Burnham Laboratory (Benthos)

Standard Operating Procedure

(SOP number: 1380)

(Issue number: 1)

SOP FOR THE COLLECTION OF MACROFAUNAL SAMPLES USING A 0.1 m^2 HAMON GRAB

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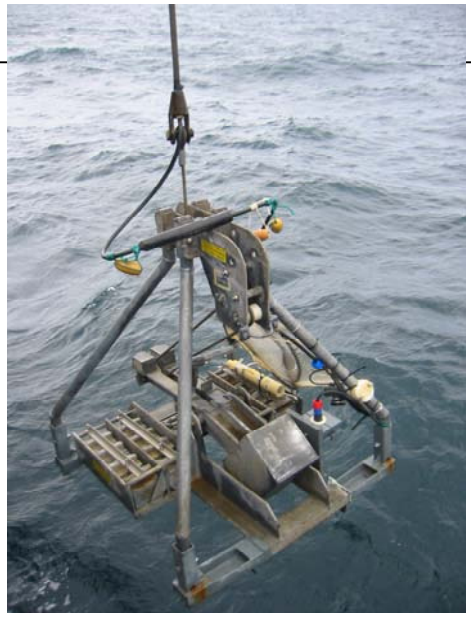

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Issue and Validation

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History of Procedure

Issue	Date Issued	Changes
1	October 2005	An up date was made in the following sections: Hamon grab deployment, DigiLog, surveying software (Tower), Cobble analysis for PSA sampling collection, Reagent section (Formaldehyde transport), photographs contained on the overall document
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*(**SOP FOR THE COLLECTION OF MACROFAUNAL SAMPLES USING A 0.1 m^2 HAMON GRAB**): Issue (1380)*

Introduction

1. INTRODUCTION

Sediments, and particularly the associated benthic fauna, can act as a useful indicator of environmental disturbance and as a result samples are routinely collected for analysis of a wide variety of biological and physical determinants. For gravelly sediments in the vicinity of marine aggregate extraction sites, sampling is aimed principally at assessing the biological and physical impacts of such activities.

Many samplers (e.g. Day grab and Box corer) are unsuitable for use in gravelly sediments as coarse particles of sediment prevent the effective operation of the devices resulting in a loss of sampled material. However, the Hamon grab (Oele, 1978), has proved to be an effective sampler of coarse sediments. This grab consists of a rectangular frame forming a stable support for a sampling bucket attached to a pivoted arm. On reaching the seabed, tension in the wire is released which activates the grab. Tension in the wire during in-hauling then moves the pivoted arm through a rotation of 98°, driving the sample bucket through the sediment. At the end of its movement, the bucket locates onto an inclined rubber-covered steel plate, sealing it completely. This procedure deals specifically with the collection of samples, from areas of coarse sediment, for the analysis of the benthic macrofauna and particle size distribution.

2 Scope

This SOP describes the procedure for the preparation, deployment, recovery and sample processing of material collected with a 0.1 m2 Hamon grab. Other types of grab (i.e. Van Veen, Day grab) are not considered in this document and other relevant stages might be appropriate to consider when using these other gears, therefore consult specific documents.

3 Training (Identify any specific training linked to the SOP)

This procedure may only be carried out by staff who have received training with this SOP. Training records must be maintained and archived accordingly.

4 Safety Precautions

Before performing this procedure staff should have read and understood the following COSHH & risk assessments.

4.1 COSHH

BOC-EQ-Coshh-SAS-Sea-01 Storage of 30% formaldehyde solution, dilution of 30% formaldehyde to 10% and use of 10% formaldehyde for preservation of benthos samples

BOC-EQ-Coshh-SAS-Sea-05 Collection of sediment samples at sea from sewage sludge, dredged material and industrial waste disposal sites

BOC-EQ-SAS-Formaldehyde Movement to and storage of samples preserved in 10% formaldehyde solution at Burnham offsite storage facility

4.2 Risk Assessments

G03 Participation in research cruises on CEFAS owned and managed ships. The collection of samples and data, all subsequent processing whilst on-board, including the use of the ships sea-rider

G04 Scientific work on chartered vessels not owned and / or managed by CEFAS (but NOT including work on commercial, un-chartered vessels or travel on passenger vessels.

G05 Work on beaches or in coastal waters, estuaries, rivers and lakes, whether operating from dinghies, small chartered vessels or from shore

G06 Working on un-chartered, commercial vessels, including observations of discards, sampling fish or shellfish or deployment of scientific gears

Before performing this procedure staff should have read and understood the following COSHH & risk assessments.

Formalin transport

Formaldehyde solution should always be carried in containers that are approved for this purpose. The container should be of a material that is impervious to formaldehyde solution or vapour. All containers must be checked prior to transport. If there is any apparent leakage of liquid or vapour from the container, or there appears to be potential for leakage then the container is not suitable for the carriage of formaldehyde solution. Ideally concentrated formaldehyde should be carried as 10l aliquots. No more than 25l of should be carried in a single container. Any vessel containing 30% formaldehyde solution should be placed in a further container that will contain all of the liquid in the event of a spill. Ideally the outer container should have a lid that reduces the risk of splash should the inner container burst. An ideal container for this purpose is an insulated fish box.

It is advisable that 30% solution is carried in a vehicle that allows occupants of the vehicle to be separated from formaldehyde solution or vapour in the event of a spill such as the Landrover, Luton type box van or open back van/lorry. However 30% solution may be carried in the same airspace as the occupants if the above guidelines are followed and the following precautions are taken. There must be an outer lidded container that will contain any leakage. The containers should be securely fastened ensuring that neither the inner nor the outer container can move. An approved formaldehyde spill kit should be carried, sufficient to polymerise the total quantity of formaldehyde carried. 30% formaldehyde solution should not be left in a vehicle in a situation where it may overheat.

If it is likely that liquid or vapour might escape from a formalin container during transport, then the container or containers must be carried in a vehicle that allows occupants of the vehicle to be separated from formaldehyde solution or vapour in the event of a spill. This is the case when preserved samples are retained in sample buckets that have an imperfect lid seal. Samples should always be carried in a separate airspace from the vehicle occupants. If dilute formaldehyde solution escapes into the vehicle it should either be washed out with water if this is feasible, or allowed to evaporate into the atmosphere. If concentrated formaldehyde solution escapes into a vehicle a sufficient quantity of formaldehyde spill material should be applied. In all situations staff should avoid working in an area that smell strongly of formalin. Formalin fumes should be allowed to evaporate, via adequate ventilation, to the atmosphere before staff work for any length of time in a space that has received a spill.

5 References/Associated documents

The following SOPs are also cited in this document:

The use of the cruise planner, Cobble analysis, Tower navigation system, bar-coding system and DigiLog, all of which will be used to record information relating to samples collected.

6 Equipment /Apparatus

6.1 (List, giving alternatives where appropriate)

7 Ingredients/Reagents/Media

7.1 Preservative – 10% formaldehyde solution

Composition: -Formaldehyde* 30%, pH 7.0 (buffered with sodium acetate trihydrate 25g/litre)

- Seawater

Buffered 30% formaldehyde solution is obtained in 10 litre drums from the Lowestoft Laboratory. A working solution of 10% formaldehyde solution is prepared by diluting approximately 3 fold with clean seawater.

7.1.2 Preparing dilutions of Formaldehyde

Prepare dilutions of formaldehyde in a well-ventilated area outside, whilst wearing safety glasses, gloves and waterproof clothing. Details on procedures for dilution, storage and transport of the chemical are contained in the relevant Control of Substances Hazardous to Health (COSHH) Risk Assessment (BOC-EQ-Coshh-SAS-Sea-01 Storage of 30% formaldehyde solution, dilution of 30% formaldehyde to 10% and use of 10% formaldehyde for preservation of benthos samples)
Label the aspirator with the following information: 10% Formaldehyde solution, Toxic, Carcinogen. Add Harmful and Flammable tape labels.

*Formalin is a toxin, a carcinogen and an irritant and should only be handled whilst wearing eye protection, disposable gloves and waterproof clothing. All containers must be clearly labelled. A funnel must be used when transferring the neat chemical from container to container. All samples fixed with formaldehyde must be thoroughly washed under fume extraction before they are handled in the laboratory.

7.2 Sample stain - Rose Bengal**

Use of Rose Bengal facilitates sorting of the sample by staining protein matter (mainly fauna) bright pink. Rose Bengal, if required, is added to the buffered formaldehyde solution (approx. 10%) at a concentration of approximately 0.01%.

**Rose Bengal is an extremely hazardous carcinogen. The neat chemical should only be handled under fume extraction. Disposable gloves should be

worn whenever handling this substance. A concentrated solution of the substance should be prepared for preparation of working solutions in the field where no fume extraction is available.

7.2.1 Preparation of concentrated Rose Bengal solution

In the laboratory fume-cupboard make up a Rose Bengal paste using a small amount of tap water. This solution should be stored in a clearly marked watertight container.

7.2.2 Use of Rose Bengal in the field

Add a 0.2g of the past to the aspirator containing the 10% buffered formaldehyde until the required concentration is obtained (seek advice from an experienced individual regarding the required quantity). Safety glasses, disposable gloves and waterproof clothing should be worn whilst carrying out this procedure.

8 Procedure

1. SAMPLING VESSELS

CEFAS Research Vessel *Endeavor* conforms to the International Maritime Organisation's *'International management code for the safe operation of ships and prevention of pollution'*. These vessels do not require checks for suitability. If using a charter vessel, the CEFAS document *'Standing Instructions for the use of Vessels other than Research Vessels in the Directorate's Field Programmes, January 1993'* [currently being updated] should be consulted. For the purposes of grab sampling, Vessels which conform to this code? do not require checks for suitability. If using a charter vessel, the CEFAS document *'Standing Instructions for the use of Vessels other than Research Vessels in the Directorate's Field Programmes, January 1993'* [currently being updated] should be consulted. For the purposes of grab sampling, the vessel should have a winch with a ³1 tonnes capacity, fitted with sufficient wire to extend 1.5 times beyond the maximum sampling depth. The winch operator should have a clear view of the grab during deployment and recovery. The deployment and recovery process should be described in detail to the winch operator and a system of signals should be agreed. The scientist in charge will have overall responsibility for the safe deployment of the grab and will halt sampling if he deems it unsafe (i.e. under worsening weather conditions). When the scientist in charge is not on watch, he/she will nominate a suitably experienced scientist as a deputy. The wire should lead from the winch to either a derrick, gantry or 'A' frame which allows the grab to be deployed safely clear of the vessel. The boat should have sufficient deck area to carry out the processing of samples. The vessel should also be fitted with a DGPS satellite positioning system and a deck-wash hose.

2. PERSONNEL

In addition to the skipper and crew, personnel must comprise a minimum of two scientists, at least one of whom is experienced in benthic sampling, according to the procedure described below. One person should also be experienced at operating the winch (normally the skipper or member of the crew of the vessel).

3. SAFETY

Hazards are presented by the improper use of reagents used in the processing of benthic samples. Survey staff should be familiar with the use of hazardous substances and should be provided with the relevant safety documentation in the form of COSHH and risk assessment forms. Copies should also be provided to the captain or nominated safety officer of the survey vessel. The working environment on board the sampling vessel also presents a number of hazards. Personnel must have the appropriate training and safety equipment and be aware of the risks associated with working onboard ships at sea.

4. EQUIPMENT

1) 0.1 m^2 Hamon grab (see *Figure 1*).

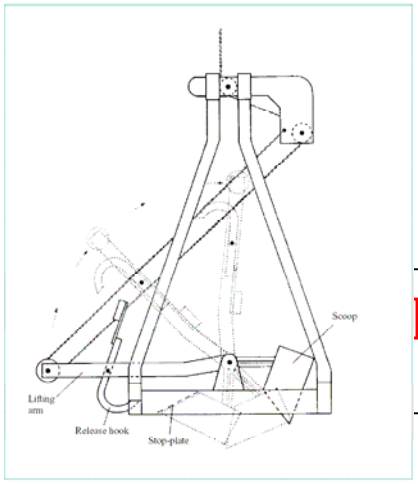

Figure 1 Hamon grab, showing mode of action. The lifting arm rotates through 90° to drive the scoop through the sediment, closing against the stop plate. (Reproduced from Eleftheriou and Holme, 1984)

The grab consists of a rectangular frame forming a stable support for an articulated sampling bucket. On reaching the seabed, tension in the wire is released allowing uncoupling of the release hook. This allows the lifting arm to rotate through 90° driving the bucket laterally through the sediment. At the end of its movement, the bucket locates on a rubber-covered steel plate, sealing the bucket mouth completely, and preventing any wash-out of sample material. The device samples an area of 0.1 m^2 and penetrates up to 15 cm into the seabed. Lead weights can be attached to the grab, allowing greater penetration of the sediment, and should be adjusted according to the prevailing substratum type. A larger version of the same device, sampling an area of 0.25 m^2, is available for use in certain circumstances, but the smaller (0.1 m^2) version has now been adopted for general use because of its versatility and ease of handling. This metal structure supports the grab before and after sampling. The stand allows enough space beneath the grab for a box to be inserted for sample collection.

2) Grab stand (see Figure 2).

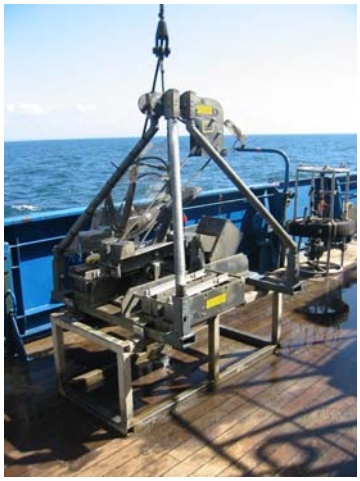

Figure 2: Hamon grab resting on its stand, primed and ready for deployment

3) Large 50-70 litre sample containers

Suitable watertight boxes, small enough to be placed under the grab stand but with sufficient capacity to receive the collected sediment and supernatant water without spillage should be used. These containers typically have a capacity of 50-70 l and may be calibrated for determining sediment volume. There should be sufficient containers to allow processing to be carried out at a later stage, if replicate samples are being taken.

4) Sieve table

Figure 3: Stainless steel sieving table with sieves on-board CEFAS Endeavor

This device consists of an open-ended stainless steel box whose interior sides slope towards an outlet pipe (see Figure 3). Small blocks mounted on the interior of the box provide support for a removable, square stainless steel frame with a 10mm or 5 mm square mesh aperture. The entire device is supported on legs that can be adjusted to allow the table to be positioned at a suitable height (normally waist height) for ease of use.

5) Sieve holder

This device consists of an aluminium frame designed to support a circular sieve of 1mm or 0.5 mm square-mesh aperture (30 cm diameter 'Endecotts' Laboratory Test Sieves certified to BS410; (0.5 mm, 1.0 mm and 2.0 mm stainless steel meshes). The sieve holder is supported on the top of an open plastic box, which allows the sieve to be positioned underneath the outlet pipe of the sieve table. The choice of sieve mesh size will depend on the objectives of the investigation. Sieves should be discarded at the first sign of damage to the mesh.

6) Plastic funnel and stand

A large, wide-bore funnel, the spout of which will fit into the necks of the sample containers, should be used. The stand holds both the funnel and smaller sample containers, minimising the risk of loss of material (see Figure 4). Where larger (e.g. 10 l) buckets are to be used, the funnel may be placed directly inside, for transfer of the sample contents.

7) Sample containers

Sample containers should be spill proof, air tight and strong enough to withstand rough handling during transport and storage. The size of the container will be determined by the size of the sample. The following sizes would generally be available at sea: 125 ml, 250 ml, 500 ml, 1000 ml bottles and 2.5 l, 5 l, and 10 l buckets.

8) 500 cm^3 plastic scoop

This is used for the collection of aliquots of sediment for subsequent particle size analysis.

9) Waterproof pen and labels

Labels made from water resistant paper are used inside the sample container. Water resistant ('Nalgene® Polypaper') sticky labels should be used for external labels. All labels should be printed with permanent ink and internal label in pencil.

10) DigiLog

DigiLog has been designed to perform the role of a digital logbook. This is an Access database used for keeping sample metadata (For specific details see DigiLog SOP). Data are entered into the database from field data recording sheets. Specific recording sheets (figure 4) are available for the different types of gear used during surveys (i.e. grab, trawls, video, sidescan, multibeam, etc.). Additionally, the positional information and environmental data (e.g. sea conditions, winds, etc.) are also recorded on the bridge on separate hand-written recording sheets.

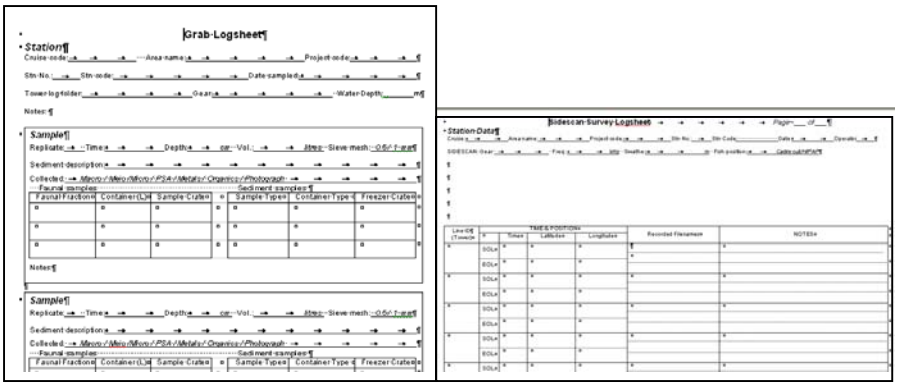

Figure 4: Example of DigiLog sheets.

11) Surveying software (TOWER)

Tower is a navigational software package (live electronic chart) used for plotting intended sampling positions (i.e. grabs, trawls, video, etc.). This software is often used by the bridge officer/vessel skipper to guide the vessel to those positions and also allows the logging of the exact sampling positions. Once the grab hits the seabed the TOWER operator records the actual position of the sample electronically using a keystroke. This operator also enters the sample metadata onto a DigiLog field records sheet.

12) 500 ml standard laboratory 'wash bottle'

13) Calibrated measuring bucket (minimum 10 litre capacity)

14) 0.75 l plastic boxes for PSA samples

15) Chemical aspirator for the storage of 10% formaldehyde

16) Water hose / deck wash (ideally with variable pressure)

5. PROCEDURE

7.1. Pre-survey checks

At the laboratory, all items required for field survey work, including disposables, should be checked against the equipment list and inspected for damage (e.g. damaged sieve meshes). Replace or repair damaged items as necessary. Once on board the survey vessel ensure all equipment is present and safely stowed.

6. PREPARATION OF EQUIPMENT

Position the grab and stand beneath the derrick or gantry and attach the wire of the Hamon grab to the winch wire from the survey vessel using a tested shackle and swivel. Check that the weights are securely fastened. Set the Hamon grab by pulling the lifting arm down from the vertical position allowing the release hook to engage (see Figure 1). Wash the grab thoroughly with the deck hose prior to deployment. Place a clean, large plastic box under the grab stand hopper.

7. DEPLOYMENT AND RECOVERY

When the boat is stationary and the skipper has given permission, the grab is deployed, typically at a rate of approximately 1 ms^{-1}. As the grab approaches the seabed the wire should be released more slowly to avoid the creation of a 'bow wave' which could wash away surface material. Once the Hamon grab has reached the seabed, slackening of the winch wire provides a signal to stop the winch (at this point the sample position is recorded by the TOWER operator). The grab should then be raised, initially very slowly to maximize sampling efficiency. When the grab reaches the surface it should be stabilized and then swung on-board, as soon as possible, as the device presents a danger on a rolling vessel. The grab is then lowered gently onto the supporting frame. Enough winch cable should be released to enable the lifting arm (and grab contents) to be released. In rough seas, the vessel should be orientated 'head to wind' thus minimizing roll and reducing the risk of loss of control of the grab during deployment and recovery (see Figure 2).

Depending on the type of surveys needed, it is also an alternative to attach a video camera to the Hamon grab to provide images of the seabed at the point of sampling. This also required specialized personnel to handle the video cables and recording procedures.

8. COLLECTION OF SAMPLES

Should the bucket of the grab fail to engage fully with the stop plate (e.g. as a result of a stone obstructing closure), resulting in the loss of sample material, the contents should be discarded and the grab re-deployed. At least three attempts should be made at each sampling station before abandonment of sampling at the station position. At the discretion of the Scientist in Charge (SIC) a smaller sample may be accepted if there is some merit in obtaining indicative (e.g. qualitative) information from a location. Alternatively, further attempts can be made at increasing distance (typically 50-100 m intervals) from the original site. Again this will be at the discretion of the Scientist-in-Charge. Slowly release the sediment into the sample container by pulling down the lifting arm to the horizontal position. The container should be moved in synchrony with the grab bucket. Any material remaining in the grab should be carefully washed into the container.

It is important to consider a minimum acceptable sample volume (5l). A verbal sediment description of the sample (e.g. 'shelly muddy sand') is provided by scientists on deck and recorded by the TOWER operator on the DigiLog sheets. The sample is labelled (station number) and taken to the processing area of the deck. A photograph of the sample should be taken in the sampling container. The photograph should be taken after most of the water has been poured off over the sieving table. The photograph should encompass the entirety of the sample and should incorporate the sample label. The volume of the sample should then be measured by transferring it into a calibrated bucket. This action should be carried out over the sieving table so that any water within the sample is not lost.

9. Particle size analysis

The sample should be labelled and photographed before the particle size analysis (PSA) sub-sample is taken. A plastic scoop should be used to extract a representative sub-sample of the sediment. This should be done by collecting a number of aliquots from the sample and should represent the full depth and surface

area of the sample. The cobble fraction (>64mm) should not be included in the PSA subsample **as this fraction will be analysed under a different methodology (for specific details consult the cobbles SOP if this methodology is required for the purpose of the study)**. For samples of 5l or greater, a PSA sub-sample of 500ml is considered to be an appropriate compromise between a statistically acceptable sample for excessive PSA purposes and not removing an amount of the biological sample. However, for some samples (e.g. of very coarse nature) will be necessary to remove smaller PSA sub-samples and some expert judgement will be required for this decision. The sample should be collected and stored directly in a plastic Tupperware type box with a sealed lid. Waterproof labels should be placed both inside the box and on the lid. The samples should then be frozen.

10. SIEVING THE SAMPLE USING A PURPOSE-BUILT SIEVING TABLE

The sediment should be washed, using gentle hose pressure, whilst still in the calibrated sample container. This should be conducted over the sieving table and the appropriate meshes and sieves should be in place. This will allow many of the lighter organisms to be released from the sediment with the minimum amount of damage to specimens. Allow the supernatant water, containing any fine sediment and benthic organisms, to overflow from the sample container and pass through the stack of removable square mesh sieves (64mm mesh grid over 5mm grid).

Larger individual animals retained on the 5 mm mesh and 1mm mesh (including all encrusting fauna present on shell and gravel) are removed and transferred to plastic bottles or buckets (depending on the size of the sample). The nature of the coarse material, including the presence of any artefacts, should be recorded in the log. If any material is lost a repeat sample should be taken.

The material passing through the 5 mm mesh is sieved over a stainless steel sieve with a 0.5mm or 1 mm precision steel mesh screens depending on the nature of the study and data required, the choice depending on the objectives of the investigation. This sieve is held within a sieve holder beneath the outlet pipe of the sieving table. Temporary blockage of fine meshes can occur and care should be taken to ensure that there is no loss of animals as a result of overflow. Periodically, the sieve should be removed from beneath the outlet pipe, and replaced by another. Accumulations of fine sediment on the mesh screen can usually be removed by gentle ‘puddling’ in a large plastic container filled with seawater (using a vertical motion as horizontal motion can cause animals to be damaged through abrasion).

11. SAMPLE PRESERVATION

On completion of the sieving process, retained animals and residual sediment on the mesh screens are transferred to plastic bottles or buckets via a large funnel in a frame support (Figure 3). The stainless steel sieve should be supported at about 45°, and rinsed using a hose under gentle water pressure from top to bottom. This whole process should be carried out within a large plastic container so that any accidental spillages can be contained and rinsed back onto the sieve. If the water pressure from the hose is too high and cannot be adjusted, a 500 ml wash bottle should be used. Any material trapped within the mesh of the sieve should be carefully removed using forceps. A scoop should not be used to remove material from the sieve as this may cause damage to specimens.

The 10% formaldehyde preservative solution, with or without added Rose Bengal (see Reagents), should be added to fresh samples with the aim of achieving a final

concentration of 5% of formaldehyde in the sample; i.e. add approximately the same volume of the 10% formaldehyde solution as the volume of fresh sample (including any liquid).

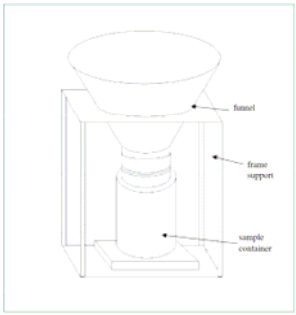

Figure 4 **Funnel in frame support**

12. SAMPLE LABELLING

An adhesive label should be attached to the outside surfaces of the sample container and an internal waterproof label inserted (so that any damage to the external label does not prevent the later identification of the sample). The plastic boxes used for subsequent storage of PSA samples should also be directly labelled. All labels should contain the following information:

- Research cruise number or code (e.g. prefix - vessel name: END – Endeavor followed by cruise number/year)
- Date
- Station number and code (stations are numbered sequentially from the start of a cruise).
- The type of sample (e.g. macrofauna, PSA etc)
- Survey area

13. Transport of samples from ship to laboratory

Formaldehyde solution should always be carried in containers that are approved for this purpose. The container should be of a material that is impervious to formaldehyde solution or vapour. All containers must be checked prior to transport. If there is any apparent leakage of liquid or vapour from the container, or there appears to be potential for leakage then the container is not suitable for the carriage of formaldehyde solution. Ideally concentrated formaldehyde should be carried as 10l aliquots with no more than 25l being carried in a single container. At sea, 30% formaldehyde solution is stored on deck in a chemical storage container. Benthic samples containing 10% formaldehyde solution are stored on deck in large labelled crates.

Formaldehyde solution must not be transported to or from a vessel in a situation where fumes generated from a spillage can come into contact with the driver or passengers. All quantities of 30% and 10% formaldehyde solution must be carried in an approved chemical container and securely stored in a vehicle that separates the occupants of the vehicle from the formaldehyde (e.g. box van, flat-bed lorry or van). Containers of formaldehyde solution should be clearly labelled with details describing the nature of the contents. An approved formaldehyde spill kit and chemical notification sheet must always be carried when transporting all concentrations of formaldehyde solution in case of accidental spillage. Spillages of formaldehyde in an

enclosed vehicle should, where possible, be irrigated with water. If this is not possible the formaldehyde must be allowed to evaporate and all fumes should be dispersed before the vehicle is used again.

Refer to the following COSHH forms for full advice on the appropriate procedures:

- **BOC-EQ-Coshh-SAS-Sea-01** Storage of 30% formaldehyde solution, dilution of 30% formaldehyde to 10% and use of 10% formaldehyde for preservation of benthos samples
- **BOC-EQ-SAS-Formaldehyde** Movement to and storage of samples preserved in 10% formaldehyde solution at Burnham offsite storage facility

14. SAMPLE STORAGE AND TRACKING PROCEDURE

Details of the samples taken are recorded in the cruise DIGILOG database. This acts as the sample record for retrieving information on samples, surveys, etc. On completion of the cruise the resultant DIGILOG file is quality assured and a master copy is saved in the cefas Benthos drive for further consultation. On return to the laboratory, samples and DIGILOG database should be dealt with in accordance with the storage and sample tracking procedure (CEFAS –Field Evaluation Team 004).

15. QUALITY CONTROL (Please consult the appropriate QA procedures)

Check operation of position-fixing equipment, winch and deck-wash prior to departure. Check the condition of the sampling equipment (particularly sieves and large volume sample containers) and replace as necessary. Comply with the criteria for sample rejection.

16. ANALYTICAL PROCEDURES

For analysis of macrobenthic samples see Procedure FET 003. For analysis of sediment particle size, refer to the appropriate SOPs.

17. REFERENCES

Eleftheriou, A. and Holme, N.A., 1984. Macrofauna techniques. In: Holme, N.A. and McIntyre, A.D. (eds). *Methods for the study of marine benthos*. Oxford: Blackwell, pp 140-216.

Oele, E., 1978. Sand and gravel from shallow seas. *Geologie en Mijnbouw*, 57: 45-54.

9 Review

This procedure will be reviewed as a minimum on the time scales given in the review / amendment programme. A record of the review will be made on a separate Review / Amendment Sheet which will be added to the Master Copy file of this SOP. Any amendments arising from such review or from operating requirements will result in the issue of the entire amended procedure as a new Issue.

10 Records

This procedure, its review sheets and its subsequent revisions constitute records in themselves and each master copy will be retained in a file as arranged by the

Quality Manager. Records will be retained for a minimum of five years unless otherwise specified.