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Chapter 3: How do I collect the data?

Recommended operating guidelines for sediment profile imagery

1. Sediment profile imagery (SPI)

1.1 Introduction

Although sediment profile imagery (SPI) is a photographic technique, its use bears more similarity to other point-sampling techniques (e.g. grabs and cores) used in benthic sampling than to video techniques, so a stand-alone ROG is provided. The SPI (Figure 1) acts like an inverted periscope, driving a mirrored prism into the sediment through which a photograph is taken of the sediment profile (Figure 2). Resulting images can be used for qualitative and quantitative analysis. Its utility in habitat mapping is mainly to provide information on the nature of sediments, which can be used to characterise and indicate the quality of the habitat. Compared to other sampling techniques, it provides only limited information on biological communities. A short movie file showing an SPI camera in action is available here (courtesy of Germano & Associates).

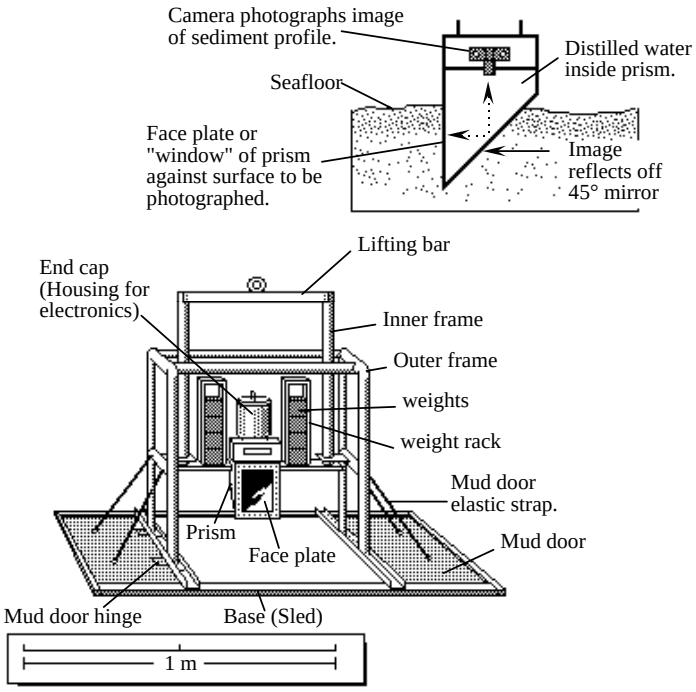

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Figure 1. Photograph (left) and diagram (right) of SPI camera equipment (source: CEFAS and Aqua-Fact International Services Ltd respectively).

Further details of the SPI technique can be found in the Review of standards and protocols for seabed habitat mapping which has sections covering general principles of operation, data acquisition, processing and interpretation.

There are very few suppliers of SPI equipment, though it is possible to hire them. Compared to a grab sampler, the equipment is fairly complex and requires strict procedures for setting up, dismantling and maintenance. These procedures will be detailed in the instruction manual supplied by the manufacturer. This ROG does not give detailed instructions on how to set up the equipment. Instead, it provides general guidelines about the use of the equipment to collect samples. These guidelines should not override or replace any instructions provided by the manufacturer.

Figure 2. SPI sediment profile image (source: Cefas).

The purpose of this document is to provide guidance on the standards and protocols that should be used to obtain and process SPI images for seabed habitat mapping. The principle aims are to ensure that:

- consistent procedures are followed when collecting and processing samples;
- each sample is accompanied by relevant metadata;
- samples can be adequately georeferenced.

Consideration is also given to matters relating to mobilisation/demobilisation of equipment and training/skills requirements.

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1.2 Mobilisation

Vessel requirements

When planning a survey, it is important to ensure that the vessel to be used is suitably matched to the gear and to the purpose of the survey. The SPI equipment itself weighs in the region of 250 kg; an additional 100 kg of lead weight can be added to aid penetration in firmer sediments. It is therefore important to consider the bulk and mass of the equipment when selecting a survey vessel. Furthermore, the SPI is deployed from a stationary vessel and needs to be lowered slowly just before reaching the seabed. Questions to consider when selecting a vessel include:

- Is the vessel suitably designed and equipped to deploy and recover the gear safely?
- Is there enough winch cable for the water depth to be worked?
- Is there sufficient control on the winch to operate it slowly as the SPI nears the seabed?
- Is the vessel capable of remaining stationary at a sampling site?
- Are there sufficient crew members to handle the gear?

Generally, if a vessel is suitable for deploying moderately large grab gears (e.g. 0.1 or 0.25 m^2 Hamon grabs), it should be suitable for SPI equipment.

Georeferencing requirements

It is important to ensure that adequate positional information can be obtained and that the configuration of any electronic navigational instruments (e.g. dGPS) is known (see also section on metadata): the position of the SPI would normally be taken as the position of the gantry from which it is deployed. There is no real need to use an acoustic tracking device as the gear is not towed behind the vessel.

Questions to be considered include:

- Is there a reliable dGPS system available?
- How is positional data logged (manually or to a logging device)?
- What position on the vessel does the navigation feed give (e.g. the position of GPS aerial or offset positions such as the stern gantry, side gantry or a ‘common reference point’)?

If the SPI camera has an internal clock, this should be synchronised with the GPS time so that the time-stamped images can be cross-referenced to the positional data.

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Gear requirements

You should consider the operational limitations of the equipment, as SPI is only suitable for use on soft or unconsolidated sediments (mud, sand, sandy gravel). It should not be used on cobble, boulder or rock substrates.

SPI systems include a number of electrical items and several delicate parts such as O-ring seals, trigger wires, etc. A comprehensive spares/maintenance kit should accompany the SPI system, suitable to carry out electrical and mechanical maintenance at sea in all eventualities (bar catastrophic accident).

In addition, a few critical items should be taken that may not routinely available on the vessel including:

- a sealed, greased-bearing swivel for attaching the SPI gear to the winch cable;
- a supply of distilled water for filling the prism housing.

Safety

The bulk and weight of the SPI system presents a hazard while working at sea. Suitable safety measures should be taken to protect personnel during operation and for the safe ship-board storage of the equipment. There are no inherently hazardous substances (e.g. chemicals) involved in SPI operations.

Briefings

Once on board the vessel, all relevant personnel should be briefed on matters relating to:

- Safety and operational hazards;
- Standard operating procedures for deployment use and recovery of the SPI gear;
- Data and metadata recording requirements.

1.3 Test and verification protocols

Unlike remote sensing systems (e.g. side-scan or multibeam sonar) that provide ‘streams of data’ that should be constantly verified during acquisition, SPI is a point-sampling photographic tool that cannot be adjusted while it is deployed. The requirement for test and verification is therefore limited to:

- ensuring the system has operated properly by checking the captured images each time the SPI is recovered onto deck. This may require the downloading of images from the camera or just checking that the frame counter in the camera has advanced by the expected number. Too few frames may indicate a mechanical or electronic failure, while too many

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frames may indicate the camera is being triggered while still in the water column;
- ensuring the system used to record positional information is functioning correctly.

The scale of the image can be calibrated by etching a scale rule (usually divided into 1 cm sections) vertically on the glass faceplate of the prism. This scale can be used to determine the penetration depth in each photograph.

1.4 Operating guidelines

This section sets out the standard procedure for carry out SPI sampling. It is assumed that the system has been assembled according to the manufacturer's guidelines and is ready for deployment. If possible, the gear should be deployed over the side of the vessel rather than the stern, as this minimises the uncontrolled vertical movement of the gear caused by the pitching of the vessel.

Pre-deployment

- Officers and deck crew should be briefed on the sampling protocol you wish to use (single drop, multiple drops at the same point, a series of 'hops' along the seabed);
- Check that any internal clock in the SPI camera is synchronised with the GPS time;
- Check the functioning of the swivel attaching the SPI to the winch cable;
- Check that the camera housing and any electrical connections are properly sealed;
- Check that any venting valves used while filling the prisms with water are closed;
- Check the security of the safety pins (or other mechanism) that lock the central carriage (camera and prism) within the main frame prevent it from descending while on deck;
- Check the mechanism for recording maximum penetration depth is set to zero;
- Prepare a field record sheet for logging the sample metadata (see example below, under 'Recommended logging information');
- Check the camera is switched on;
- Take a test photograph to check the camera is working (this could be used to record a 'header-shot', giving the details of the station, such as the station number or station code);
- Take a reading from the camera's frame counter and record this on the field record sheet.

Deployment

Once the vessel has come to a complete halt at the sampling station, the deployment should generally proceed as follows:

- Using a crane or davit, lift the SPI system off the deck and remove the locking pins (or other mechanism) that prevent the central carriage (camera and prism) from moving within the SPI frame;
- Lift the SPI over the side of the vessel and start lowering to the seabed at a rate of approximately 1 m per second;
- About 10 m before reaching the seabed, slow the rate of descent so that the SPI comes into contact with the seabed in a controlled and gentle manner. This prevents a bow-wave displacing flocculent material at the sediment/water interface.

On contact with the seabed, the winch wire will slacken:

- Pay out a little more wire (approximately 1 m) to allow the central carriage to descend and drive the prism into the substrate;
- Take a dGPS fix and record the fix number and time on the field record sheet.

Leave the wire slack for about 20 seconds to allow time for the prism to fully penetrate the sediment and the photograph to be taken. If only a single photograph is required, retrieve the SPI system back onto deck (see below).

If replicate or multiple samples were required then:

- Gently lift the SPI off the seabed by around 5 m and hold it there for over one minute to allow the carriage system to reset within the frame;
- Lower the system gently to the seabed until the winch wire slackens;
- Pay out a little more wire (1 m) to allow the central carriage to descend and drive the prism into the substrate;
- Take a dGPS fix. Record the fix number and time for that replicate on the field record sheet. Also record the distance moved from the last sampling point (usually only a few metres, but this may be more if you are actively attempting a SPI transect by ‘hopping’ the camera along the seabed);
- Repeat these steps until you have completed sampling (Figure 3).

Once sampling has finished bring the SPI to the surface and lift back onto the ship, but do not place it immediately on the deck. When the SPI is inboard and steady:

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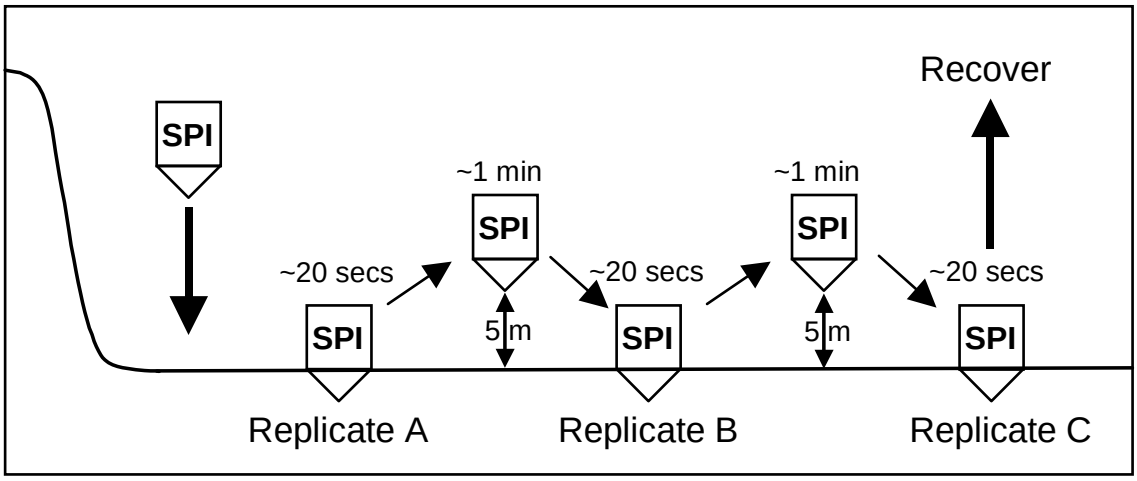
- **Replace the locking pins** (or other mechanism) that prevent the central carriage (camera and prism) from moving within the SPI frame;
- Once the central carriage is locked to the SPI frame, lower the gear to the deck;
- Read off the maximum penetration from the measurement scale (often located on the moving part of the SPI frame);
- Record the reading from the camera's frame counter on the field record sheet;
- Wash the entire system with fresh water before downloading the camera. On several systems, images can be downloaded via a USB connection, without disassembling the SPI.



used for triplicate sampling. The same principle can be used for single or transect sampling.

Special considerations

The attachment of a small video-camera to the SPI can provide a real-time image of the seabed during SPI deployment (Figure 4). This enables the SPI to be used more selectively, sampling features of particular interest. Protocols for using the video should be the same as those outlined for drop-cameras in the MESH Recommended Operational Guidelines for video techniques.

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Figure 4. SPI equipment fitted with a small video-camera (right) and lighting system (left) enabling the SPI to be used more selectively (source: Cefas).

1.5 Quality control procedures

The quality of the images can be checked as soon as they are downloaded from the camera. Check the images are in focus and that the flash has operated correctly. Remedy any faults prior to the next deployment.

Images may be unusable if the prism has not penetrated the sediment far enough or has penetrated too far (Figure 5). The sediment-water interface should always be visible in the image, and ideally should be captured about three-quarters of the way up the photograph. If the sediment-water interface cannot be seen, adjustments should be made to the weight of the SPI and the samples repeated.

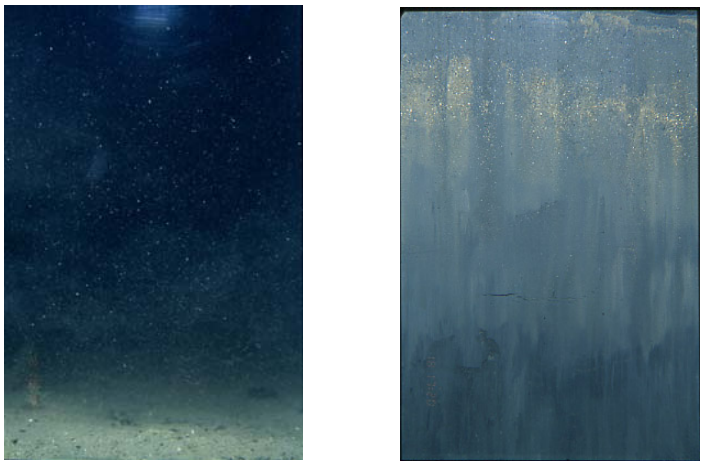

Figure 5. Image quality issues related to insufficient penetration (left) and over-penetration (right) (source: Cefas).

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Other quality issues may arise from the image being partially obscured in some way (Figure 6).

Figure 6. Examples of obscured SPI images. Left to right: flare from flashlight, suspended sediment in water reducing visibility, smearing on the face plate, obstructions in the image (photos by R. Diaz).

A formal quality control procedure should be followed to check the field record sheet has been fully and properly completed. The observer should initial the sheet and pass it to a third party (e.g. scientist-in-charge) for checking. Any omissions or errors should be corrected by the observer. The third party should then initial the sheet to confirm the quality control check has been completed (see example field record sheet illustrated in the section below on Recommended logging information).

Once checked, the metadata from the field record sheet should be entered into a dedicated meta-database for permanent storage. The person entering the data should initial the original field record sheet as part of the quality assurance/control procedure.

1.6 Data storage and backup recommendations

Digital stills images should be copied to a portable media (i.e. a CD or DVD) to provide a backup in case the original files stored on PCs or network servers become damaged or lost. Traditional film-based stills images should be scanned into a digital format and saved to a portable media, and the film (or slides) stored in archive-grade containers under appropriate conditions.

Magnetic and digital media (tapes, CDs, DVDs, etc) have a limited life span, which varies with the quality of the media and the conditions under which they are stored. Under adverse storage conditions this life span can be reduced to <2 years for DVDs and CDs. It is therefore advisable to have a formal policy for copying and replacing archived material. These matters are dealt with more fully in the report of the Action 2 Video Workshop Sub-group.

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A ‘media catalogue’ should be kept, listing the labels and contents of all recording media (DV tapes, DVDs, CDs, film, etc) produced during the survey.

1.7 Recommended logging information

The clearest way to give guidance on recommended logging information is by annotated example. Figure 7 shows a copy of a *pro-forma* field record sheet used by Cefas in 2006 for recording metadata from SPI sampling events. Table 1 explains the purpose of each field in the record in the sheet.

It is recognised that different surveys and institutes will have their own methods of recording data and metadata relevant to each sample. The record sheet covers information that should be logged in the field and which should accompany the sample data. Further, higher-level metadata will be required relevant to the research programme, the cruise/campaign, the area being surveyed, and the analysis and management of the data. These are detailed in the general section on metadata.

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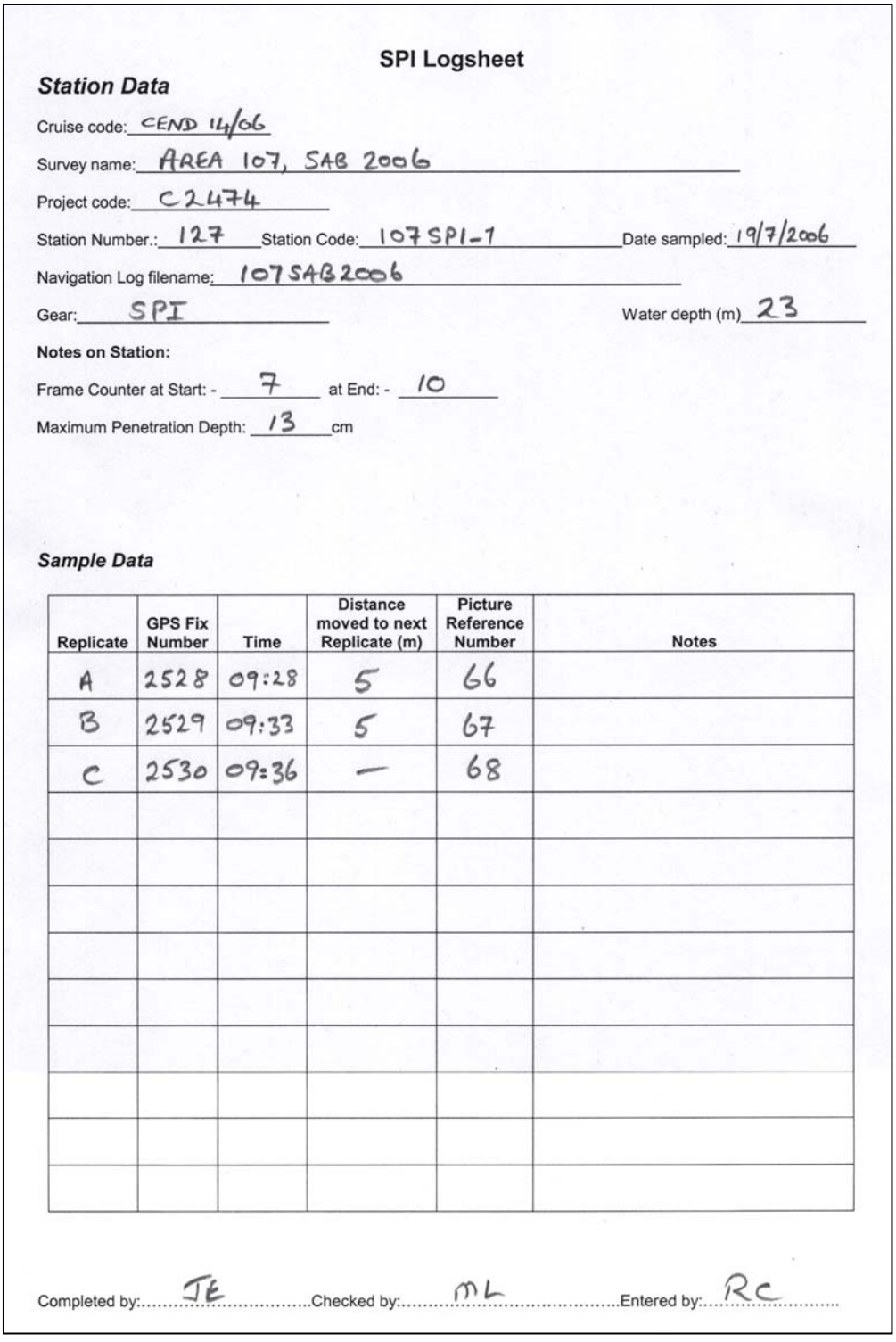

SPI Logsheet

Station Data

Cruise code: CEND 14/06

Survey name: AREA 107, SAB 2006

Project code: C2474

Station Number.: 127 Station Code: 107SPI-1 Date sampled: 19/7/2006

Navigation Log filename: 107SAB2006

Gear: SPI Water depth (m) 23

Notes on Station:

Frame Counter at Start: - 7 at End: - 10

Maximum Penetration Depth: 13 cm

Sample Data

Replicate	GPS Fix Number	Time	Distance moved to next Replicate (m)	Picture Reference Number	Notes
A	2528	09:28	5	66	
B	2529	09:33	5	67	
C	2530	09:36	—	68	

Completed by: JE Checked by: ML Entered by: RC

Figure 7. Completed field record sheet from a Cefas SPI survey in 2006. The top part of the form contains metadata about the sampling station, and the bottom part contains details relating to the individual samples (photographs).

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Explanation of metadata fields used in the SPI Logsheet	
Station	Section for recording metadata relevant to the sampling station
Cruise code	Unique identifier for the research cruise
Survey name	Name of the survey, indicating location and year
Project code	Unique code for the project undertaking the survey
Station number	Serial number of the sampling station
Station code	Unique identifier for the sampling station
Date sampled	Date on which the station was sampled
Navigation logging file	Filename for positional data (generated by navigation system)
Gear	Sampling gear used
Frame counter	Readings from the camera's frame counter at the start and end of sampling
Maximum penetration depth	Reading from the scale on the SPI frame showing penetration depth
Sample data	To record metadata about each replicate sample
Replicate	Code letter (or number) of replicate
GPS fix number	The serial number of the dGPS fix taken as the SPI contacts the seabed
Time	Time at which SPI contacted the seabed
Distance moved to next replicate	Distance (in metres) between subsequent sampling points (may only be relevant where a transect is attempted by 'hopping' the camera over the seabed)
Picture reference number	Serial reference number for each picture (can be used to rename electronic image filenames assigned by the camera)
Notes	Space for any notes relating to the sample
Quality control footnote	To provide an audit trail giving information on who has been involved with processing this data record
Completed by	Person who completed the field record sheet
Checked by	Person who checked the sheet was properly completed
Entered by	Person who input records to meta-database and spreadsheets

Table 1. Explanation of data fields used in the field record sheet for SPI sampling.

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1.8 Demobilisation notes

Once the survey has finished, the SPI system should be thoroughly washed with fresh water and dismantled ready for transport ashore. Once ashore, the system should undergo a thorough service, washing, drying and lubricating (where relevant) all parts including screws, nuts and bolts that may seize if not properly maintained. All O-ring seals should be serviced and left dismantled (i.e. uncompressed). All batteries should be removed and dust-caps replaced (particularly on the camera). The system should be stored under dry conditions and not exposed to the weather.

1.9 Training

All personnel involved with the SPI survey should be familiar with these recommended operational guidelines and any further standard operating procedures (SOP) that may be specific to operations on the vessel that will be used for sampling.

At least one person on the vessel should have a thorough knowledge of the manufacturer's recommended procedures for setting up, using and dismantling the SPI system. It is often useful if more than one person is familiar with the routine for downloading images from the camera. Staff assisting in the deployment should be trained in safety procedures.

Where required, employers should ensure that staff are properly trained in 'heavy lifting' techniques and are aware of COSHH and Health & Safety regulations.

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