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Marine technology — Marine environment impact assessment (MEIA) — Performance specification for in situ image-based surveys in deep seafloor environments

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 13, *Marine technology*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

From the mid-1990s, attention has been paid to potential environmental impacts to deep-sea environments caused by sea debris, bottom trawling, seabed mining, etc[2].

In situ observations of the deep-seafloor provide useful data sets to assess the amount of natural variation in biological systems over a range of different spatial and temporal dimensions[3]. They can also provide data on recruitment and community succession patterns. Imaged-based surveys are an integral component of underwater surveys conducted both with moving platforms (e.g. ROVs, HOVs, AUVs)[4, 5, 6], and stationary platforms (e.g. moorings, buoys, standalone seabed platforms, cabled observatories)[7, 8]. The images have the potential to provide a broad range of significant scientific information and educational benefits long after data acquisition and are non-destructive to the monitored environments. In order to obtain the necessary spatial coverage for robust statistical analyses of the intrinsic variability within environments and their associated biological ecosystems, it is necessary to deploy multiple standalone seabed platforms concurrently[9].

In the case of seabed mining operations, it will be necessary to accumulate long-term data sets of different environments within the proposed mining field and downstream where any sediment plumes can be expected to be transported in order to detect and monitor any environmental impacts due to the extraction and processing of minerals (see ISBA/25/LTC/6). As such, a standard for long-term in situ image-based surveys in deep sea environments needs to be developed for use in such scenarios.

This document gives specifications for in situ image-based surveys in deep seafloor environments to be used for marine environmental impact assessments and other purposes where a long-term image-based survey in the deep-sea is required.

Marine technology — Marine environment impact assessment (MEIA) — Performance specification for in situ image-based surveys in deep seafloor environments

1 Scope

This document specifies minimum requirements and provides recommendations for the gathering of image-based data at seafloor where epifauna and benthopelagic fauna with a minimum dimension of 1 cm are used as a proxy for the status of the biological community.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISA[1)] ISBA/25/LTC/6, *Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area*, 2013. Available at https://www.isa.org.jm

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISBA/25/LTC/6 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
autonomous underwater vehicle
AUV
underwater robotic vehicle that does not have a tether to the surface

Note 1 to entry: AUVs are pre-programmed to operate over a particular course or to respond to sensor data or perhaps acoustic commands. Applications include surveying, scientific data collection and mine-hunting.

3.2
benthopelagic
pertaining to the zone very close to, and to some extent having contact with, the sea floor of deeper portions of the open ocean

1) ISA: International seabed authority.

3.3
codec
compression/decompression algorithm used to take a raw stream of audio and/or video data and to make it smaller by removing elements that are deemed unnecessary, and later to take the compressed stream and restore the original version so that it can be replayed on a display and/or sound system

Note 1 to entry: Some codecs attempt to only remove elements that the average person would never miss, while others notably reduce the image or sound quality, usually in order to make the content as small as possible for transmission over slow or low bandwidth connections. Codec selection is usually based on what is more important: quality or size/speed of the transmission.

3.4
container
outer shell of a media file that organizes the stream(s) that it carries

Note 1 to entry: A particular container format can support several different encoding formats (e.g. H.264, WMV, Sorenson AVC, RealVideo, DivX and ProRes 422), and no container format can handle every possible encoding format. Thus, for example, there can be two different MOV files, one of which plays just fine on a computer, while the other fails to play, due to that computer having a *codec* (3.3) for the encoding format of the first file, but no matching codec for the encoding format found in the second file.

Note 2 to entry: Most video files have one video data stream and one audio data stream, but can contain multiple audio streams (possibly in different languages, or to support special surround-sound systems), or even additional video streams (to support watching the same program from multiple angles). The container format of a file is usually directly connected to the file extension or MIME type (e.g. Quicktime MOV, RealMedia RM, MPEG, MP4, Windows AVI, Windows WMV).

3.5
epifauna
organisms that live on the surface of the sediment/substrate

3.6
mooring
physical *platform* (3.8) containing a buoyant element constrained to a geographic location by an anchoring device

3.7
observatory
infrastructure that is able to accommodate sensors and instruments either permanently installed or by demand, to provide certain services like power supply and communication links for all connected instruments

EXAMPLE Global, regional.

3.8
platform
collection of nodes, sensors and instruments together with necessary controllers physically connected together, with a known external geometry

EXAMPLE *Mooring* (3.6), surface mooring, profiler, *AUV* (3.1), glider.

3.9
resolution
smallest amount of input signal change that an instrument/sensor can detect reliably

3.10
scavenger
organism that eats waste products and dead remains of other animals and plants that it did not kill itself

4 Principle

The suggested protocols are image-based as these methods are non-destructive to the monitored environments. They incorporate a temporal survey element to allow intrinsic variability within systems to be differentiated from anthropogenically-caused disturbances. The observation platform stays without motion at the observation site to obtain fixed point data. Video (or > 15 fps stills) is employed to a) increase the accuracy of mobile organism identification due to the availability of images from multiple observation angles, b) allow estimates of organism activity, c) allow calculation of current speed and direction through the tracking of suspended particles between frames/images. These in situ image-based surveys are done with monitoring by video camera systems where the field of view and depth of focus are fixed and known or recorded. The duration of the monitoring is determined prior to the set-up of the monitoring system, and monitoring data can be acquired autonomously. Examples of seafloor observatories are shown in Annex A.

5 Performance requirements and recommendations

5.1 Angle and scale of the monitoring

The angle of the camera vs. the seafloor and the altitude above the seafloor should be known or recorded.

Scale information and minimum resolvable dimensions should be extractable from the image/images. This may be done via calibrated stereo cameras, a laser scaling system, imaging of a physical object/ scale of known dimensions or the like.

5.2 Illumination

Illumination should be by white light of known and/or recorded intensity and wavelength characteristics. Red light can be used in addition.

5.3 Bait

Bait of a size where the flesh is considered able to be fully consumed within 7 days should be standardized between deployments and attached to the imaging platform, or deployed where it can be imaged by an AUV or other moving platform, somewhere in the field of view to obtain information on mobile predators/scavenger types and abundances.

5.4 Image capturing schedule/timing

Images shall be captured either as video or as stills at 15 frames per second (fps) or faster, with total duration per imaging event of 5 s or greater. Imaging events should be recorded at 6- to 8-h intervals or less over a continuous period (e.g. 372 days; see NOTE). For moving survey platforms, the position accuracy for repeated observations should be enough to image 50 % or more of the previously imaged area/volume[14, 15]. If a combination (the preferred scenario) of a stationary long-term observation platform and a moving platform, able to image large horizontal distances is used, the moving platform should image at least 50 % of the area/volume imaged by the stationary platform. Video/images should be timestamped, either on the image itself or as associated data, and a CTD (conductivity temperature depth profiler), or other instrument for measuring temperature and other physicochemical environmental parameters and recording data at least for the time period that is imaged, should be deployed on the imaging platform to allow the determination of correlations between environmental parameters and organisms, particle abundances/types, bottom current speed/direction, etc.

NOTE Seven days or less with the presence of bait affecting the data set and 365 days or longer without the effect of bait. A minimum of three video recordings at 6- to 8-h intervals allows per day averages to be calculated for both numbers and types of organisms in the field of view. Continuous recording at 7-h intervals allows the effect of diel rhythms to be filtered/extracted from the acquired data. A full year, or more, of imagery at an interval of every 3 days or less allows quantification of organism activity and current speed and direction over the entire seasonal cycle. Incorporation of a moving platform into the system allows determination of fine-scale spatial heterogeneity.

5.5 Data synchronization and management

All data shall be synchronized to a single clock or be able to be synchronized post-retrieval to frame level accuracy, especially in the case of stereo imaging, or within one second drift for other instruments. Filenames for archived images should include a unique identifier for the cruise/survey/platform, the date and time of the first frame in the format YYYYMMDD-HHMMSS, and a camera identifier, separated by hyphens (e.g. PLATFORM-YYYYMMDD-HHMMSS-CAMERA1-01.mov). Images should be recorded or archived in a format that is able to be viewed/played back in non-proprietary software such as VLC[2] (VideoLAN Client). A container such as Quicktime[1], which allows embedding of timecode, closed captions and other metadata, and which is frame-level accurate, is to be preferred. A codec such as Apple ProRes[1] and a format such as 422 LT or better that is ≥ 10-bit, rather than 8-bit, allows better enhancement of video if lighting is sub-optimal. Metadata associated with each video file should include, but not be limited to, a timestamp including date and start time of the video (YYYYMMDDTHHMMSS.ssss) with a Z added if the value is in Coordinated Universal Time (UTC) rather than local time.

2) VLC, QuickTime and Apple ProRes are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

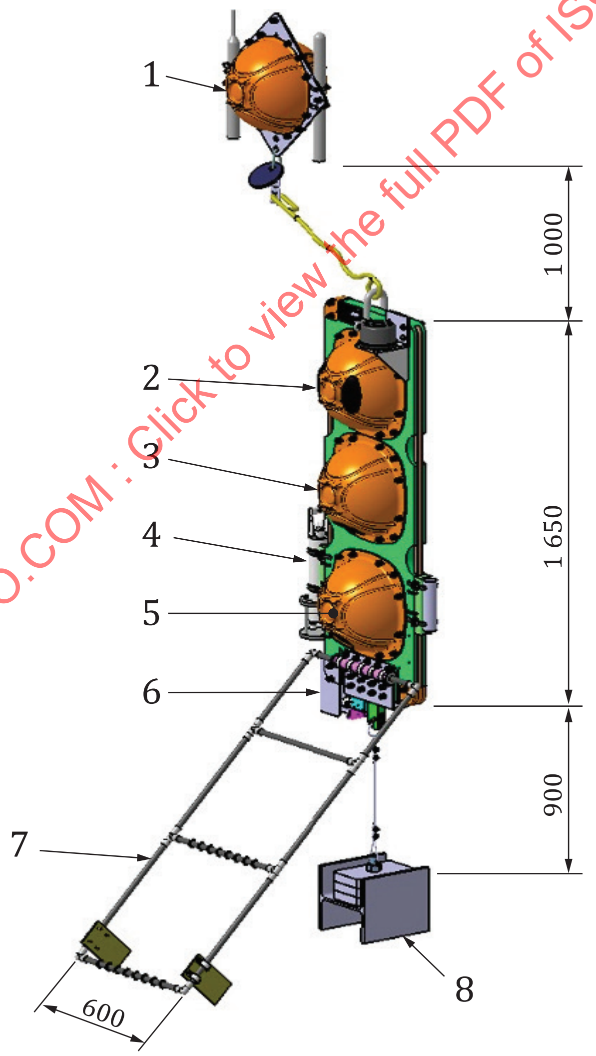
Annex A
(informative)

Example of seafloor observatories

A.1 Free-fall platform for seafloor observation (mooring type)

The free fall type hadal zone research lander called "Edokko Mark1" consists of 3 glass spheres with a wireless connectable rubber bridge, observation equipment and a transponder device that can be installed in the glass sphere. This lander is composed of pressure-resistant glass floats with built-in observation equipment, a time-lapse camera system, LED array illumination synchronized with the camera system, and a transponder device[9, 10]. See Figure A.1.

Dimensions in millimetres



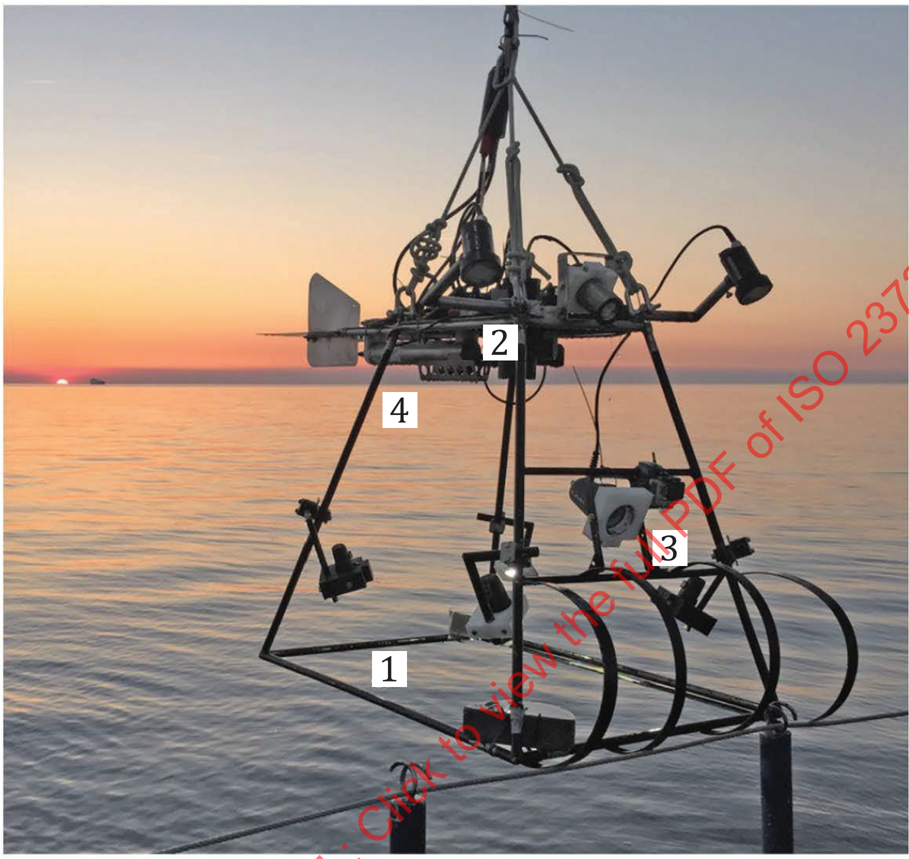
Key

1 communication unit
2 transponder
3 light unit
4 sensors (CTD profiler)
5 camera unit
6 release unit
7 stabilizer
8 weight

Figure A.1 — Compact platform for seafloor observation

A.2 Free-fall platform for seafloor observation (lander type)

The Baltic Seafloor Imaging System (BaSIS) is a towed steel frame of 110 × 70 cm (item 1 in Figure A.2), equipped with a downward-looking, high resolution photo and video camera system (item 2). A second, forward and oblique-looking HD video camera (item 3 serves for orientation and piloting. A CTD at the tail measures water quality parameters (item 4)[11]. See Figure A.2.



Key

1 steel frame

2 downward-looking photo and video camera system

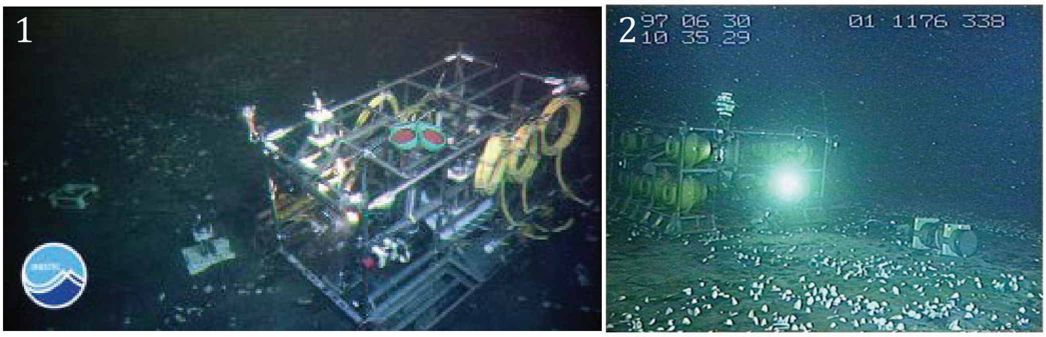
3 oblique-looking HD video camera system

4 CTD (conductivity temperature depth profiler)

Figure A.2 — Lander platform

A.3 Cable connected seafloor observatory

The off-Hatsushima Observatory on the seafloor within a colony of the vesicomyid clam, *C. soyoae*, at a depth of 1174 m in the Sagami Bay, Japan[12]. See Figure A.3.



Key

1 second cable network observatory from oblique view

2 first cable network observatory from front view

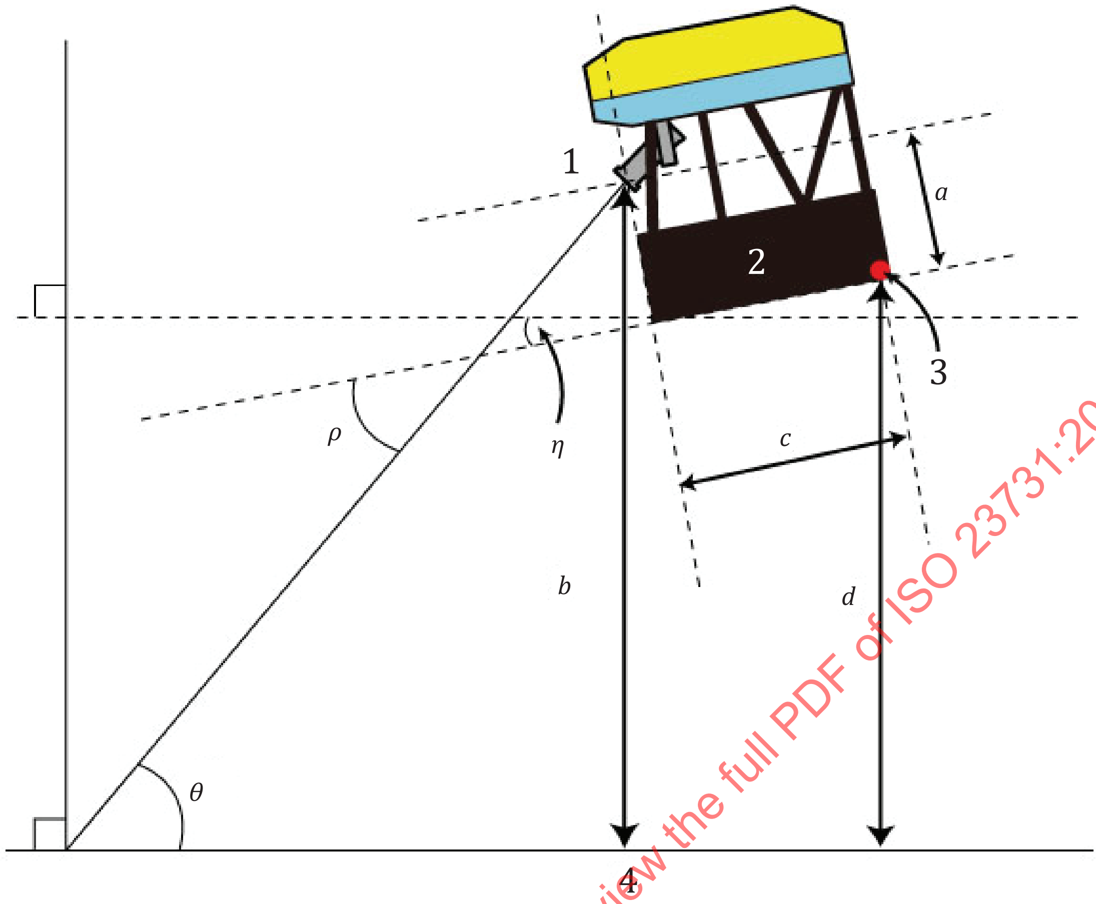
Figure A.3 — Deep sea cable network observatory

Figure A.4 illustrates frames from the POD4 camera in Barkley Canyon at 890 m depth showing the scaling ruler on the seafloor. The two red laser points are 10 cm apart. The image on the left shows the sablefish *Anoplopoma fimbria*. The image on the right shows the buccinid gastropod *Buccinum viridum* and the hippolytid *Heptacarpus* sp. (circled in white)[13].

Figure A.4 — Deep sea cable network observatory

A.4 Moving survey platforms

Figure A.5 shows the parameters to estimate the seafloor area of captured image by submersible camera[14,15].



Key

1	camera	*a*	lens-to-vehicle bottom distance
2	vehicle	*b*	camera lens-to-seafloor distance
3	altitude meter	*c*	horizontal distance of lens-to-altitude meter
4	sea floor	*d*	altitude
		θ	angle of incidence
		η	angle of vehicle pitch
		ρ	angle of camera tilt

Figure A.5 — Diagram of various angles and distances in relation to the vehicle camera

A.5 Observation angles and areas

Figure A.6 shows the parameters of oblique image emphasizing the lower-half of view from camera for deep-sea observation[14,15].