .hob file or points shape file with the H102 and rendering an extract from the dataset with an explanation. This will avoid reporting long lists of depths saving unnecessary work for the Surveyor and UKHO.

Complete form H102 and submit to UKHO and other local authorities* (if applicable) within 24 hours.

List the Hydrographic Notes in the Report of Survey including the dates they were submitted.

The Admiralty H Note App for submitting H102's may also be used and is available on Google Play and the App Store.

C16 H102 Example

The H102 should be completed as fully as possible without any blank sections. If a section doesn't apply please state N/A (Not Applicable).

C16 H102 Example Continued

The H102 should be completed as fully as possible without any blank sections. If a section doesn't apply please state N/A (Not Applicable).

HYDROGRAPHIC NOTE H.102 (V8.0 Oct 2014)

Reporting information affecting Admiralty Products

For new information affecting Admiralty Charts and Publications forward to sdr@ukho.gov.uk
To report issues related to ENCs or their display forward to customerservices@ukho.gov.uk
This form H.102 and instructions are available online at www.ukho.gov.uk/msi

Date	06/10/2018	Ref. Number	HI 1602 – 004		
Name of ship or sender	UKHO survey vessel "Just a Splash"				
IMO number if applicable	N/A				
Address	UKHO survey vessel "Just a Splash", St Lucia				
E-mail/Tel/Fax of sender	UKHO.surveyteam@gmail.com				
General Locality	Vieux Fort, St Lucia				
Subject	Depth shallower than charted.				
Position *(see instruction 2)*	Latitude	13°44.320'N	Longitude	061°00.336' W	
	GPS	yes	Datum	ITRF2014	Accuracy 0.2m
Admiralty Charts affected	1273		Edition	2	
Latest Weekly Edition of Notice to Mariners held	Yes				
Replacement copy of Chart No *(see instruction 3)*	~~IS~~ / IS NOT required				
ENCs affected	GB401273				
Latest update disk applied	Week:	NA			
Make, model and or age of ECDIS if applicable	NA				
Publications affected (NP/DP number, Edition No.)	none				
Date of latest supplement/update, page & Light List No. etc	NA				

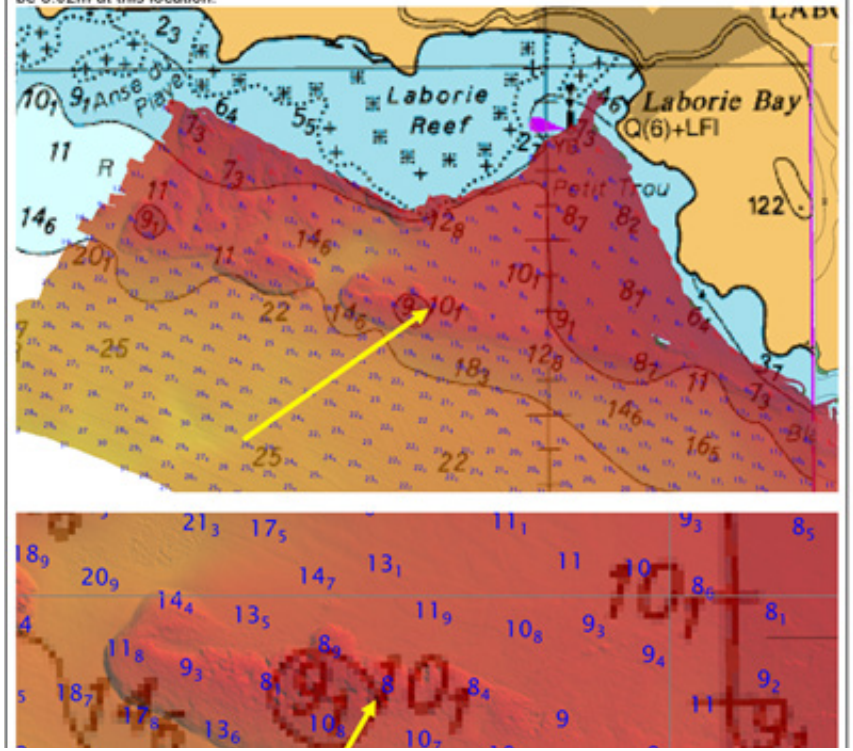
C17

Please provide as much detail of the observation as possible. Include graphics of the survey depths overlaid on the latest version of the Admiralty Chart to illustrate the anomaly/observation.

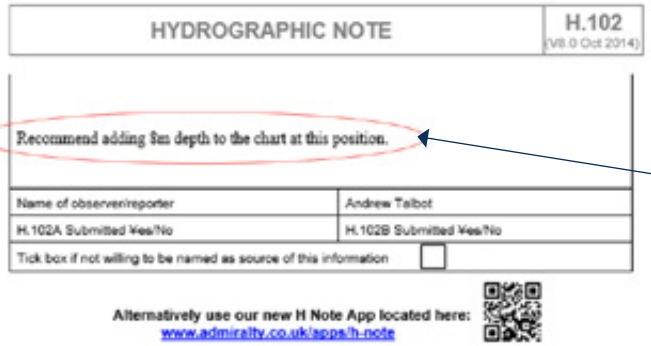
HYDROGRAPHIC NOTE H.102 (V8.0 Oct 2014)

Details of anomaly / observation:

Chart implies a depth of around 10m whereas the depth found during survey HI1602 is found to be 8.02m at this location.



C18



HYDROGRAPHIC NOTE H.102 (V8.0 Oct 2014)

Recommend adding 8m depth to the chart at this position.

Name of observer/reporter	Andrew Talbot
H.102A Submitted Yes/No	H.102B Submitted Yes/No
Tick box if not willing to be named as source of this information	☐

Alternatively use our new H Note App located here:
www.admiralty.co.uk/apps/h-note

INSTRUCTIONS

1. Mariners are requested to notify the United Kingdom Hydrographic Office (UKHO) when new or suspected dangers to navigation are discovered, changes observed in aids to navigation, or corrections to publications are seen to be necessary. Mariners can also report any ENC display issues experienced. The Mariner's Handbook (NP 100) Chapter 4 gives general instructions. The provisions of international and national laws should be complied with when forwarding such reports.

2. Accurate position or knowledge of positional error is of great importance. Where latitude and longitude have been used to specifically position the details of a report,a full description of the method used to obtain the position should be given. Where possible the position should be fixed by GPS or Astronomical Observations. A full description of the method, equipment, time, estimated error and datum (where applicable) used should be given. Where the position has been recorded from a Smart Phone or Tablet, this is to be specifically mentioned. When position is defined by sextant angles or bearings (true or magnetic to be specified), more than two should be used in order to provide a redundancy check. Where position is derived from Electronic Position Fixing (eg LORAN C) or distances observed by radar, the raw readings of the system in use should be quoted wherever possible. Where position is derived after the event, from other observations and/or Dead Reckoning, the methodology of deriving the position should be included.

3. **Paper Charts:** A cutting from the largest scale chart is often the best medium for forwarding details, the alterations and additions being shown thereon in red. When requested, a new copy will be sent in replacement of a chart that has been used to forward information, or when extensive observations have involved defacement of the observer's chart. If it is preferred to show the amendments on a tracing of the largest scale chart (rather than on the chart itself) these should be in red as above, but adequate details from the chart must be traced in black ink to enable the amendments to be fitted correctly.

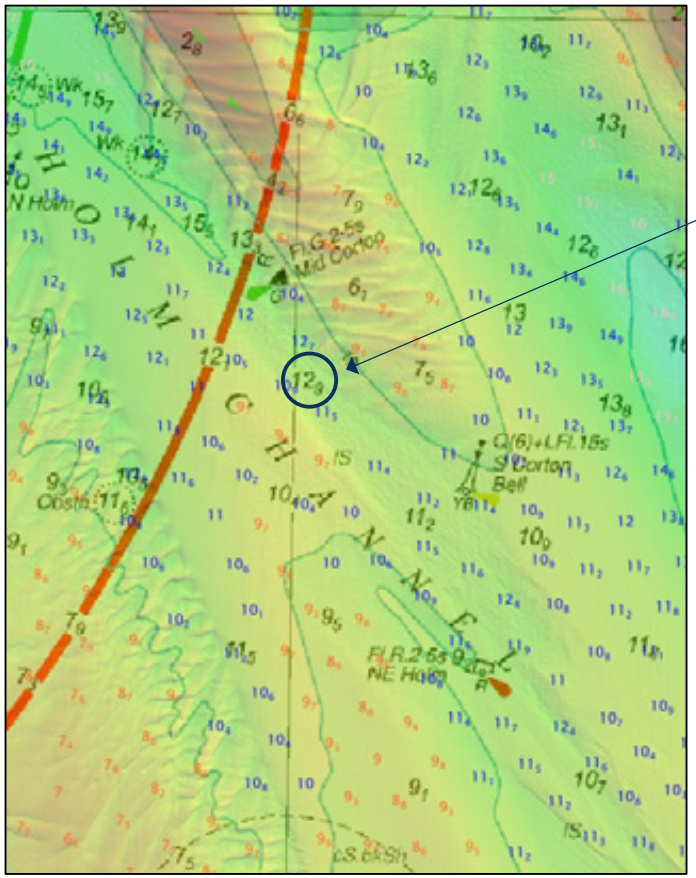
4. **ENCs:** A screen shot of the largest scale usage band ENC with the alterations and additions being shown thereon in red. If it is to report an issue with the display of an ENC, a screen shot of the affected ENC should be sent along with details of the ECDIS make, model or age and version in use at the time.

5. When **soundings** are obtained The Mariner's Handbook (NP 100) should where possible be consulted. It is important to ensure that full details of the method of collection are included with the report. This should include but not limited to:
    1. Make, model and type of echo sounder used.

Use additional space
for comments or recommendations

C19 Example 1

Controlling Depth Change

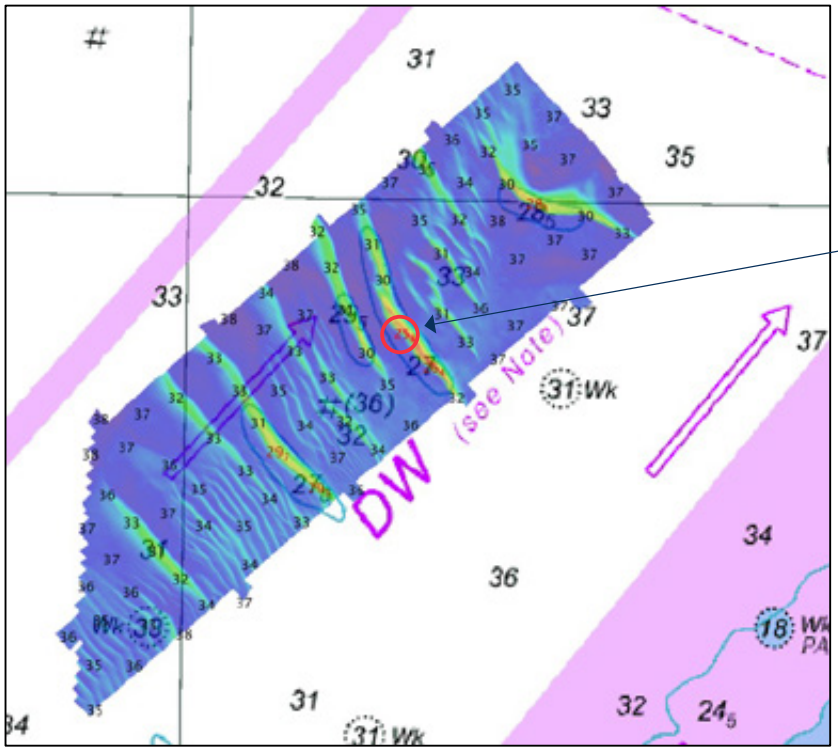


*The direction of traffic can be determined by examining the charted Aids to Navigation, and Automatic Identification System (AIS) data (if available).

In the example above the lateral buoys and South Cardinal buoy clearly show the channel limits.

C20 Example 2

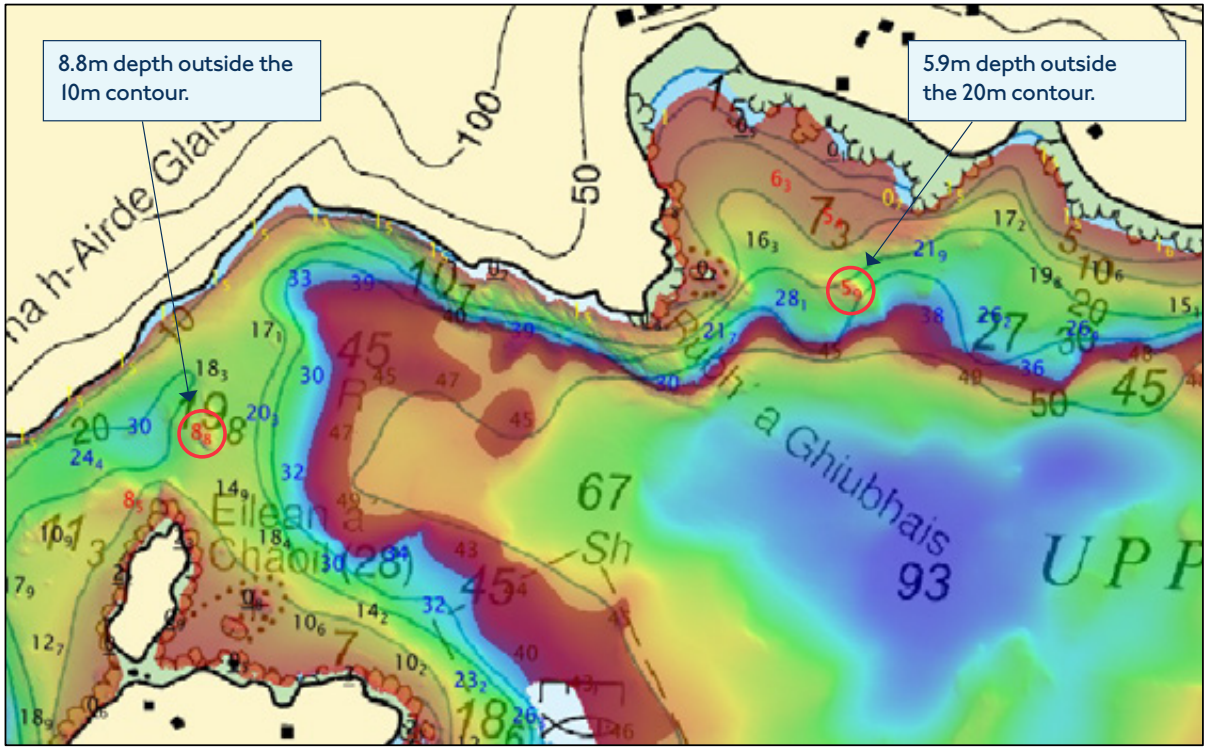
Controlling Depth Change



In this example the 25.8m depth should be reported by H102 as it is the new controlling depth in the Deep Water TSS.

C21 Example 3

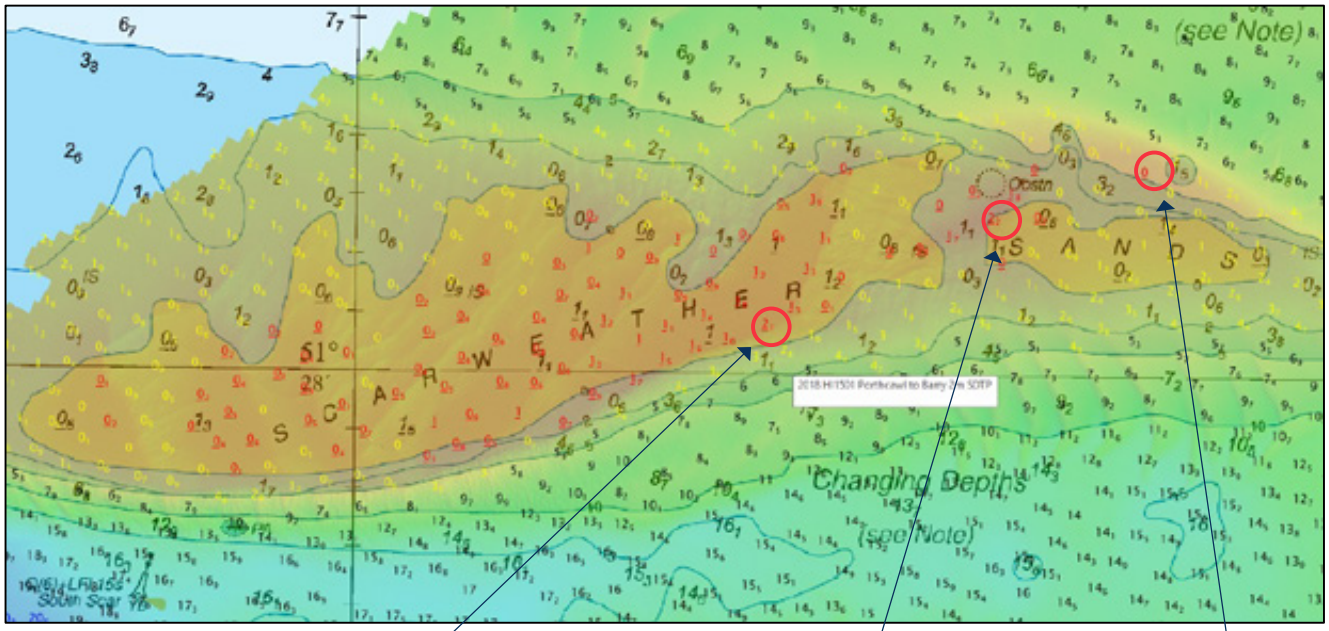
In the following example two uncharted shoals were correctly identified and submitted by H102. Both depths were issued by Notices to Mariners:



This example demonstrates how using a colour banded sounding selection helps to identify depths of interest.

C22 Example 4

Least depths over banks: An area of changing depths creating shoaler drying heights. (Charted notes for Changing Depths should be ignored for this process).



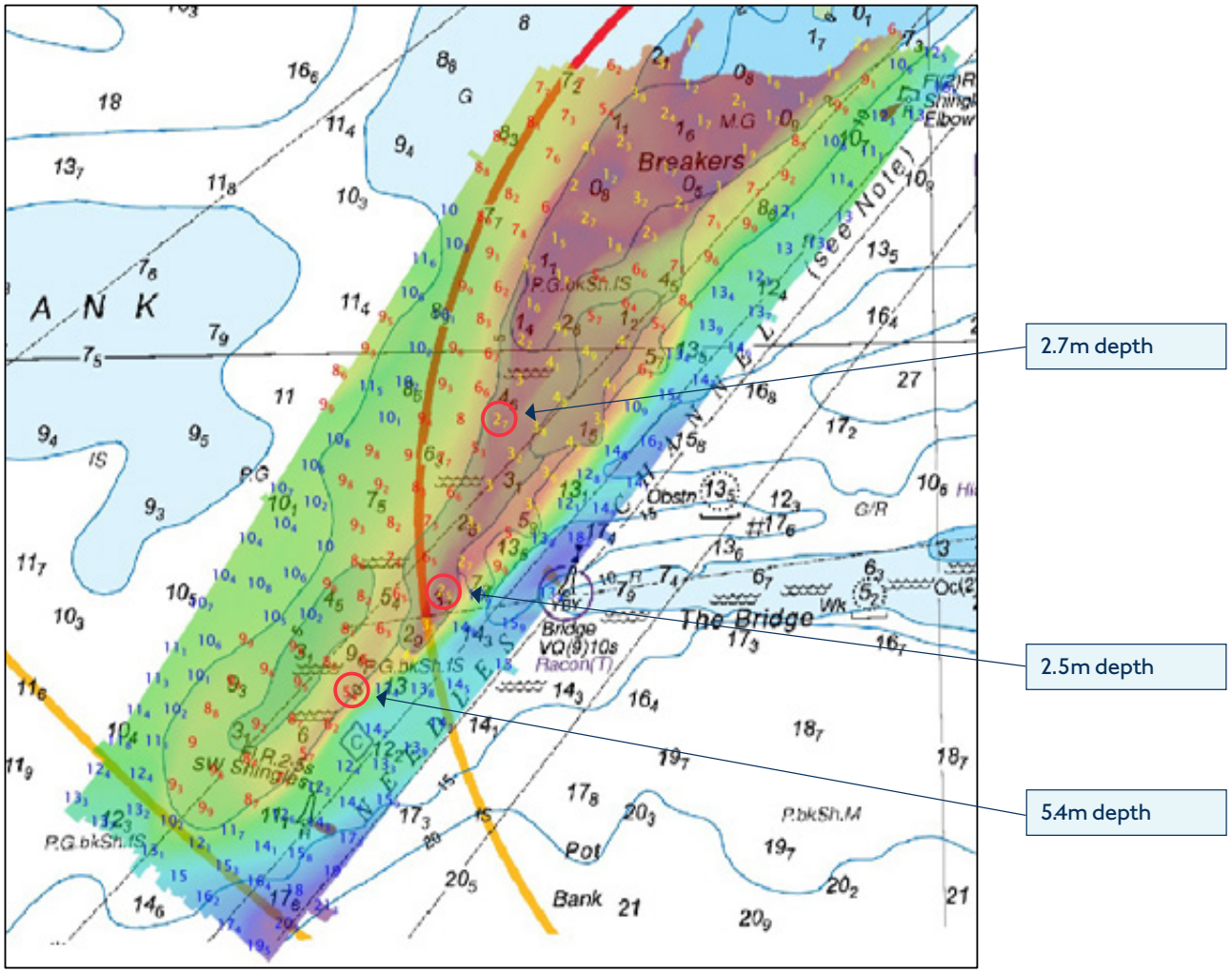
-2.1 m drying height to be submitted by H102. (Highest charted drying height -1.5m)

-2.2m drying height to be submitted by H102. (Highest charted drying height -1.4m)

0m depth to be submitted by H102.

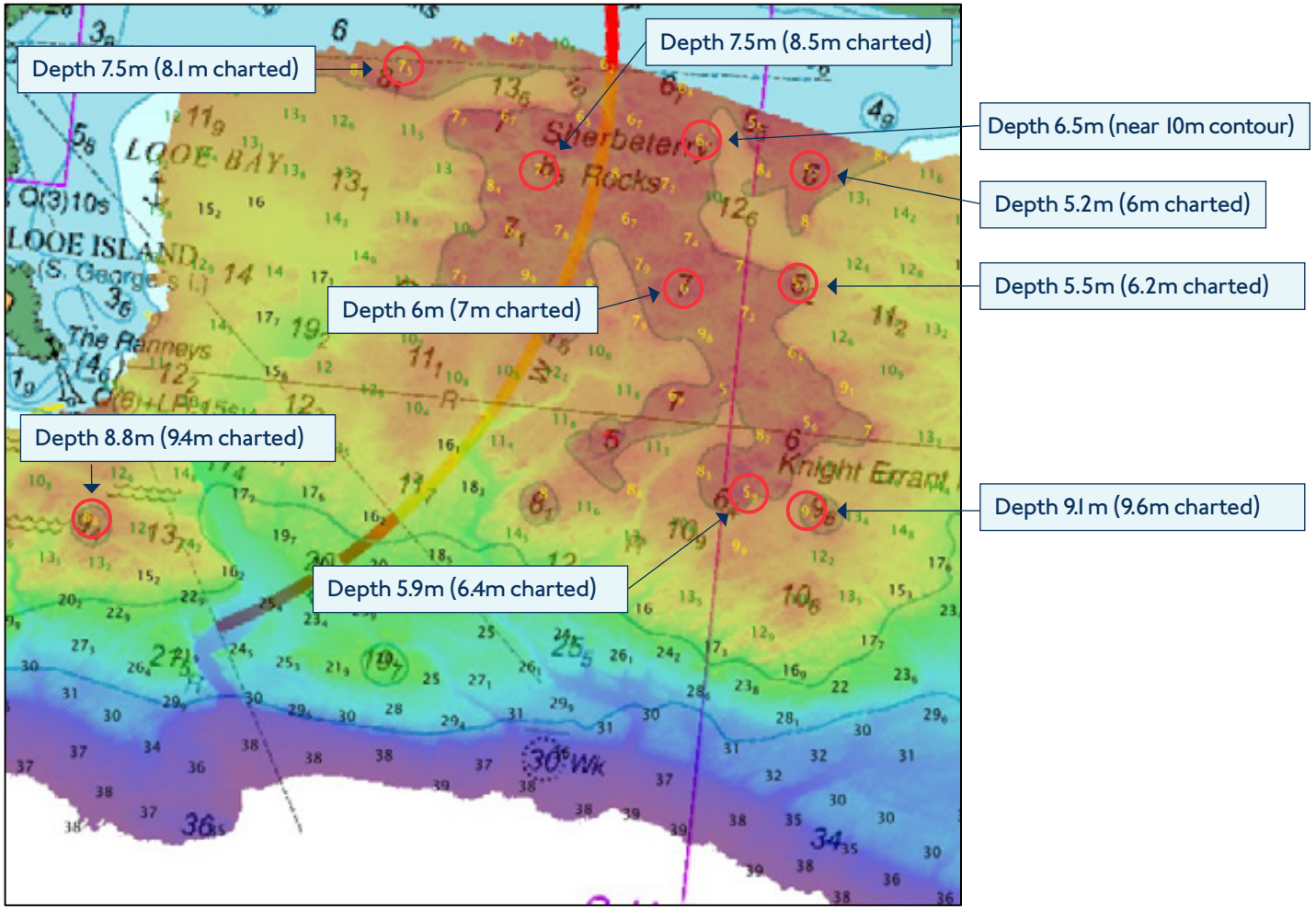
C23 Example 5

NM's were issued for the shoaler depths in the Channel, and to show the shoaling bank in this example.



C24 Example 6

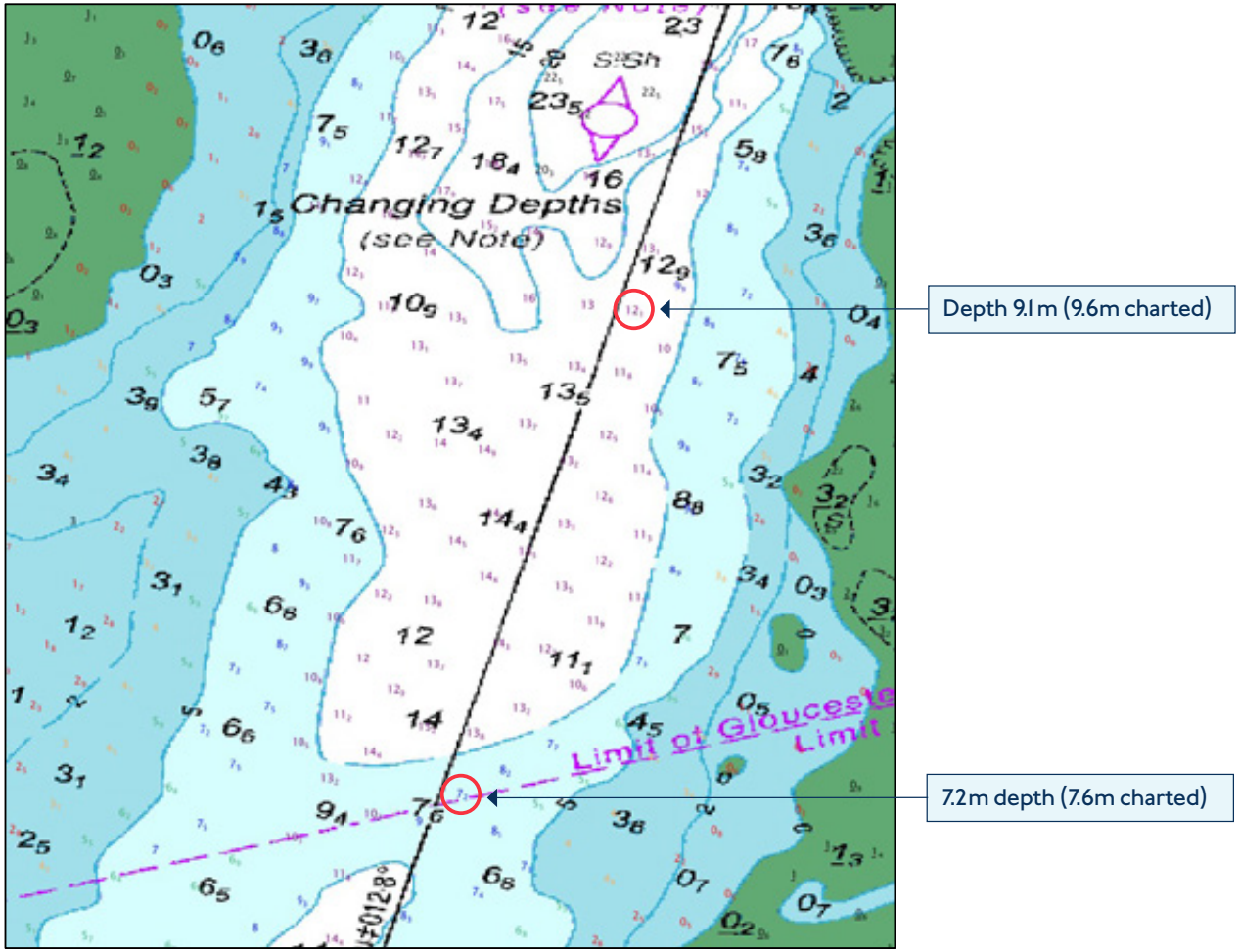
In this example there are several depths which meet the criteria in a localised area. In this case, if the software is available, it would be better to submit a .hob file or points shape file of the positions with the H102 for the UKHO to assess.



C25 Example 7

Depths on or close to a Leading line:

Any shoaling of the depths along or adjacent to a leading line are important to consider.



C26 Glossary

Acronyms

ENC	Electronic Navigation Chart
NM	Notice to Mariners
DWR	Deep Water Route
TSS	Traffic Separation Scheme
H102	Hydrographic Note

UKHO Terms

A shoal (noun):	a natural physical feature on the seabed
Shoal (adjective):	"a shoal depth" (a shallow depth)
Shoaler (comparative adjective):	"Shoaler than charted" (shallower than charted)