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Water quality — Sampling —

Part 12:
Guidance on sampling of bottom sediments

Qualité de l'eau — Échantillonnage —

Partie 12: Guide général pour l'échantillonnage des sédiments

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5667-12 was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 6, *Sampling (general methods)*.

ISO 5667 consists of the following parts, under the general title *Water quality — Sampling*:

— *Part 1: Guidance on the design of sampling programmes*

— *Part 2: Guidance on sampling techniques*

— *Part 3: Guidance on the preservation and handling of samples*

— *Part 4: Guidance on sampling from lakes, natural and man-made*

— *Part 5: Guidance on sampling of drinking water and water used for food and beverage processing*

— *Part 6: Guidance on sampling of rivers and streams*

— *Part 7: Guidance on sampling of water and steam in boiler plants*

— *Part 8: Guidance on the sampling of wet deposition*

— *Part 9: Guidance on sampling from marine waters*

— *Part 10: Guidance on sampling of waste waters*

— *Part 11: Guidance on sampling of groundwaters*

— *Part 12: Guidance on sampling of bottom sediments*

— *Part 13: Guidance on sampling of sewage, waterworks and related sludges*

- *Part 14: Guidance on monitoring the quality of sampling procedures*
- *Part 15: Guidance on the preservation and handling of sludge and sediment samples*
- *Part 16: Sampling and pretreatment of samples for biotesting*

Annexes A, B, C, D, E, F, G, H, J, K, L and M of this part of ISO 5667 are for information only.

Introduction

This part of ISO 5667 should be read in conjunction with ISO 5667-1, ISO 5667-2 and ISO 5667-3.

The general terminology used is in accordance with the various parts of ISO 6107, and more particularly, with the terminology on sampling given in ISO 6107-2.

Water quality — Sampling —

Part 12:
Guidance on sampling of bottom sediments

1 Scope

This part of ISO 5667 provides guidance on the sampling of sedimentary materials from

— inland rivers and streams;

— lakes and similar standing bodies; and

— estuarine and harbour areas.

Industrial and sewage works sludges, palaeolimnology sampling and open ocean sediments are specifically excluded although some techniques may apply to these situations. Sampling specifically for the measurement of rates of deposition, other transport criteria and detailed strata delineation is not within the scope of this part of ISO 5667.

The investigation may have the following objectives:

— the descriptive mapping of an area;

— the monitoring at regular intervals of fixed markers such as buoys;

— examining the quality of dredger spoil; and

— fundamental research.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 5667. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5667 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2602:1980, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

ISO 2854:1976, *Statistical interpretation of data — Techniques of estimation and tests relating to means and variances.*

ISO 5667-1:1980, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes.*

ISO 5667-3:1994, *Water quality — Sampling — Part 3: Guidance on the preservation and handling of samples.*

ISO 9391:1993, *Water quality — Sampling in deep waters for macro-invertebrates — Guidance on the use of colonization, qualitative and quantitative samplers.*

ISO 10381-6:1993, *Soil quality — Sampling — Part 6: Guidance on the collection, handling and storage of soil for the assessment of aerobic microbial processes in the laboratory.*

3 Definitions

For the purposes of this part of ISO 5667, the following definitions apply.

3.1 composite sample: Two or more samples or subsamples mixed together in appropriate known proportions, from which the average result of a *designed characteristic* may be obtained. The individual portions may be derived from the same stratum or at the same sediment thickness. The sample components are taken and pretreated with the same equipment and under the same conditions.

3.2 pile-working: The phenomenon which occurs when the sample rising up the inside of a piston corer meets a resistance due to its own friction, a blockage by a large piece of stone, or the tube being full.

3.3 descriptive mapping: A description of the sediment present, in terms of its nature, variation and extent. The exercise is carried out by precise marking of sample locations and recording of site conditions. Pre-established conditions may be a requirement of the exercise.

3.4 monitoring: Establishment of variation with time of the physico-chemical and descriptive characteristics of the sediment.

3.5 quality of dredger spoil: To establish the chemical nature and, in the case of sandbank dredging, the physical properties of the sediment layer removed by the dredging process and disposed of off-site.

4 Sampling equipment

4.1 Sampling container materials and types

Polyethylene, polypropylene, polycarbonate and glass containers are recommended for most sampling situations, although glass jars have the advantage that the condition of their internal surface is more readily apparent and they can be sterilized more easily than most plastics materials prior to use in microbiological sampling situations.

Glass containers should also be used when organic constituents are to be determined, whereas polyethylene containers are preferable for sampling those elements that are major constituents of glass (e.g. sodium, potassium, boron and silicon) and for sampling of trace metallic moieties (e.g. mercury). These containers should only be used if preliminary tests indicate acceptable levels of contamination.

If glass containers are used for storing sediments with pore waters which are weakly buffered, borosilicate rather than soda glass containers should be chosen.

Reference should always be made to both the standard analytical procedure for detailed guidance on the type of sample container to be used and the receiving laboratory. For guidance on the cleaning of sample containers, reference should be made to ISO 5667-3. In all cases, consultation with the receiving laboratory should be regarded as mandatory practice.

4.2 Criteria for selection of apparatus

4.2.1 Type of investigation

Three types of investigation can be distinguished:

a) chemical investigation;

b) physical investigation; and

c) biological investigation exclusive of colonization samplers, traps or nets.

When a grab system (4.3.1) is not used, the criteria for selection of sampling apparatus may also be required to meet the following conditions:

— storage of the sediment without changing the stratigraphy;

— allow the selection of a layer; and

— allow sampling at the required water depth.

4.2.1.1 Chemical investigation

In this type of investigation, the nature and amounts of the substances which have become bonded to the sediment may be determined. Some chemical species bond in preference to small mineral particles and organic matter while some are incorporated in residual pore water. It should be noted that where the sampling device is made of metal then abrasion and chemical action, for example from sulfides and phosphates, may lead to specific contamination. Appropriate quality control measures should be undertaken in full consultation with the receiving laboratory in order to establish the degree of influence of such effects on the survey results. Some study parameters may require to be maintained in an oxygen-free atmosphere (e.g. sulfides) and storage and handling under pressure of an inert gas may be needed. In all cases analysis should be performed as quickly as possible.

4.2.1.2 Physical investigation

In this type of investigation the structure, texture and layer formation of the water bed are determined. These details are particularly important for sand, clay and shell production and for geographical, morphological and, in some cases, geotechnical investigations.

4.2.1.3 Biological investigation

A biological investigation generally involves classifying the species and numbers of flora and/or fauna present on and in the sediment bed. In nearly all cases sampling is carried out in the habitat layer. The probe depth is generally a maximum of 50 cm. For specific details, reference should be made to ISO 9391 for methods involving colonization traps or net sampling. In some cases microbiological action may also be of interest, such as denitrification, phosphate release, methylization of metals such as mercury or tin.

4.3 Types of apparatus

NOTE 1 Additional equipment, which emulates or compliments the advantages of that discussed in this part of ISO 5667, may also be available commercially. The scope for inclusion in future revisions will be considered at the appropriate time.

4.3.1 Grab systems

4.3.1.1 General

Many samples are collected using bed grabbers. The most well-known is the scissor-grab, sometimes known as the van Veenhapper type. There are, however, a large number of variations. In general, grab systems consist of one or more hinged buckets which close whilst being raised. During closing, sediment is enclosed by the buckets providing disturbed samples. Probe depths vary from 5 cm to 50 cm, depending upon the size and mass of the sampler and the structure of the bed material. Due to the grab construction, there is a large chance of losing part of the finer fraction and/or the top layer. Grabs are available in a variety of designs. Since all grab systems have the same sampling characteristics, only the van Veenhapper type is described in detail in annex A. In general, detailed operating instructions are provided by the manufacturer.

4.3.1.2 Scissor grab or clam-shell buckets

4.3.1.2.1 Application

The system is recommended for physical, chemical and biological investigations.

4.3.1.2.2 Type of bed

The system is most suitable for sampling sediment beds consisting of silt and/or sand and gravel. It is not suitable for sampling peat, clays or gravel beds in riffle areas.

4.3.1.2.3 Accuracy of sample

A sample taken with a scissor grab will always be disturbed. Inaccuracies arise because of washing away of the fine fractions. The depth of penetration is unknown and dependent on the nature of the bed for any particular instrument, for example, the grab can sink through a thin silt layer so that it will not be known at what depth the sample has been taken from within the bottom sediment.

4.3.1.2.4 Nautical conditions

The scissor grab can be used in both shallow and deep water and in areas of slow and fast currents. However, the construction and mass need to be adapted to suit the conditions. It is recommended that trials using objects of a similar mass be carried out; this indicates whether strong currents affect the position of the samples. Additional weights can then be added if it is found necessary. It is recommended that a secondary line carrying a marker float be attached as a security measure, in case the main line has to be abandoned for safety reasons. This will aid recovery.

4.3.2 Corer systems

Sampling using a corer system depends on the principle of driving a hollow tube into the bed so that the sediment is pushed into it. A sample is obtained by pulling the tube out of the bed. This sampling principle is used in many different ways. It is possible to distinguish between systems in which the tube, where necessary extended by rods, is pushed into a bed manually and systems in which the tube is inserted by means of its weight or a vibration mechanism.

4.3.2.1 Application

The systems described are recommended for physical, chemical and limited biological investigations.

4.3.2.2 Type of bed

Some sandy beds may be suitable but trials will need to be undertaken first. Clay types and soft peaty materials are also suited to corers. Peat borers have a specific application.

4.3.2.3 Accuracy of sample

Most corer samples are relatively undisturbed and may be used to define strata.

4.3.2.4 Nautical conditions

Hand-operated types are prone to nautical constraints such as fast flow or high winds in small boats. They are usually confined to use at shallow depths unless a diver is employed.

Mechanical devices can be used remotely from boats and are more suitable for use in rough weather. They are not recommended for use from bankside or bridges.

4.3.2.5 Other information

So-called "pile-working" (3.2) can occur with corer systems. The amount of pile-working depends on such variables as the diameter of the tube, the composition of the bed and the penetration speed. It is difficult to judge when this phenomenon is recurring, as each location is different, and interpretations should be made with caution.

Evidence can be found by observing distortions in the strata indicating compression at the centre of the core and a lack of movement at the core periphery during sampling. In general, a concave appearance will predominate from the bottom of the sample up. The consequences of this occurring vary depending on the reason for occurrence and the end use of the sample. Stratification studies can be acutely hampered by this phenomenon. It is possible that the only way to overcome the problem may be to use a different technique, for example a core tube with a larger diameter. Lubrication of the inside of the sample tube should only be used with the agreement of the laboratory carrying out subsequent testing.

A cored sediment sample frequently requires dimensionally accurate subsampling in order to take full advantage of subsequent laboratory analysis and interpretation. The extrusion device can be a simple piston or a variety of fixtures using a stationary vertical piston over which the core tube is placed. The extruded material can be sectioned with a device, which can be put on the top of the sampling tube. The sample can be simply removed with a spoon or, if the sediment is solid enough, a spatula. The material of the corer or sectioning devices should be chosen so as not to conflict with any chemical analysis.

4.3.2.6 Manually operated sampling apparatus

In this apparatus the tube is pushed into the bed by means of rods. Penetration is generally up to a maximum of 2 m, depending on the nature of the bed materials. Gravels are unlikely to be suited to this sampling method. Because extension rods are used, there can be problems in obtaining samples when working from the bank where a distance of more than 4 m must be bridged by rods. Due to movement of a vessel, it is often difficult to obtain good samples from a boat. However, it is possible to obtain reliable samples in a water depth of approximately 2 m; beyond this a diver may need to be employed.

Various types of manually operated corers with a multitude of modifications, all based on the same principle, are in use. The characteristics of a number of types of corer systems and recommended typical applications are described in 4.3.2.6.1 to 4.3.2.6.5.

4.3.2.6.1 Piston drill

The piston drill is recommended for chemical, physical and biological investigations. It is suitable for use in sampling beds consisting of consolidated silt and/or in peat. It is not recommended where the sediment bed consists of fine sandy or silty material, as there is a possibility that the sample will be lost from the bottom of the core tube because it is not closed off underneath.

4.3.2.6.2 Corer system involving a diver

In this system a corer tube is pushed into the sediment by a diver. If necessary, the tube can be coupled to a vacuum pump so that the sample can be taken up into the tube more easily. Maximum penetration is 2 m.

The diver core tube is applicable to chemical, physical and limited biological investigations.

4.3.2.6.3 Beeker core sampler (see annex D)

The tube is mounted on a cutter head containing an inflatable bellows which prevents the sample from falling out of the tube when it is withdrawn from the sediment.

4.3.2.6.4 Sealed core sampler (see annex E)

The stainless steel tube containing a plastics inner sleeve is closed off by inflating two small bellows, one at the top of the tube and one in the cutter head, so that when the tube is removed from the sediment the sample does not fall out.

As long as its limitations are taken into account, the sealed core sampler can be used for physical, chemical and limited biological investigations. It is suitable for silty and fairly soft water beds and can be operated from a (small) vessel or from shore (for example from a pier, quay or bridge).

NOTE 2 The terms hard and soft (as used in this part of ISO 5667) are largely arbitrary and a certain amount of trial and error will have to be employed when assessing the suitability of certain sampler types to those particular physical sediment characteristics.

Because the top and bottom of the tube can be shut off, the sample can be collected undisturbed. Use of the sample-removal apparatus often supplied with the sealed core sampler can allow various strata to be sampled accurately.

WARNING — The chance of "pile-working" is high in consolidated silt. In this case, the penetration depth is greater than the compressed strata depth of the sample in the core tube. This should be borne in mind during the sampling operation and when interpreting the core.

When using a boat it is important that it remains stationary so that, when the core tube is pushed into the sediment, the vessel is not pushed away. There is a possibility of the vessel being moved against the rods by wind or currents. This should be prevented in order to avoid damage to the sampling equipment and boat.

The consistency of the bed largely determines the sampling result. Because of its construction (air and pressure hoses) the apparatus is only usable in silty, fairly soft beds up to a water depth of approximately 3 m.

4.3.2.6.5 Vrijwit drill or wedge corer
(see annex F)

The wedge core tube has a maximum penetration of 1,50 m. One side of the wedge remains open whilst it is pushed into the sediment. The open side of the core tube is then closed off with the slider, and the sample is extracted from the sediment.

4.3.3 Mechanically operated sampling apparatus

Many types and modifications are in use. Subclauses 4.3.3.1 to 4.3.3.8 describe the characteristic properties of a number of common types and recommend typical applications and suitability to various types of sediment.

4.3.3.1 Falling bomb core sampler (see annex G)

The core tube is mounted in a weighted holder which is dropped freely from a vessel and penetrates the sediment. The method is fast and efficient because it is not necessary for the vessel to be anchored. This method is not suitable for use in unconsolidated sediments.

4.3.3.2 Jenkins mud sampler core sampler
(see annex H)

The corer is mounted in a frame and due to its large mass it sinks into the bed. Once the suspension cable is slackened sufficiently, a closing mechanism is activated which shuts off the sample tube by means of hinged arms.

The Jenkins mud sampler is suitable for physical, chemical and limited biological investigation of the top layer of very soft beds. It is not suitable for hard sediment beds. By shutting the valves gently using an oil pressure device, an undisturbed sample of the soft top layer of sediment can be obtained.

The bed needs to be soft since the valves do not shut properly if the bed is hard, due to the resistance experienced, and the core tube will not penetrate. Samples can be taken in deep water.

4.3.3.3 Craib corer sampler (see annex J)

The Craib corer consists of a core tube mounted in a frame. When it is lifted out of the sediment layer, the core tube is first closed off at the top by a valve. As soon as the bottom is free of the bed, it is closed off by a ball.

4.3.3.4 Easy All core sampler

The Easy All is a corer whose mass can be increased to approximately 110 kg. After the sample has been taken, the core tube is shut off at the top and the bottom by means of valves. The filled core tube can be removed from the holder completely once it is aboard. It is also possible to take readings directly from the core material by inserting electrodes in tiny side openings in the tube wall. Parameters such as temperatures and redox potential can be studied easily.

4.3.3.5 Vibro corer sampler

A casing containing a polyvinylchloride tube is pushed into the bed by means of weights and a vibration mechanism. A piston ensures that the sample can be moved into the tube more easily. When the core tube has reached the required depth, it is removed from the sediment bed. A core catcher and the piston ensure that the sample does not fall out of the tube. Penetration depths of various Vibro corers vary between 1,2 m and 6 m. The total mass is approximately 850 kg. A vessel with a lifting capacity of at least 1 000 kg is necessary if the Vibro corer is to be used. This type of sampler consists of highly specialized equipment and its use is considered to be beyond the scope of this part of ISO 5667.

4.3.3.6 Piston corer sampler (see annex K)

The Piston corer consists of a core tube which is weighted at the top and can have fins for added stability. Its operation depends on the free fall principle.

4.3.3.7 Peat borer

These devices generally comprise hand augers specifically designed to cut cores out of saturated or partially drained peat sediments. Some examples from the Polish Peat Institute are given in annex L.

4.3.3.8 Cold finger techniques

During the preparation of this part of ISO 5667 it was noted that some success has been reported in the literature with the use of "cold finger" sampling of sediments. This involves the insertion of a refrigerated device into the sediment which freezes a portion of its surroundings allowing stratigraphical extraction and separation. Users of this part of ISO 5667 are recommended to refer to the literature sources cited in the bibliography in annex M for more details of the scope of application.

5 Sampling procedure

5.1 Choice of sampling site

In choosing the exact point from which samples are required, two aspects are generally involved:

a) the selection of the sampling site (i.e. the location of the sampling cross-section on the base of the water body);

b) the identification of the precise point at the sampling site.

The purpose of sampling often precisely defines sampling sites (as is the case when studying deposition from a particular discharge point), but sometimes the purpose only leads to a general definition of the sampling site as in the characterization of the quality and type of material in a river delta.

The choice of sampling sites for single sampling stations is usually relatively easy. For example, a monitoring station for a baseline record of sediment quality may be chosen to permit the use of a convenient bridge, or to allow an upstream effluent discharge or tributary to be well mixed laterally before the station.

Low-frequency echosounders should be considered to assist in locating bed areas of appropriate quality prior to sampling.

The criteria for choice can include:

— ease of repeat access to the location, for example a tidal influence;

— seasonal availability, for example, affected by safety, problems in spate;

— the influence of marine traffic, for example, sample points may need to be avoided due to traffic.

5.2 Choice of sampling point

This will be influenced by physical constraints such as boat size or water depth but the precise point will largely depend upon the purpose of the investigation. For example, if geophysical mapping is the sole purpose then choice may be the function of flow and current conditions only, whereas if chemical composition/contamination is being studied, the sampling point will depend largely on the geophysical condition of the bed areas. For instance, it would not be expected to find contamination caused by gross metals in a riffle area of a stream compared to a pool area. The choice of sampling point will be a desirable pre-qualification for the programme, but exact locations will inevitably be revised in the field.

Locations will need to reflect the proximity to outfalls, the influence of stream mixing and other factors such as plant growth.

5.3 Choice of sampling method

The choice of sampling method will largely be restricted by the two following factors.

a) The requirement for a largely undisturbed sample for stratigraphical delineation.

b) The acceptance of a disturbed sample taken near the bed surface for a general morphological or chemical examination.

These factors will be decided upon during the programme design stage. Certain types of chemical parameter may necessitate the use of inert liners in piston or tube type recovery devices, for example, polytetrafluoroethylene linings if low-level pesticides are being examined.

The remaining factor affecting the choice of sampling method will be the applicability of the proposed device to the sediment conditions. This regime is summarized in table 1.

5.4 Frequency and time of sampling

Analytical results from a sampling programme need to provide estimates of the required information within acceptable tolerance limits defined in the objectives of the programme. If the objectives do not include a definition of the tolerable error, a statistically based sampling programme is impossible. It should be remembered that changes with time of sediment composition may require a much longer period of observation to detect than changes observed for water. For example, diurnal variation in concentration of metals may be detected in an estuary water but the respective sediments may only show fluctuation over a much longer sampling period. When using systematic sampling, it is essential to ensure that the frequency of sampling does not coincide with a natural cycle present in the system. In the case of sediments this may be seasonal variation. It may be necessary to increase the sampling frequency in order to observe any seasonal variation in some cases, for example when monitoring pore water nutrients. The frequency of sediment sampling is only likely to have a major influence on the interpretation of results when rapid deposition rates are expected. For example, weekly sampling of a river bed downstream of a discharge point is not likely to reveal any data that is different from that demonstrated from sampling at half yearly intervals, other than the inherent variability of the sediment. The reasons for sampling dictated by the needs of a particular project will themselves define the frequency of sampling. For details of the application of statistics to sampling frequency refer to ISO 5667-1.

5.5 Site conditions

Conditions at the sampling position are of vital importance to effect correct sampling. A number of these conditions will usually be known before sampling takes place and should be taken into account when preparing the operation and also when choosing the apparatus to be employed.

The following conditions are important:

— climatological;

— hydrographical;

— geological;

— shipping/nautical.

Table 1 — Sediment type and recommended sampler

Sediment type	Sampler[1)]
Gravel	Grab systems; large particle size may require heavier grabs
Sand	Both grab and corer systems can be used. A sand bed can be very hard and thus prove difficult for lightweight grabs and manually operated corer systems. Grabs of larger mass and heavy mechanical corers may be required
Clay	It may be necessary to use a corer because grab systems often cannot penetrate easily into the clay
Peat	A difficult medium to sample but it is sometimes possible to use a hand operated corer system, or a special peat borer
Consolidated bottom sediment	Both grab and corer systems can be used. If a grab is used it is not possible to determine the sample penetration depth.
Unconsolidated bottom sediment	Grab systems are not suitable as they are prone to sinking through the soft layer. Corer systems are better but, when a frame is used at greater depth, care is essential to prevent the frame from sinking through the soft layer. More support can usually be given to prevent this by adding large plates to the feet of the frame. Samplers which depend on the free fall principle are not suitable for this bed type.

1) Sampler type versus sediment type may have to be determined by experimentation.

5.5.1 Climatological conditions

Temperature, wind direction and force can be restricting factors when carrying out sampling. For example, if the sampling location is situated in an area which is strongly affected by wave movements then this should be taken into account when planning the operation and when using the apparatus. The restrictions relating to climate are covered specifically for each type of instrument in the annexes.

In countries with cold climates it may be practical to work on ice surfaces of lakes. However, safety should always be a priority and local regulations should apply. Equipment can be protected from freezing in heated tents.

The need for sampling needs to be judged against the safety factors influenced by climatic conditions. In addition, storm conditions may disturb sediment beds such that sampling becomes impractical or meaningless if material is washed away.

5.5.2 Hydrographical conditions

5.5.2.1 Tidal areas

In tidal areas, attention should be paid to variations in the depth of water, current speeds and directions. Variable currents, in particular, are often a restrictive factor in the choice of apparatus to be used. Large instruments cannot be used where fast currents are present. Sampling using these instruments should be restricted, due to the effect on the sampling vessel, to periods of low flow rates.

Since the depth of water in tidal areas varies, it is advisable to carry out sampling at low tide, for example on dried out sandbanks, where manual sampling using conventional spades and similar tools is possible, giving due regard to relevant safety precautions. Each sampling occasion should be judged against local conditions and experience of local tides.

The sampling of tidal river beds and mud flats may be approached in a similar manner to that employed for the sampling of soil. This will be covered in a future International Standard.

5.5.2.2 Rivers

Account should be taken of high flow rates in rivers. If the project allows, it is advisable to restrict sampling to periods of low water level with low flow rates, where sampling equipment is less likely to be affected. Other local hydrographical conditions may occur, for example the operation of locks, which will require investigation before sampling.

5.5.2.3 Standing bodies

In lakes, harbour areas and some sedimentation ponds, the currents are often negligible so that the hydrographical conditions have very little effect on the type of apparatus to be employed. When choosing the apparatus to be used, the water depth at the sampling point is important in all three water systems mentioned here. If the depth is less than 4 m then manually operated apparatus is advisable. At depths of greater than 4 m, sampling systems operated by lifting or guidance mechanisms are recommended. In the case of the grab systems, the size of the apparatus will determine whether this can be manually operated or not. Further guidance is given in table 1.

5.5.3 Sediment conditions

The general nature of the sediment layer is important when choosing the apparatus to be employed. If no prior knowledge is available then it is advisable to carry out a preliminary investigation using geological maps, coastal charts and visual investigations, or even an inspection via diving, thus preventing many problems arising during the actual sampling. Recommendations for various combinations of sampler type and sediment bed material are summarized in table 1.

5.5.4 Nautical conditions

Due to certain nautical conditions, it is not usually possible to carry out sediment sampling from an anchored vessel in harbour mouths or busy waterways. In these cases, the sampling equipment should be able to be used quickly to compensate for these conditions and hand-operated systems are preferable. In all cases, compliance with local safety regulations is essential.

5.5.5 Weed congestion

The use of all types of sampling device may be severely hindered by heavy macrophyte growth; on-site decisions will be dictated by the conditions found. Clearing an area with a dragline is worth trying before sampling, but it is not successful for all types of plant growth and it limits the sample to chemical and physical examination. Data distortions may arise since the sediment/water inferface will be significantly disturbed.

6 Composite samples

Depending on the aim of the investigation, in order to avoid conflicting results and obtain an average picture, a single composite sample per location can be prepared.

A composite sample consists of two or more single samples or subsamples and should be prepared as follows.

a) The individual single samples should be homogenized.

b) Equal volumes of each sample should be taken, combined and homogenized.

NOTE 3 Subsamples from equivalent penetration depths should be used.

A composite sample should not be made from samples taken from beds of a different nature. The nature of the bed should always be visually checked first to ensure that the sediment beds are geologically compatible.

When samples have been taken by means of a core tube, the length of the sample will vary. In order to make a composite sample, the sample lengths need to be the same. Therefore, the sample with the shortest length should be used.

When a grab system is used, the penetration depth can vary with each sample. Since this depth cannot be easily determined such samples are not generally suitable for making a composite sample.

There is a high risk of contamination when making a composite sample. It is therefore recommended that this activity be carried out in a separate location, away from the area where the samples are taken, so that conditions are more easily controlled than on the deck of a small boat, for example.

7 Storage, transport and stabilization of samples

In practice, it has become apparent that every project or investigation sets its own particular demands in the field of sample treatment. The investigation plan prepared for the field sampling should include a section on the treatment of the samples. This plan should take account of the particular aim of the project and the requirements for sample treatment given by the receiving analyst.

When transferring samples from the collection equipment to the storage container, care should be taken to ensure the continuance of anaerobic conditions, if appropriate to the planned analysis. The maintenance of anaerobic conditions will, to a large extent, depend on the equipment being used. A practice run may be found useful to refine any techniques developed. In addition, if trace organics are to be studied, the use of some plastics implements during subsampling may contribute to interference. Similarly the use of a metal spatula should be avoided if trace metals are of interest. The type and composition of sample transfer tools should be noted in the field report.

Sediment samples should generally be kept in glass containers and stored and transported cool (by convention at or below 4 °C), see ISO 5667-1. If it is necessary to keep them longer than one month, this should be done in a deep-freezer giving due regard to the physico-chemical changes that can affect colloids on freezing. For example, changes in de-watering characteristics may be observed when specific laboratory sample preparations are used. There may be a requirement for composite sampling when

— baseline data after dredging are required; and

— an estimate of quality is required in order to describe a sediment as "waste" after dredging.

Changes in stratification can be avoided if frozen cores are divided before thawing. In all cases, sample containers should be delivered to the laboratory tightly sealed and protected from light and excessive heat because the sample may change rapidly due to gas exchange, chemical reactions and the metabolism of organisms. The build-up of gas pressures in the sample container, due to anaerobic digestion, should not be overlooked and it may therefore be necessary periodically to release pressure from the container. This may become necessary if temperature regulation cannot be provided in warm climates.

If freezing the sample is chosen as the preferred method of preservation, as defined by the sampling programme and specified analytical method, notice should be taken of the following.

a) It is essential for the sample to be completely thawed before use, as the freezing process may have the effect of concentrating some components in the pore water of the inner part of the sample which substantially freezes last. The freezing of samples can lead to a loss of material of interest from pore water solution by absorption/adsorption on the precipitating compounds (e.g. calcium phosphate and sulfate). When the sample thaws, dissolution may be incomplete and thus erroneous results for pore water parameters such as phosphates may be produced.

b) Chemical preservation techniques should only be used after careful assessment of the project needs, the requirements of the analytical method and with the specific guidance of the receiving laboratory on the techniques required for homogenization of the sample with the preservative. For example, mineral acid may be added in an attempt to arrest or inhibit anaerobic digestion of organic matter if a study of organic acids is being made. Therefore, separate subsamples may be required prior to freezing. Additional guidance can be found in ISO 5667-3 and will depend on specific project needs.

Some sampling requirements may dictate that division by slicing a core is carried out on-site before storage.

All preservation steps should be recorded in a field report and the temperature measured and recorded on-site. If appropriate, other physical and chemical parameters (e.g. description, pH, redox potential) should be determined on-site, or as soon as possible after sample collection.

Further guidance on the handling and storage of aerobic samples may be found in ISO 10381-6.

8 Safety

For general safety precautions refer to ISO 5667-1. However, particular attention should be paid to the following safety aspects.

Safe access to routine sampling sites in all weathers is particularly important; failure to satisfy this criterion will normally rule out a given site, even where it is preferred from the point of view of satisfying the technical objectives of the sampling programme.

In swamps and shallow waters, some safety benefit may be gained if the ground is frozen. However, caution should always be exercised and the durability of frozen surfaces assessed. When samples are to be taken by wading into a river or stream, account should be taken of the possible presence of soft mud, quicksand, deep holes and swift currents. A wading rod or similar probing instrument is essential to ensure safe wading. By probing ahead, the person sampling can estimate the current and locate holes, benches, soft mud and quicksand. If in doubt, a safety line should be attached to a secure object on the bank or shore for support. The increased volume of chest waders (as compared to thigh waders) can be an impairment to rescue, should total immersion occur.

WARNING — If circumstances dictate that sampling needs to take place at sites where a fall could occur and in the vicinity of deep water, by any person, a life jacket must be worn and an appropriate system of regular reporting to a central control point must be employed. A life jacket must be worn in all cases when working on boats.

It should be recognized that there may be chemical, bacteriological, virological and zoological hazards in many aquatic sampling situations.

Additional guidance on safety may be found in a future International Standard covering soil sampling.

9 Statistical considerations of sampling

The design of sediment sampling programmes is project specific and generalizations cannot be made. However, the statistical interpretation of data obtained can be dealt with using the principles detailed in ISO 2602 and ISO 2854.

10 Sample identification and records

When a sample has been collected, a number of steps should be taken before it is sent to the laboratory for analysis, in order to achieve as good an interpretation of the analytical results as possible. The sample and its location should first be described and this report should be made as soon as the sample has been obtained. An example of the type of form which is recommended is given in table 2.

Table 2 — Example of a sample report form

Item		Observation
A	Description of sample location (name of area)	
B	Water course sampling position which should be clearly identified using a map reference, if possible	
C	Date and time of sampling	
D	Weather conditions (wind, waves, water movement)	
E	Ambient temperature, temperature of water at sample depth and the temperature of the sediment	
F	Sampling apparatus	
G	Types of sample taken: spot or composite	
H	Number of single samples combined	
I	Sample depth from surface	
J	Geological description and quantification of layers within the sample in line with accepted convention	
K	Colour in line with accepted convention (see bibliography in annex M)	
L	Odour (for example oil, hydrogen sulfide)	
M	Fauna present	
N	Temperature of sediment	
O	Sampler penetration depth and core length	

Annex A
(informative)

Description of the scissor-grab system (van Veenhapper type)

A.1 Apparatus (see figure A.1)

The system consists of two open-topped mutually hinged buckets which close whilst the sample is being taken. The opened grab is placed overboard. When the bed is reached, a catch is released (usually under gravity) so that the buckets can be shut. When this happens a surface sample of sediment is collected. Small models can be operated manually without requiring a winch.

A.2 Types in use

Several types of scissor grab are in use; their main difference is the mass (1 kg to 100 kg) and capacity of the buckets (0,5 litres to 25 litres). Most grabs are manufactured from galvanized or stainless steel. Modifications for various purposes have been made such as:

a) addition of a top valve for sampling the surface of the sample;

b) side walls to prevent the top layer being washed out;

c) extra weights.

A.3 Method of operation

The grab is locked into an open position and then lowered into the water by means of a davit and winch, or manually depending on its size. The locking device is released on contact with the bed. The grab then shuts itself as it is raised and while this happens sample material is collected in the buckets. The grab is placed in a receiving tray on the deck to allow the sample to be dealt with, for example by tipping it into the collection bin or by subsampling via top valves. The way in which samples are taken from the collected material depends on the aim of the investigation and should be recorded in the sampling report. After cleansing by brushing or with a high pressure hose, the grab can be prepared for the next sample.

A.4 Screen top sediment sampler

The screen top sediment sampler differs from the conventional grab in that it has two plates on the side which shut off the opening between the hinged buckets so that no sediment can escape. (Sediment can escape through the sides whilst shutting the buckets of the scissor-grab type.)

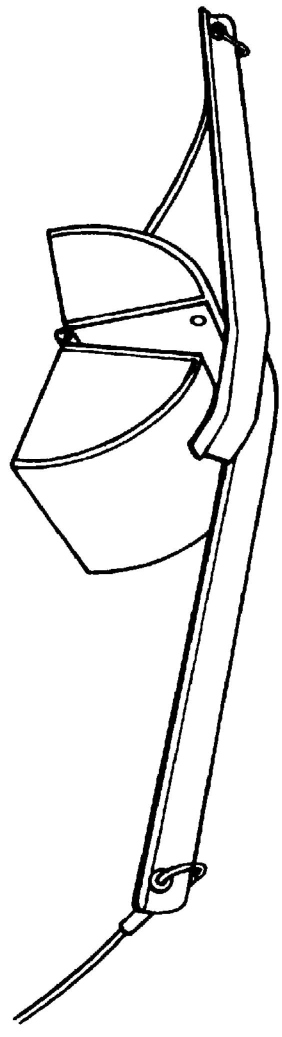

Figure A.1 — Scissor grab

Annex B
(informative)

Description of the piston drill system

B.1 Apparatus (see figure B.1)

A tube, of stainless steel, or occasionally (transparent) plastics, containing a piston is pushed into the bed. The piston is withdrawn whilst inserting the tube in the bed, which allows the sediment to enter the tube more easily.

B.2 Nature of the sample

In general, all samples will be somewhat compressed due to the influence of pile-working.

B.3 Location conditions

The use of extension rods allows accurate working from the bank in water up to 3 m deep. Samples can also be taken from a well-anchored vessel in water up to a maximum of 3 m deep.

B.4 Nautical conditions

When working from a vessel, there is always a possibility that wind or current will push the vessel up against the piston drill rods. This will affect the accuracy of the sampling and may compromise operator safety.

B.5 Method of operation

The depth of water at the sampling site is determined. The required number of extension rods are then fixed to the core tube. The core tube is then lowered to the sediment bed and the rod attached to the piston is fastened or held tightly. The core tube is pushed in as far as required. Pressure under the piston is reduced by lifting, which will reduce pile-working to some extent, so that the material can enter the core tube more easily. When withdrawing the core tube, the piston has to be held in the same relative position within the tube in order to retain the sample. The piston can be used to push out the contents of the tube after which the sediment can be subsampled.

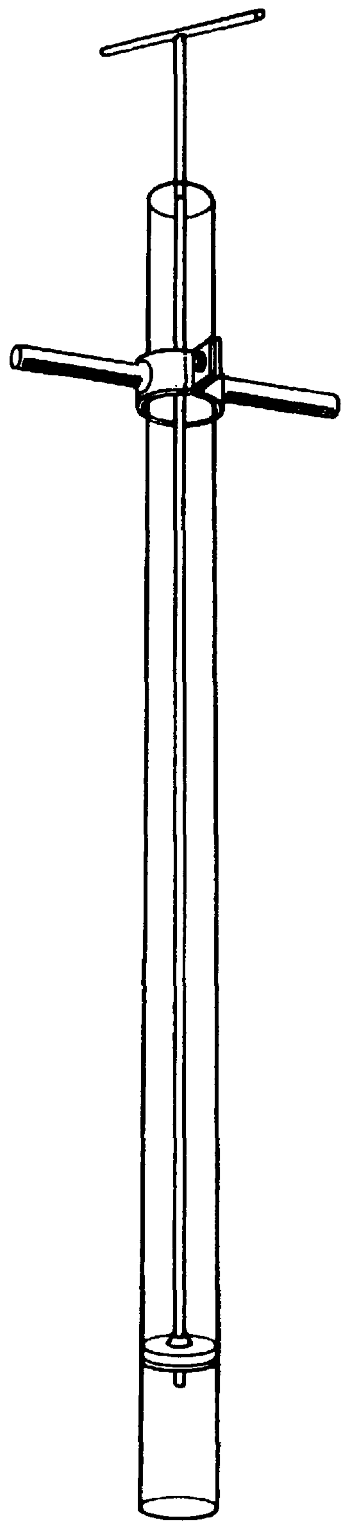

Figure B.1 — Piston drill

Annex C
(informative)

ion of the corer system involving a diver

Facilities for diving and experienced divers are necessary. A plastics core tube is pushed into the bed by a diver. If necessary, a pump is used to reduce the pressure in the tube so that the sample experiences less resistance when entering the tube.

C.1 Apparatus

C.1.1 Core tube, made of clear plastics, with decimal gradation. External diameter: 70 mm and internal diameter: 66 mm. The tube can vary in length from 1 m to 3 m. The material used for the tube may also vary in wall thickness and in composition.

C.1.2 Adjustable handle, with quick shutting clamp.

C.1.3 Rubber stoppers, for core tube.

C.1.4 Geared pump, operated by an electric or petrol motor.

C.1.5 Vacuum pump hose.

C.2 Nautical conditions

The surroundings should allow diving. Restricting factors include current speeds, wave and shipping movements and clarity of water. In certain locations possible hazards may arise from sharks etc.

SAFETY PRECAUTIONS — At all times, when it is necessary to use a diver to operate equipment, consideration should be given to good diving safety practice and in particular to the need for decompression requirements.

C.3 Method of operation

The core tube (C.1.1) is pushed into the water sediment bed at the sample site by the diver. If the resistance to this is too great, the diver may fit the vacuum pump hose (C.1.5). Reduced pressure provided by the pump (C.1.4) on board the vessel or bank allows the diver to insert the core tube more easily. To do this the diver turns or vibrates the tube using the handle (C.1.2). When the desired penetration has been reached, the valve to the pump is closed, the tube is withdrawn and closed off underneath with a stopper (C.1.3).

Annex D
(informative)

Description of the Beeker sampler system

D.1 Apparatus (see figure D.1)

The Beeker sampler consists of a cutter head fitted to a transparent polyvinylchloride (PVC) tube which is forced into the sediment by means of extension rods or a frame construction. A piston in the core tube causes the pressure in the tube to be reduced so that the sample can slide into the plastics sample tube more easily. When the core tube has penetrated to the required depth, a rubber gland in the cutter head is blown up so that the bottom is closed off. The sample tube can then be withdrawn, the tube removed and closed. The sample is now ready for transport or for the preparation of a description and subsamples. It can be used either with extension rods or in a frame. The sample tube lengths can vary by up to 2 m. The dimensions are summarized in table D.1.

Table D.1 — Dimensions of the Beeker sampler

Type	Dimensions	Mass kg	Sampling depth m
Beeker sampler with extension rods	Length: 2 m to 6 m Internal diameter of tube: 63 mm	5 to 15	up to 2
Beeker sampler in a frame	Height: 1,80 m Base: 2,00 m Internal diameter of tube: 63 mm	50 to 100	up to 2

D.2 Application

The Beeker sampler is suitable for physical, chemical and limited biological investigations.

The use of a transparent tube allows a description of the sample to be made, for a limited morphological investigation. The PVC tube can, if desired, be replaced by a thin-walled stainless steel tube when a chemical investigation is being carried out in order to avoid interference by the plastics and associated materials. The Beeker sampler can be used with extension rods from the bank or from a vessel. Sampling in this manner is difficult at water depths greater than 3 m.

The Beeker sampler in the frame requires the use of a lift or davit with a lifting capacity of 150 kg. When working from a vessel, the deck space has to be big enough for the frame, an equilateral triangle of sides 2 m, and the lift height sufficient for a frame 1,80 m high.

D.3 Type of bed

The sampler is suitable for unconsolidated and consolidated silt beds.

D.4 Accuracy of sample

It is possible to obtain an almost undisturbed sample by using the piston and, at greater depths, the frame as well.

D.5 Nautical conditions

When working with extension rods, any vessel has to be stationary in calm conditions. Due to its light weight, the Beeker sampler in a frame is affected by currents, particularly at great depth, and cannot be used where the current speed is greater than 50 cm/s.

The vessel has to remain stationary so that the lift remains above the sampling position, otherwise the core tube could break when it is raised. Too much wave movement makes it difficult to collect an undisturbed sample and could make working from a vessel dangerous. The Beeker sampler is thus best suited for inland or very shallow waters.

D.6 Sediment conditions

The Beeker sampler with extension rods is suitable for soft sediment beds. Due to the vessel movement, it is difficult to sample a top layer without disturbance at water depths of 3 m. The Beeker sampler in the frame can be used at much greater depths. By using an echo-sounder attached to a guide box, a controlled sample of the top layer can also be obtained. It does not sink into soft beds due to its large bottom plate and the relatively light weight of the frame. The piston, which is attached to the frame, can then reduce pressure in the tube at the same time as this penetrates the bed. The Beeker sampler is less suitable for sand beds.

D.7 Methods of operation

D.7.1 Use of the Beeker sampler with extension rods

The sample tube is clamped between the sample tube holder and the cutter head. The depth of water at the sample location is determined and the required number of extension rods fixed to the core tube. The rubber gland in the cutter head is evacuated so that it lies against the inside of the cutter head. The core tube is lowered to just above the sediment. The piston in the core is arranged so that, when the tube is pushed into the sediment bed, the pressure in the tube is reduced. The sample can now enter the tube easily.

When the tube has reached the required depth, the rubber gland in the cutter head is inflated so that the sample cannot slide out of the tube. The Beeker sampler is then withdrawn. The sample tube is then removed and sealed underneath with a stopper. The top is already sealed by the piston. The sample is now ready for transport or further treatment.

D.7.2 Use of the Beeker sampler in a frame

The frame is set up to the required height for the length of sample tube to be used. The echo-sounder (if available) is mounted onto the guide box. The sample tube is clamped between the cutter head and the sample tube holder and fixed to the guide box in the frame. The piston at the bottom of the tube is fixed to the frame with a steel wire. A pump is used to evacuate the rubber gland so that it lies against the inside of the cutter head. The frame is lowered into the water, to just above the bottom, with the help of the echo-sounder. The sampler is set on the bed gently and the line let out further so that the core tube penetrates the bed.

The piston attached to the frame causes reduced pressure in the tube so that the sample slides into it easily. The tube is pushed into the bed because the guide box is weighted in accordance with how deep the penetration is to be. It is also possible to attach a vibration motor inside the guide box to use vibrations to lessen the tendency of the sediment to stick to the tube, thus making it easier to push in the core tube. The echo-sounder may be used to determine the penetration depth.

When the tube has reached the required depth, the rubber gland in the cutter head is inflated so that the sample cannot slide out of the tube. The Beeker sampler is then raised. The core tube is removed from the guide box. The sample tube is then removed and sealed underneath with a stopper. The top is already sealed by the piston. The sample is now ready for transport or further treatment.

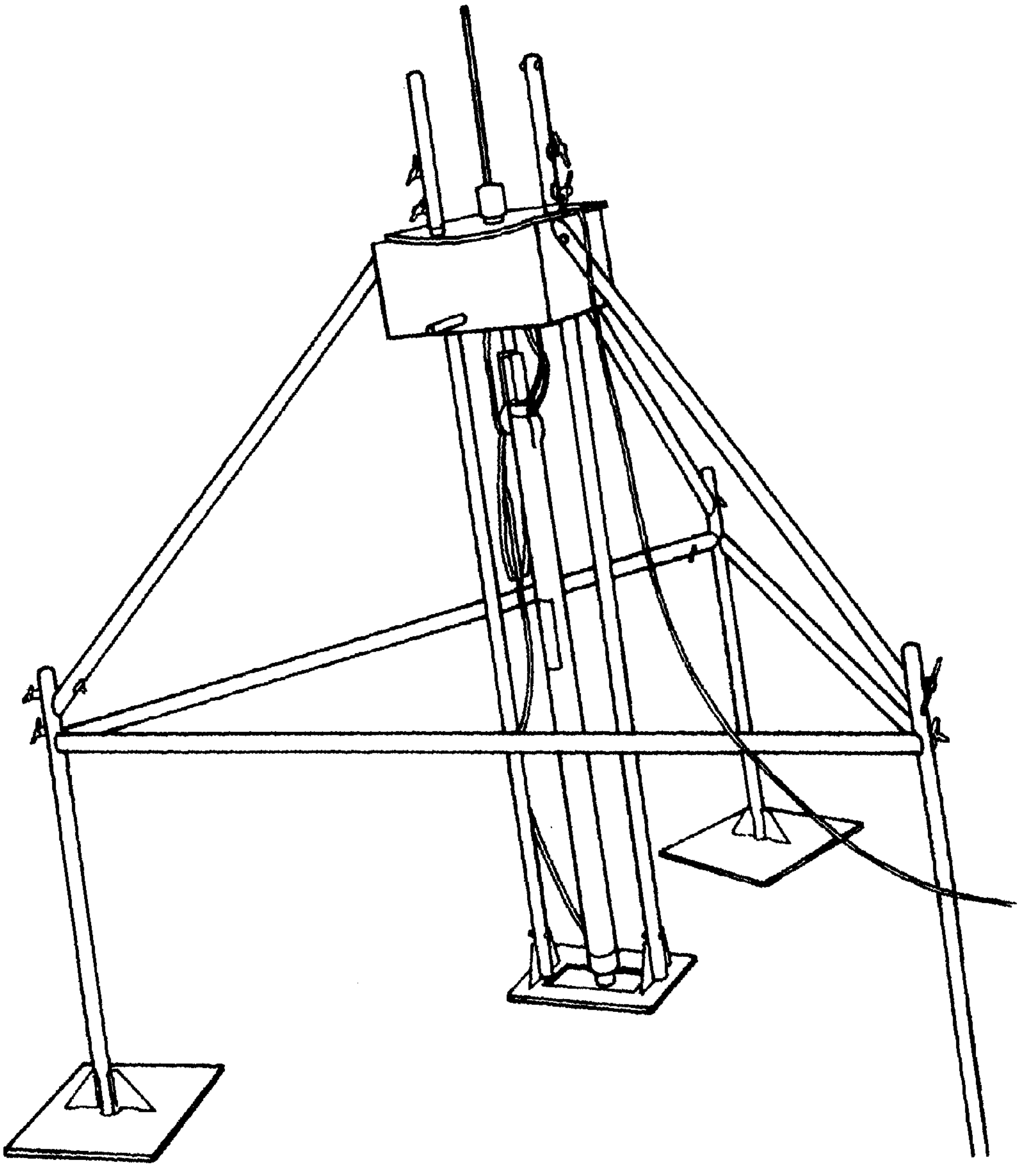

Figure D.1 — Beeker sampler

Annex E
(informative)

Description of the sealed core sampler system

E.1 Apparatus (see figure E.1)

The sampler consists of a stainless steel tube with a perspex liner. The top and bottom of the core tube can be shut off with a rubber bellows so that the sample cannot fall out and also cannot be disturbed at the top.

The core tube is pushed into the bed by means of rods; the rubber bellows are opened and closed by inflating or deflating with a manually operated pump. There is only one type in use, its dimensions are as follows:

Length:	700 mm
Diameter:	nominally 58 mm, but may vary
Mass:	approximately 15 kg
Penetration:	600 mm

E.2 Method of operation

The depth of water at the sampling position should be determined and the appropriate number of rods fitted. The tube is lowered to the bed with the rubber bellows at the top and bottom evacuated. After the desired or maximum possible penetration has been achieved, the rubber bellows are inflated, shutting off the core tube at the top and bottom. It is then withdrawn. The cutter head containing the rubber bellows is removed, allowing the perspex liner containing the sediment to be taken out of the core tube.

The sediment is extruded from the top, allowing the sample to be analysed layer by layer from the top.

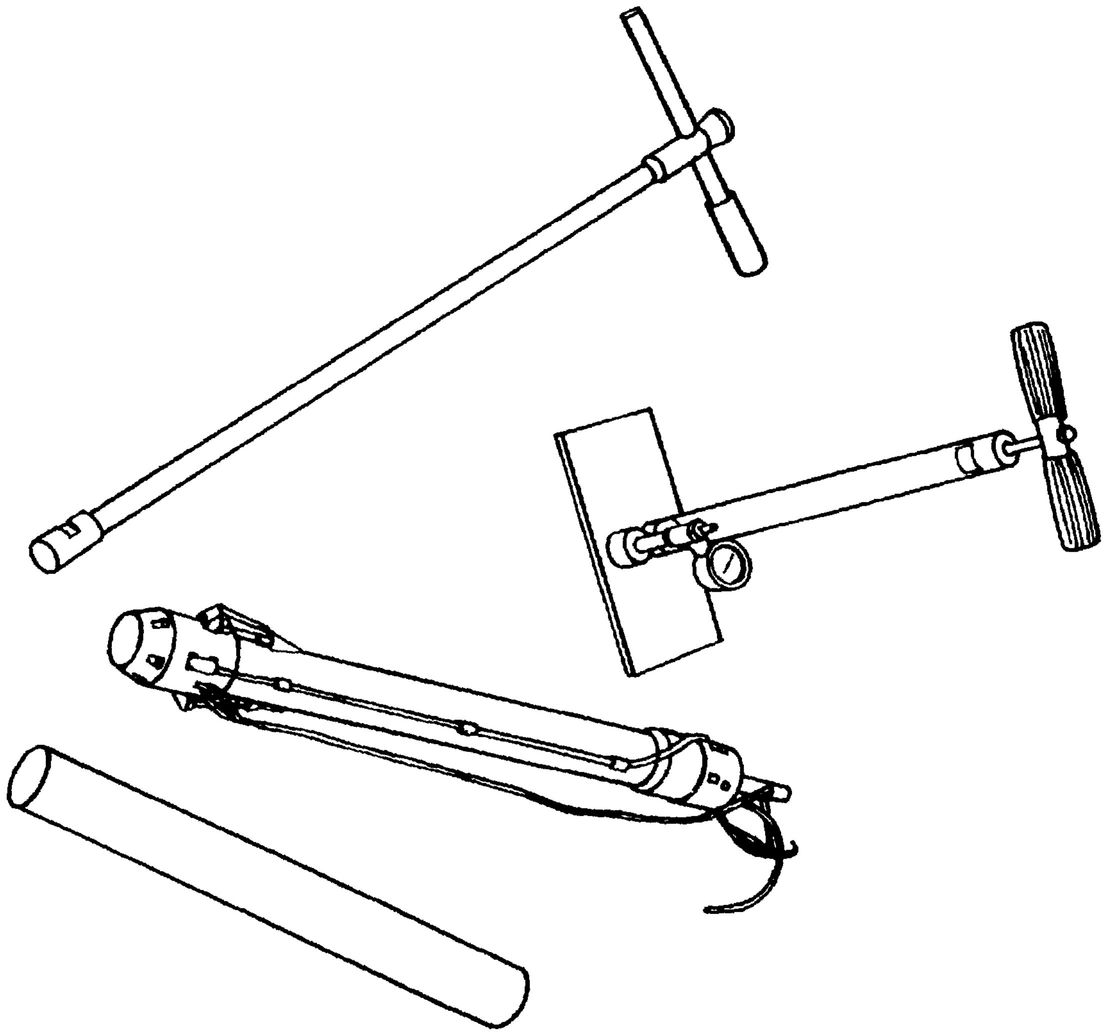

Figure E.1 — Sealed core sampler

Annex F
(informative)

Description of the wedge core or Vrijwit drill system

F.1 Apparatus (see figure F.1)

The Vrijwit drill is a wedge-shaped, stainless steel core tube. The tube can be opened on one side with a slider. The opened drill is pushed into the bed by means of extension rods. Because one side of the wedge remains open when it is pushed into the sediment, there is a little friction on the surrounding material, thus reducing the tendency of compaction when collecting the sample. When the desired penetration depth has been reached, the Vrijwit drill is shut off with the slider. This can be removed after the tube has been raised, allowing the sample to be taken out. There are a variety of types in use with penetration depths up to 1,5 m.

F.2 Method of operation

The water depth at the sampling position should be determined and the required number of extension rods attached to the core tube. The tube is then pushed into the bed to the required depth and the slider is pushed down with extension rods so that the sample is enclosed in the wedge. The drill is raised and laid horizontally on a receiving tray. The slider is removed and the sample is available for a description and subsampling, as required.

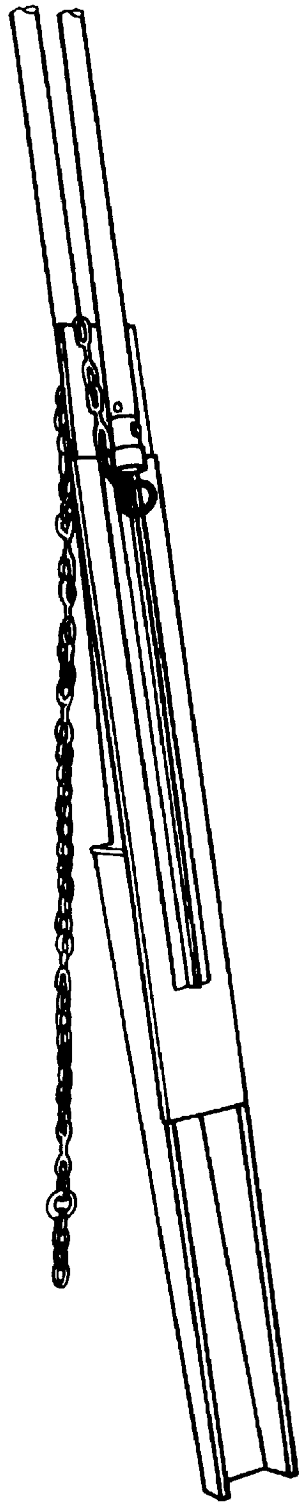

Figure F.1 — Vrijwit Drill

Annex G
(informative)

Description of the falling bomb system

G.1 Apparatus (see figure G.1)

The falling bomb consists of a graduated perspex sample tube fitted in a weighted tube holder which is dropped in free fall from a davit on a vessel. Due to its own weight and speed, the sample tube penetrates the bed. The apparatus is then withdrawn and a rubber ball shuts off the tube from above. Formation of a vacuum in ascent prevents material from falling out of the bottom. Once the tube is above the water level, the vacuum is released by raising the rubber ball slightly and the sample can be collected in an appropriate container after first siphoning off water held above the sediment.

There are various types which differ largely in the length and diameter of the core tube as well as their total weight.

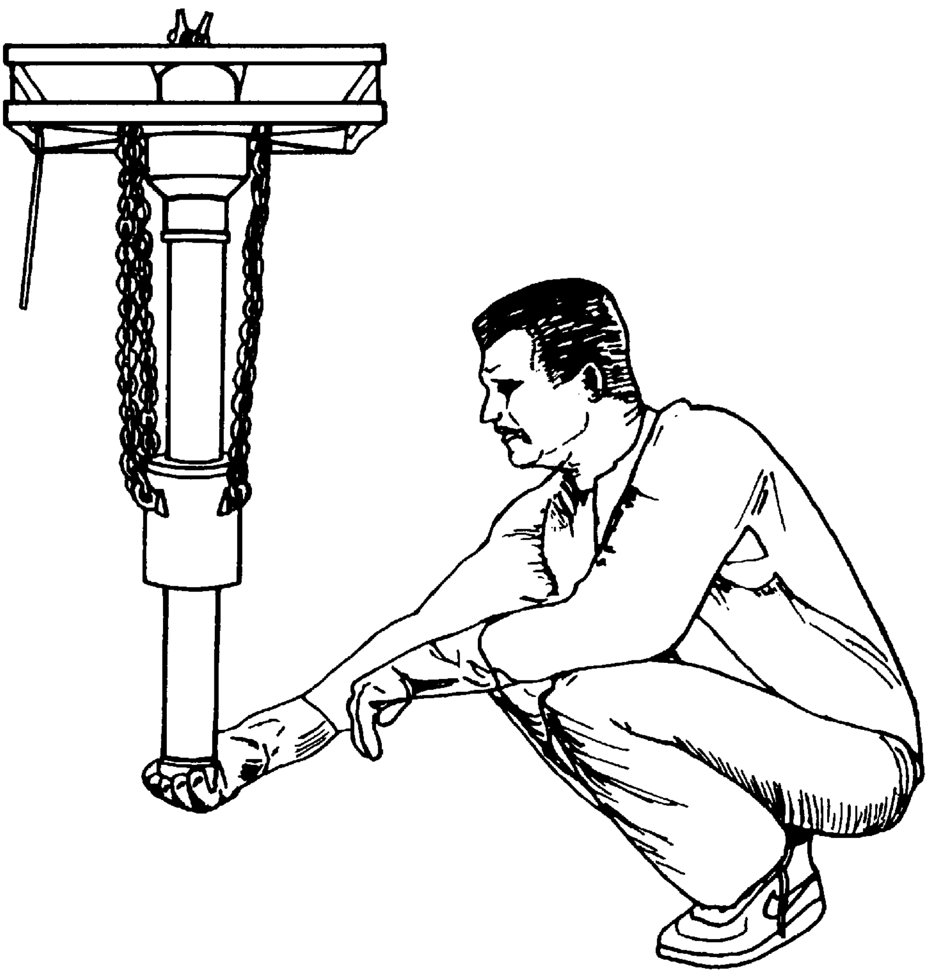

Figure G.1 — Falling bomb

G.2 Application

The falling bomb can be used for physical, chemical, and limited biological investigations in the top layer of the sediment.

G.3 Type of sediment bed

To make the best use of the falling bomb, the sediment bed should ideally consist of a mixture of sand and silt, possibly with some organic matter. Due to its limited penetration, the falling bomb is not suitable for coarse, sandy or gravel beds or hard sand beds. Where the sediment bed is not properly consolidated, problems with interpretation of the results can arise because of disturbance of the top layer on impact.

G.4 Accuracy of sampling

With the exception of very soft beds, sampling with minimal disturbance of the layer structure is possible. It should be noted that penetration of the bed is not always equal to the length of the sample in the core tube, due to compression and angle of attack.

G.5 Operation

The vessel has to be fitted with a davit and preferably a free-fall winch. It is also possible to work manually but a pulley system for lifting will be a minimal requirement. Only a small working space on deck is required for the falling bomb and its sample tubes.

G.6 Nautical conditions

The falling bomb can be used for sampling sediment layers with a penetration depth up to 2 m in areas where the depth of water is 3 m. Where the difficulty of holding the vessel stationary makes the use of other systems difficult, this technique can prove a useful alternative.

G.7 Method of operation

The falling bomb is held in a davit and allowed to fall freely into the sediment bed. It is then raised at once and brought back on deck. Whilst this is done, it may be necessary for someone to hold their hand underneath the tube to prevent the sample from dropping out.

Next, the water above the sample can be sucked with a small pump or syphoned away, **taking into account relevant safety precautions**. This has to be done very carefully, particularly if the water is very turbid, to prevent solids being removed. In such cases, it is recommended to wait until the solids have settled and that a consistent procedure be adopted.

The layer strata of the sample in the perspex core tube can then be described prior to subsampling and any further treatment.

Annex H
(informative)

Description of the Jenkins mud sampler system

H.1 Apparatus (see figure H.1)

The Jenkins mud sampler consists of a metal stand supporting a sample tube. The sample tube can be shut off at both ends by valves. The valves and their closing mechanism are made from aluminium whilst the stand is steel. The valves are covered with rubber to ensure that a proper seal is made. The sample tube is 50 cm long and made from perspex. The stand is in the form of a pyramid, of base 70 cm and height 90 cm. The total mass is 15 kg. The frame and core tube penetrate into the sediment due to their weight.

H.2 Operation

Due to its relatively light weight, the apparatus can be operated manually or with a davit from the bank or vessel. Only a small working space on deck is necessary for operating this apparatus.

H.3 Nautical conditions

When working from a vessel, the conditions have to be calm to ensure that the samples are undisturbed and that the work can be carried out safely.

H.4 Method of operation

A tube together with the valves is mounted in the frame. The valves are locked open mechanically and fixed by springs. The water depth is determined and the sampler set carefully on the water bed. The core tube penetrates into the bed due to its weight. When the line is slackened sufficiently, the valves are gently closed by means of the mechanical arms which are operated by a hydraulic "brake" cylinder. The sample can now be recovered for transport or treatment.

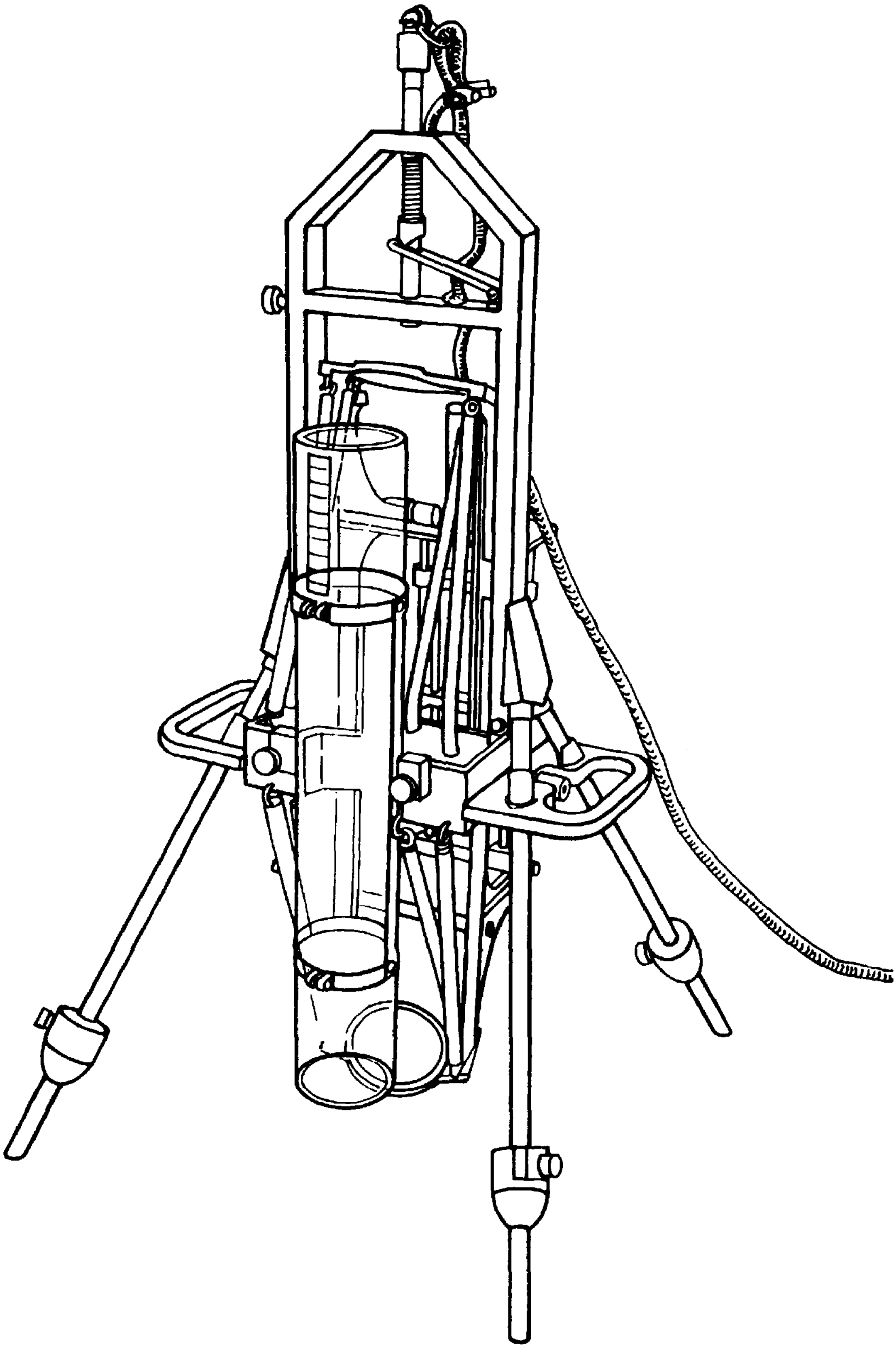

Figure H.1 — Jenkins mud sampler

Annex J
(informative)

Description of the Craib corer system

J.1 Apparatus (see figure J.1)

The Craib corer consists of a corer which is free to move within a frame and has exchangeable, plastics core tubes. The corer is made from brass and the frame is galvanized.

J.2 Application

The Craib corer can be used for physical, chemical and limited biological investigations. Its only limitations are the diameter and length of the samples. The top layer remains undisturbed. A davit with a minimum lifting capacity of 150 kg is necessary.

NOTE 4 Brass fittings may contribute to contamination of the samples by copper and zinc.

J.3 Nautical conditions

It is not advisable to work with a Craib corer from the deck of a tossing vessel. Not only is it unsafe but it is also not possible to control the placing of the apparatus on the sediment bed. If the current is strong the Craib corer will hang crookedly. Therefore, lowering to the sediment bed has to be done carefully and it may be necessary to choose an alternative sampling location.

J.4 Sediment bed conditions

The Craib corer does not work well on a very soft bed as the frame also penetrates it. Modifications to the frame can prevent this to some extent. There is little penetration of the frame into hard beds.

J.5 Method of operation

Once the corer has been prepared, the piston in the hydraulic damper is at the highest point of its stroke and the core tube is about 15 cm above the base level of the frame. The ball for closing the bottom is held against the side of the core tube, about 5 cm from the bottom, by an automatic catch. This ball is mounted on the end of a freely moving vertical rod. The spherical-shaped shutting valve is also kept open by an automatic catch. It is necessary to fill the piston with water before the first sample is taken. This is easily done by taking a preliminary test sample. When the corer is raised the piston fills with water.

When the apparatus has been lowered, the frame rests on the sediment bed. The lifting cable should have some slack to prevent movement of the vessel from affecting the corer.

The weighted core tube holder then sinks slowly down, dampened by the hydraulic piston and is pushed into the sediment. This takes about 30 s. When the tube has penetrated 5 cm, both locking catches are released. The spherical top valve closes the top of the core tube but allows water to escape. The ball now lies on the bed next to the core tube. When the corer is withdrawn, the weight of the rod holds the ball on the bed. As the core tube comes out, two rubber bands pull the ball under the tube, thus closing it.

Whilst the core tube is being pulled out of the sediment, the top valve causes reduced pressure in the core tube. As the apparatus is being raised the hydraulic piston refills with water.

The core tube is removed from the holder while the apparatus hangs in the davit alongside the vessel. In order to do this, the ball must be pushed to one side and the bottom of the tube shut off with a stopper. Water can be run out of the holder by opening a tap situated level with the top of the core tube. The ring holding the tube in the holder can then be loosened and the tube, containing the sample plus a little water on the top, can be removed from the holder. The locking catches are then reset for taking a new sample.

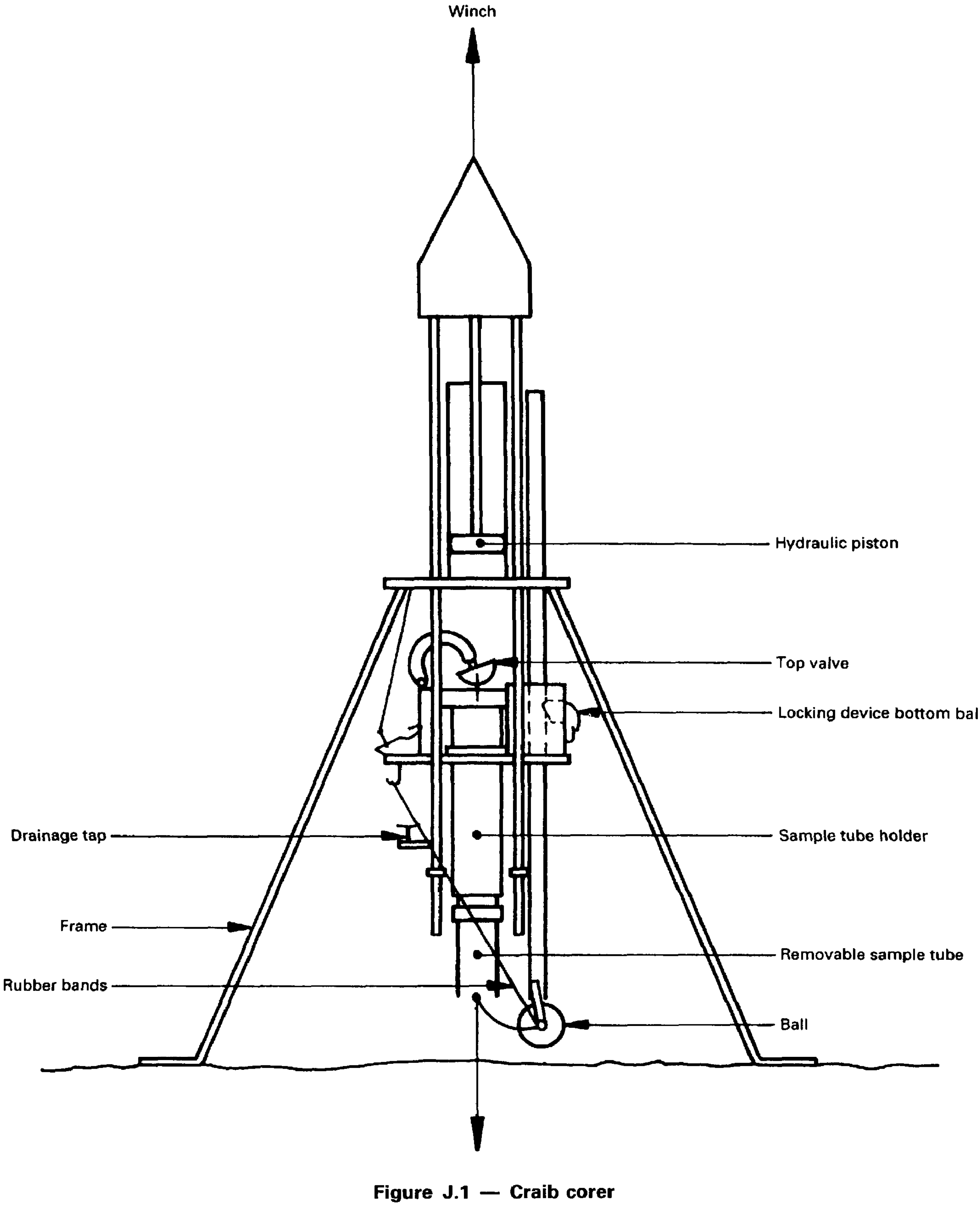

Figure J.1 — Craib corer

Annex K
(informative)

Description of a piston corer

K.1 Apparatus (see figure K.1)

The piston corer consists of a core tube weighted at the top and possibly with added vanes for extra stability. The method relies on free fall commencing at a predetermined height above the bed. There is a piston in the core tube which can be fixed at a constant height above the bed during the sampling. A second tube can be enclosed in the core tube, allowing tube and sample to be removed together. The core tube can be made of various metals with lead weights attached and the inner tube can be of metal or plastics.

K.2 Types in use

The diameter, mass and length of the core tube can be varied according to requirements. The free-fall mechanism of piston corers is generally activated by a trigger weight touching the bed. This can cause problems where the bed is very soft or has a thick drifting layer. There are also models available where the free-fall mechanism is activated by a photocell. The mechanism is activated as soon as the photocell registers a change from water to drifting layer.

K.3 Application

The piston can be used for physical and chemical investigations of the topmost layer of the sediment bed.

K.4 Type of sediment bed

The piston corer is not suitable for beds consisting of hard sand or stones. It can be used effectively for the other types.

K.5 Accuracy of sample

The risk of pile-working is limited because a piston is used. Apart from the sides, the sample is practically undisturbed.

K.6 Operation

Operation is simple and can be carried out from a vessel. The smaller version can even be used from a bridge or quay. Since the core tube can be lifted over the rail of a vessel horizontally, no davit is required.

K.7 Nautical conditions

It is not advisable to work with this apparatus from a tossing vessel but, once the corer is in the water, the movement of the vessel has little effect on the quality of the sample, since once free fall has started the corer goes its own way. Due to the self-righting characteristics of the corer, currents have little effect on it. The piston corer is used for sampling beds in areas where the use of other sampling techniques causes problems, i.e. where the water is too deep and/or it is difficult to hold the vessel stationary due to currents or the wind. The piston corer can be used on sandy or silt beds.

K.8 Method of operation

The piston corer consists of three main parts: the core tube, the core tube holder and the "no-load" mechanism. The "no-load" mechanism is fixed to the operating cable. The core tube is fitted to one side of this and the counterweight to the other. This counterweight is suspended on a chain of adjustable length attached to a lever. The length of this chain minus the length of the core tube and weight determines the free-fall height. As soon as the counterweight touches the bottom whilst the apparatus is being lowered, the lever goes up and the core tube slides off and falls to the bed. The length of sample depends on the free-fall speed, resistance of the sediment and the diameter of the core tube.

In order to prevent pile-working, a piston can be fitted inside the core tube. This is attached to the "no-load" mechanism via a cable passing through the tube. This line should be a little shorter than the counterweight chain. In this way, the piston remains just above the bed level.

It is possible to include fittings on the inside of the penetration head to prevent the sample from dropping out or being washed out, but this will depend on the manufacturer.

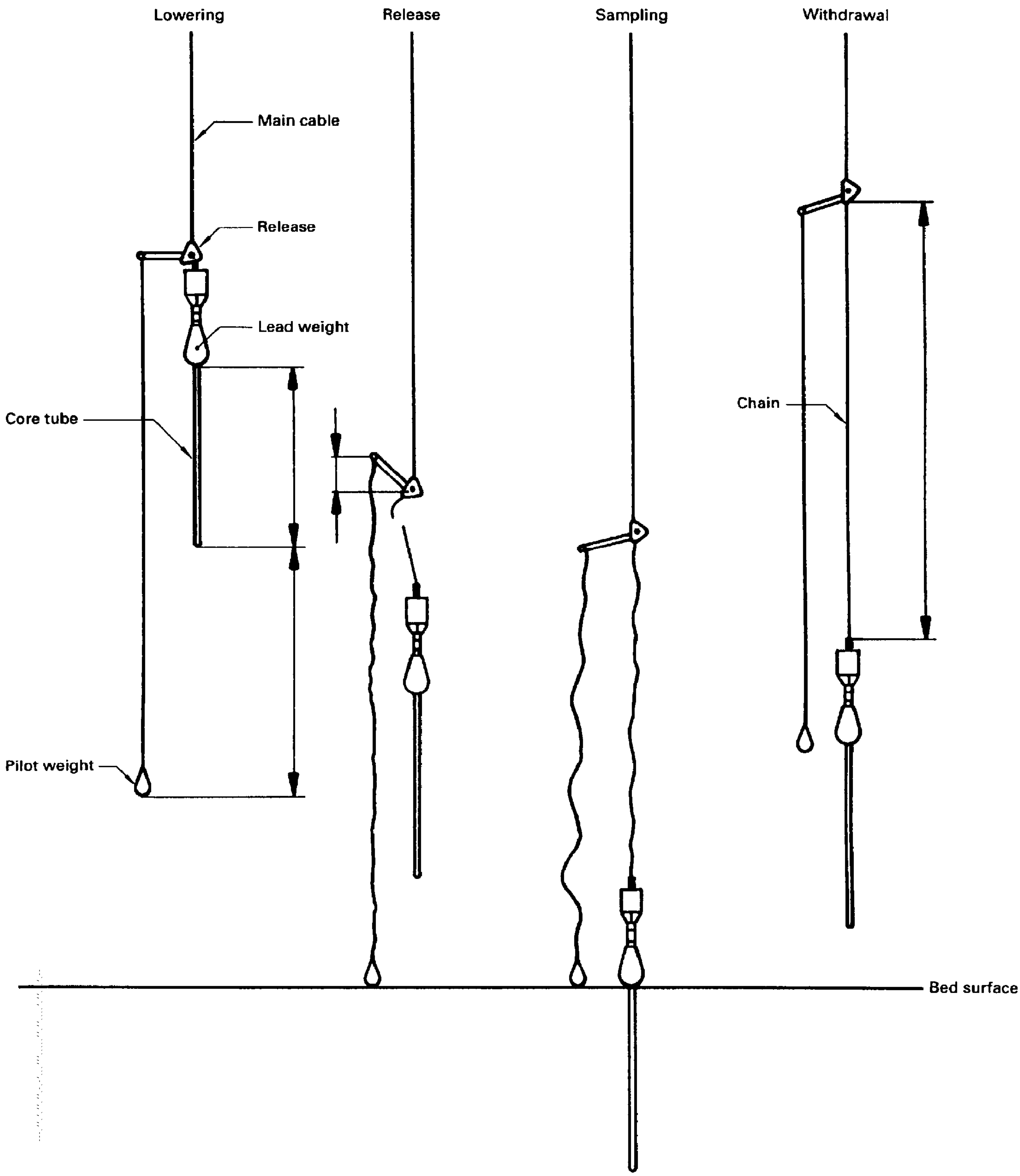

Figure K.1 — Piston corer

Annex L
(informative)

Description of peat borers

L.1 Description of the Peat Institute peat drill model 1

The main working piece of the Peat Institute drill (later referred to as the P.I. drill) is its container which is made up of a part with cutting edge "scoop", a core and a penetrating blade. The scoop has the shape of a hollow semicylinder tapering at both ends into truncated cones. Both edges of the scoop are sharp and function as cutters. The container's capacity is 150 cm^3.

When in operation, the P.I. drill is inserted forcibly into the deposit, with its container closed, to a depth of 30 cm shorter than the depth from which the peat sample is to be taken. As the drill sinks deeper, successive rod sections are fastened on, but never more than two of them at the same time. After the drill reaches the required depth within the deposit (30 cm shorter than the depth from which the peat sample is to be taken), the container is forced open by turning the handle 180° clockwise. It is then pushed deeper down to the depth from which the sample is to be taken. An anticlockwise 180° turn of the handle closes the container. Having performed a semicircular movement, the "scoop" adheres closely to a comb on the core, slicing a peat sample from the deposit without disturbing its structure. The peat-filled drill is pulled up from the deposit.

L.2 Peat Institute drill (year 1939 model)

The container of the new model of the P.I. drill also consists of a scoop and a core, the difference being that the core is fitted with a lateral fin instead of a blade to prevent turning of the container core in the deposit (see figure L.1). The capacity of the container is 76,5 cm^3. Operation of the drill is the same as in the case of the P.I. drill model 1.

During the taking of peat samples, the smaller capacity of the 1939 drill model container is a disadvantage. In most cases, large peat samples are needed and so the drill has to be reinserted into the deposit several times.

L.3 Sounding-rod drill

The container consists of two hollow cylinders. The inner cylinder, which has about a third (its width) of its circumference removed lengthwise, fits closely into the outer cylinder. The wall of the outer cylinder is slit lengthwise and bent away at an angle of 45°. This bent-out wall is sharpened like a knife. The outer cylinder rotates round the internal one by less than a full circle. When the container is open, the openings in both cylinders are aligned. When it is closed, the opening in the internal cylinder is covered by the wall of the outer one. At its lower end, the container is fitted with a drill; its upper end is connected with a rod. The container of the sounding-rod drill, like the container of the P.I. drill, comes with a set of rod sections, a handle, a key and spare couplings.

There are two sounding-rod drills: large and small. The dimensions and masses of both are given in table L.1 for comparison:

Table L.1 — Dimensions and masses of large and small drills

Drill	Length of individual rods m	Container capacity cm^3	Mass of drill with a full set of rods kg
Large	1,5	140	13,2
Small	1,0	90	4,2

It is recommended to use the lightweight, easily transportable, small sounding-rod drill during reconnaissance sounding of peat deposits, when a team of workmen has to cover large distances during one workday. The additional advantage of this drill model is the small diameter of its container, which is more or less easily inserted through mineral layers overlying the peat deposit.

The advantage of the P.I. drill is that it is the only drill suitable for taking peat samples with undisturbed structure and natural moisture content, and as such should be used when determining moisture content. Its disadvantage is that, with a relatively large container diameter, it requires the application of somewhat more force when it is pushed down into the deposit (especially when the deposit is highly compacted). Because of this, it may not always be used for taking samples from the substrate.

The P.I. drill model from 1939 is more convenient for stratigraphic studies.

Dimensions in millimetres

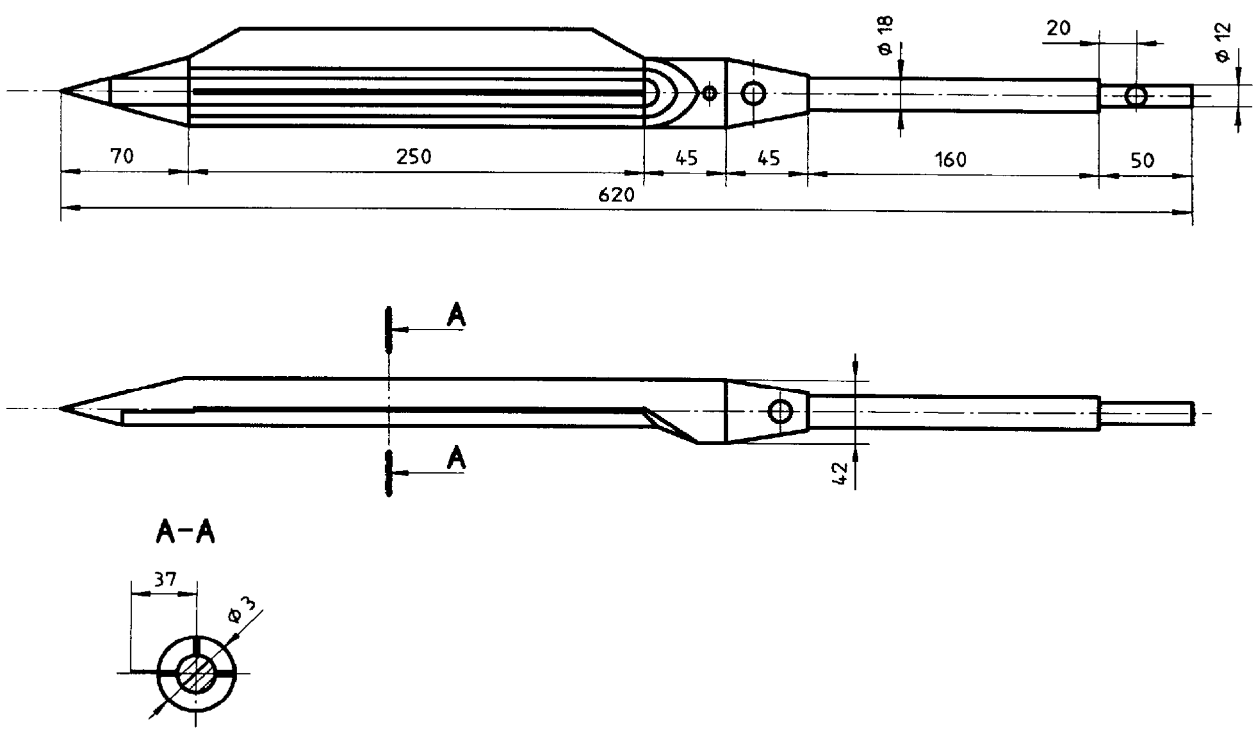

Figure L.1 — Peat Institute drill

Annex M
(informative)

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Descriptors: water, quality, sediments, sampling, sampling equipment, samplers, general conditions.

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