INTERNATIONAL STANDARD

ISO 5667-19

First edition
2004-06-01

Water quality — Sampling —

Part 19: Guidance on sampling of marine sediments

Qualité de l'eau — Échantillonnage —
Partie 19: Lignes directrices pour l'échantillonnage des sédiments en milieu marin

Reference number
ISO 5667-19:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5667-19 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 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 sludges from sewage and water-treatment works*

— *Part 14: Guidance on quality assurance of environmental water sampling and handling*

— *Part 15: Guidance on preservation and handling of sludge and sediment samples*

— *Part 16: Guidance on biotesting of samples*

— *Part 17: Guidance on sampling of suspended sediments*

— *Part 18: Guidance on sampling of groundwater at contaminated sites*

— *Part 19: Guidance on sampling of marine sediments*

Introduction

Analysis of marine sediments plays a major role in monitoring of the aquatic environment and providing information on the status and development of polluted conditions in sediments because of ability of sediments to accumulate contaminants. Marine sediments are characterized by a wide range of organic content, mineralogy and texture.

In ideal sedimentary conditions, i.e. in accumulation areas (deep basins, trenches, etc.), the sediment is deposited in chronological order, such that changes in the deposition of, for example, contaminants can be related to an identifiable time period. However, monitoring of marine bottom sediments, involving both qualitative and quantitative analyses of contaminants, is carried out world-wide in the absence of a common set of procedures and this International Standard is part of an attempt to remedy this situation.

Water quality — Sampling —

Part 19: Guidance on sampling of marine sediments

1 Scope

This part of ISO 5667 provides guidance for the sampling of sediments in marine areas for analyses of their physical and chemical properties for monitoring purposes and environmental assessments. It encompasses:

— sampling strategy;

— sampling devices;

— observations made and information obtained during sampling;

— handling sediment samples;

— packaging and storage of sediment samples.

This part of ISO 5667 does not provide guidelines for data treatment and analysis which are available from other references (see the Bibliography).

This part of ISO 5667 is not intended to give guidance for sampling of freshwater sediments.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6107 (all parts), *Water quality — Vocabulary*

3 Terms and definitions

For the purpose of this document, the terms and definitions in ISO 6107 (all parts) and the following apply.

3.1
acoustic survey
mapping of bottom topography and sediment stratigraphy by use of sound waves

3.2
baseline survey
survey with emphasis on classification and description of conditions in the survey area, which provides the basis for future monitoring and/or follow-up surveys

3.3
contaminant
compound or element which, at concentrations above background, are considered to be harmful to the environment

3.4
receiving water body
recipient
recipient water body
water body which receives an input of material of either natural or anthropogenic origin

NOTE The term often appears in the context of contamination by, for example, effluent from municipal wastewater outlets or industrial processed water. Receiving water body surveys describe the state of contamination in a given area.

3.5
reference point
sampling point chosen to represent the natural environmental conditions in a given area

3.6
replicate samples
series of samples taken simultaneously at the same sampling point in the same manner

3.7
sub-sample
representative portion removed from a sample

4 Strategies and objectives for sediment sampling

4.1 Sampling programme and plan

Developing an appropriate sampling plan is one of the most critical steps in monitoring and assessment studies. The sampling programme is designed in accordance with the individual survey aims and specific data quality objectives to be achieved. The elements in the sampling strategy include definition of the study area, the choice of methodology and survey type, location of sampling points and the number of sampling points required. These will be built into a sampling programme taking account of requirements such as seasons, discharge patterns, etc.

The required precision of results, local sediment substrate variability, topographical and hydrographical conditions in the survey area, information on local contamination sources and knowledge from previous surveys (if any) should all be taken into account. The number of sampling points, their locations and number of replicate samples to be taken at each sampling point should be established prior to the initiation of the survey, but appropriate adjustments may be made in the field, particularly in the case of pilot surveys. It is important to harmonize the design of the trend surveys to the statistical power required of the data, i.e. over what time scale change is to be measured. In statistical terms, the two sources of variability are sampling error and measurement error.

See ISO 5667-1 for further information on design of sampling programmes.

4.2 Types of surveys

4.2.1 General

Surveys of sediments may be divided into three main categories according to the objectives and required precision of results. The strategies related to these categories are summarized in Table 1.

Table 1 — Strategies for different types of sediment surveys

Survey	Strategies
Pilot survey	Reconnaissance, few randomly placed samples
Baseline survey	Impact assessment, grid or gradient sampling
Temporal trend survey	Time changes, repeated sampling of surface sediments along gradients or sediment cores

4.2.2 Pilot and/or reconnaissance survey

This is an initial assessment of physical and chemical conditions in the bottom sediments in an area where the contamination source is not known or where there are no existing data pertaining to the receiving water body. The survey allows a coarse assessment of environmental conditions and can provide the basis for development of a sampling programme for other surveys as well as long-term surveillance. The requirements for equipment, sampling methodology and reproducibility are usually relatively simple (see Table 2).

A pilot survey generally requires only a few, randomly placed samples in an area deemed to be a sediment deposition area. If the objective is to describe the conditions on the seabed, a series of samples should be required, in both deep and shallow water. The sampling area should cover as much of the survey area as possible, ideally in the form of sampling points placed in a grid. An acoustic survey of the bottom sediments should be performed prior to the sediment sampling. Sediment sampling will in any case be required to confirm the acoustic data. In regions with varying sea floor topography and open to wind and currents, an acoustic survey or a remote operated vehicle (ROV) reconnaissance, is the only means of determining the uniformity of sediment deposition. Uneven distribution occurs both in areas of coarse and fine sediment deposition.

4.2.3 Baseline survey and/or environmental impact assessment

This is a survey carried out where the contamination source is known, and the aim is to describe the spatial extent of the zone of contaminant influence (potential biological impact). Such surveys may be carried out using relatively simple methodology, but there usually are specified requirements for the methodology and procedures to be used.

For describing the spatial extent of sediment contamination around a known point source, the sampling points should be placed in a grid or along a gradient of expected contamination. Information on the current regime should be used to guide the survey grid and can sometimes be anticipated from acoustic and/or hydrographic data. An acoustic survey of the bottom sediments should be performed prior to the sediment sampling as well as obtaining information on the hydrographic regime. A contour map should be constructed to indicate the spatial extent of sediment contamination, requiring a large number of sampling points. At the same time, the investigation also provides information on how the concentrations in the sediments decrease with distance from the source. The results can also be used to quantify the total amount of contaminants in the upper sediment layer.

An environmental assessment should be carried out at locations where changes in environmental conditions are to be expected, for example in polluted water bodies or at places where activities that can affect the environment are established. This environmental assessment should be based on a detailed chemical and physical investigation of the sediments. The investigation provides the basis for characterization of the environmental conditions in the areas in question, according to specified sediment quality criteria and by comparison with the sediments in reference areas. Thereafter, follow-up monitoring surveys should be carried out, their frequency depending upon the particular circumstances.

4.2.4 Temporal trend survey

This is a survey of the temporal changes in the chemical and/or physical conditions in the sediments to document either contamination or natural variation over time. The surveys should be carried out using fixed sampling points and using standardized methodology according to an established programme.

All sampling equipment and procedures should be documented and any field observations and measurements recorded on an appropriate field sheet/log book. This will facilitate future surveys for the purpose of temporal trend monitoring.

It is important that the statistical power of the sampling is robust and suited to the requirements of the study.

A trend monitoring investigation follows temporal development of contamination in the receiving water and may be carried out in one of the following two ways.

a) Surface samples should be taken within a set radius of the reference point according to the aims and objectives of the survey. Once set, the radius should be adhered to for future surveys within the time series. This requires accurate positioning, for example using a differential global positioning system (DGPS). Sampling frequency will be determined by a variety of factors including the rate of sediment deposition in the area, seasonality and flushing rates.

   EXAMPLE For an annual sediment deposition rate of 2 mm, sampling could for practical reasons be carried out every 5 years (1 cm depth). However, the relevance of sampling at 5-year intervals is highly dependent on the number of samples taken and the statistical power required to establish trends.

b) Analyses should be carried out on several layers from undisturbed sediment cores. The depth and intensity of bioturbation (caused by physical disturbance of sediments by animals and gas bubbles) should be taken into account. If the monitoring is to be based on cores, the samples should normally be taken along a transect of maximum depth ("deep-spots") where experience indicates that the sediments are the least disturbed. However, the suitability of the sampling area should preferably be checked by doing an acoustic survey. The deepest parts of channel-type formations are not necessarily the best sampling areas.

   EXAMPLE Use of sediment cores in temporal trend monitoring requires data on sedimentation rates (e.g. achieved by isotope dating of cores). The depth resolution of the sediment sub-sampling will depend on the sediment accumulation rates. Vertical sampling should take place down to a depth corresponding to non-contaminated sediments if possible.

Sediments that are physically disturbed by human activities (e.g. trawling) are generally not suitable for retrospective trend monitoring purposes.

4.3 Sampling strategy and/or design

4.3.1 General

Sampling points should be positioned according to the individual survey objectives, previous surveys in the area and local sediment type and hydrographic conditions.

Shallow areas with uneven topography generally provide poor material for sampling (fine-grained sediments are transported or eroded due to waves or currents). Deep areas (basins) and flat bottoms are typical accumulation areas, where fine-grained sediments potentially carrying contaminants are deposited (no wave activity and weak currents). Coarse, sandy sediments should be avoided for contamination studies as these are poorly suited as a sampling medium, although they may be studied as part of wider investigations, for example for benthic biology.

The number of replicate samples to be taken per sampling point should be chosen with care. A statistical assessment should be made of the number of replicates required, in accordance with the survey parameters and the required density of sampling points. Depending upon the outcome of the statistical assessment, at

least three separate replicate samples may be required to be taken from each sampling point and analysed separately to assess the extent of variation at the sampling point concerned.

Where it is suspected that contaminated sediments may have an uneven distribution, many replicate samples may be necessary to ensure a representative picture. This is particularly important close to contamination sources, in harbour areas and in shallow waters or other areas where the nature of the bottom sediments shows considerable variation across a relatively small area. If analyses of replicate samples are not possible, a composite sample should be made of all the replicate samples taken at the sampling point. In the latter case, an equal aliquot of sediment should be taken from each sample and homogenized prior to analysis.

The spatial extent of contamination may be mapped by placing sampling points in several ways. Positioning of sampling stations should be carried out according to one of three main principles or in combination:

— random;

— grid;

— gradient.

4.3.2 Random sampling (probabilistic based)

A pre-determined number of samples should be collected. Random sampling designs avoid bias in the results of sampling by randomly assigning and selecting sampling locations. This sampling strategy is relevant for pilot surveys and, to some extent, baseline surveys.

4.3.3 Grid sampling

In grid sampling the first sampling location is chosen randomly and all subsequent stations are placed at regular intervals (e.g. 50 m apart) throughout the study area. The station grid should be adjusted according to the topographic and hydrographic conditions in an area. Sampling points arranged in a grid often are used for environmental assessment of sediment quality and for assessing the size of the area of influence, as for baseline surveys.

4.3.4 Gradient sampling

Sampling points should be arranged in sectors or along selected transects in relation to a contamination source. The decrease in concentration of contaminants away from the source will indicate the dispersal pattern of the contaminant. It is essential to consider natural factors which may affect the sediments, such as grain size, content of organic matter, redox conditions, currents, etc. This sampling strategy is particularly applicable for baseline studies and for temporal trend monitoring purposes.

4.4 Reference points

For surveys carried out in contaminated areas, reference points may be established outside the affected area. As far as possible, reference points should represent natural conditions, without any influence of point-source discharges. An alternative to using a reference point is to measure contaminants in layers down the sediment core, which represent sediment deposited during a pre-industrial era.

Sampling at reference points, where applicable, should be carried out under conditions as similar as possible to those at the sampling points (i.e. similar depth and sediment type).