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Water quality — Sampling —

Part 10:
Guidance on sampling of waste water

Qualité de l'eau — Échantillonnage —

Partie 10: Lignes directrices pour l'échantillonnage des eaux résiduaires

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 147, *Water quality*, SC 6, *Sampling (general methods)*.

This second edition cancels and replaces the first edition (ISO 5667-10:1992), which has been technically revised. The main changes compared to the previous edition are as follows:

— integration of radioactive liquid effluent sampling and its specificities;

— integration of qualified spot sampling.

A list of all parts in the ISO 5667 series can be found on the ISO website.

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

Water quality — Sampling —

Part 10: Guidance on sampling of waste water

1 Scope

This document contains details on the sampling of domestic and industrial waste water, i.e. the design of sampling programmes and techniques for the collection of samples. It covers waste water in all its forms, i.e. industrial waste water, radioactive waste water, cooling water, raw and treated domestic waste water.

It deals with various sampling techniques used and the rules to be applied so as to ensure the samples are representative.

Sampling of accidental spillages is not included, although the methods described in certain cases may also be applicable to spillages.

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 5667-1, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes and sampling techniques*

ISO 5667-3, *Water quality — Sampling — Part 3: Preservation and handling of water samples*

ISO 5667-7, *Water quality — Sampling — Part 7: Guidance on sampling of water and steam in boiler plants*

ISO 5667-14, *Water quality — Sampling — Part 14: Guidance on quality assurance and quality control of environmental water sampling and handling*

ISO 5667-16, *Water quality — Sampling — Part 16: Guidance on biotesting of samples*

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

ISO 19458, *Water quality — Sampling for microbiological analysis*

3 Terms and definitions

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

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

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

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

3.1
composite sample
two or more samples or sub-samples, mixed together in appropriately known proportions (either discretely or continuously), from which the average value of a desired characteristic may be obtained

Note 1 to entry: The number of samples or sub samples are usually based on time, flow measurements, area or depth profile sampling.

EXAMPLE Composite sample can be made in different ways:

— constant volume variable time sampling (C.V.V.T): flow proportional sampling based on collecting equal volumes of sample at frequencies proportional to flow.

— constant time variable volume sampling (C.T.V.V): flow proportional sampling based on collecting samples at fixed time intervals but where the volume of sample is varied in proportion to the flow.

— constant time constant volume sampling (C.T.C.V): equal volumes of sample or sub-sample collected at equal increments of time.

3.2
sampling point
precise position within a sampling location from which samples are taken

3.3
spot sample
discrete sample taken randomly (with regard to time and/or location) from a body of water, usually taken manually, but may be taken by automatic sampling equipment or by event-triggered automatic samplers

3.4
qualified spot sample
special form of a *composite sample* (3.1), consisting of at least five spot samples, taken and mixed within a maximum period of two hours and at an interval of not less than two minutes

3.5
radioactive liquid effluent
water or waste water that contains radioactive substances, resulting from a process and that can be recycled, treated and/or discharged to the environment

Note 1 to entry: The activity concentration of the radioactive liquid effluent is usually measured before being discharged in the environment to verify that it is lower than the authorized levels in order to comply with national regulation.

3.6
supernatant
solid or liquid phase present on the surface of an effluent

3.7
planned discharge
discharge subject to prior agreement further to a consultation between several parties based on knowing certain predefined parameters and referring to limit values (regulatory or otherwise)

Note 1 to entry: These parameters may, for example, be physical, chemical and radiological measurements, the estimated discharge volume, the discharge period or the maximum discharge flow rate.

3.8
permanent discharge
direct discharge into a channel or collector or water body, which is not subject to a specific prior agreement, but which shall conform with limit values

3.9
tank
hollow object, very variable in size, used to hold liquids

Note 1 to entry: Covers the usual names such as tank, chamber and pool. The content of this tank is intended for direct and indirect liquid discharge to the environment or to a specific treatment.

3.10
event-trigged sampling
sampling which is triggered because a pre-determined criterion has been met (e.g. rainfall, change in electrical conductivity, pH or the introduction of a polluting substance), when samples should be taken manually or by automatic equipment

4 General aspects

4.1 Design of sampling programme

Sampling is usually the first step in carrying out an investigation and largely determines the quality of the whole investigation. It is therefore recommended that a detailed sampling strategy be drawn up, often based upon a preliminary investigation in which an assessment has identified the important aspects. Both the purpose and the ambient situation determine the way in which the sampling is carried out. General aspects for sampling programme design can be found in ISO 5667-1.

4.2 Sampling point selection - Representativeness

The sampling point selection should be representative of the waste stream to be examined. In some waste waters this representativeness may be difficult to obtain because of the spatial and temporal heterogeneity of the water body. It is necessary to carry out the sampling in the sections where the flow is well mixed and homogeneous.

The term “representativeness” encompasses two notions depending on the type of environment to be sampled:

— representativeness in a flow (canal, sewer, manhole, pressurised pipes, etc.);

— representativeness in a storage (tank, lagoons, basins, etc.).

These two notions should be treated in different ways, but the goal remains to obtain a representative sample of the water body.

Sampling points may be clearly identified (by regulatory text) or not, in which case a preliminary investigation is recommended. This is generally the case for the selection of sewer sampling locations. By studying drawings of the sewer system initially, possible locations can be identified. Subsequently, a site inspection should be conducted to ensure that the locations of the sewers and the path of the waste stream corresponds to the drawings, and to make sure that the selected location is representative for the sampling purpose. The tracer studies may be a helpful tool.

Each sampling point should be documented. It is important to gather, for example, the following information: identification, location of the site, photos, geographical coordinates, site location, type of flow (open, closed), access conditions and sampling technique.

If necessary, specifically describe and label the sampling site. Select the site so that representative samples can be obtained and the waste water flow (with the exception of fixed sampling equipment) is clearly visible from the sampling site.

The following facilities should be available for the for the sampling sites involving a fixed automatic sampling device:

— access for motor vehicles to the immediate vicinity of the sampling site;

— flat working surfaces at appropriate height above the sampling point for the set-up of sampling devices;

— adequate lighting and power connection;

— water connection to clean the equipment after sampling;

— adequate safety precautions (e.g. grids, railings, fall arresting devices); and

— flow meters in the case of a flow-dependent sampling.

If the hydraulic conditions do not ensure the representativeness of the sample (absence of flow, reduced activity, abnormal load rise), this unusual situation should be noted on the sampling report and the client and the analytical laboratory should be informed.

4.3 Frequency and time of sampling

4.3.1 Number of samples

Analyses should be based on samples taken at regular intervals during a certain period (composite or spot). The decision on the required number of samples taken during each period should be decided based on statistical techniques (see ISO 2602,[1] ISO 3534 (all parts)[2] and ISO 5667-1). But the number of samples to be taken may often be decided by the regulatory body or pollution control authorities.

4.3.2 Sampling time for effluent stream

The objective of a sampling programme often dictates when and how a sample is collected and is often determined by legislation or directives. Generally, when sampling sewages and effluents, it is normal to make allowances for the following sources of variation in quality:

a) diurnal variations (i.e. within-day variability);

b) variations between days of the week;

c) variations between weeks and months;

d) variations between seasons;

e) variations due to storm water episodes; and

f) trends.

If there is little or no diurnal variation, or day-to-day variations, then the particular time of day or day of the week for sampling is relatively unimportant.

If the identification of the nature and magnitude of peak load are important, sampling should be restricted to those periods of the day, week or month when peak loads are known to occur.

Relating the times of sampling to the particular process being monitored may be very important when considering industrial effluent discharges that are either seasonal or operated on a batch basis. In either case, the discharge will not be continuous, and the sampling programme will need to take this fact into account.

Sampling for the detection of trends needs careful planning. For example, when detecting trends on a month-to-month basis, it can be appropriate to always sample on the same day of the week, in order that any diurnal and daily variations are eliminated from the overall variability of data, thus allowing trends to be more efficiently detected.

When the number of samples has been decided upon according to 4.3.1, the sampling times should be determined. The samples should normally be taken at fixed intervals during the whole control period. The sampling period may be one year, a number of months or weeks, or even shorter periods of time.

If the sampling period covers one year, the days of sampling may be determined using a formula. An example of this is:

Formula (1) for a number of samples (n), larger than about 25 and from Formula (2) for a number of samples less than about 25.

Formula (1) indicates the day number during which sampling should take place.

$$A+\frac{365}{n}, A+\frac{365\times 2}{n}, A+\frac{365\times 3}{n}, \ldots, A+\frac{365\times n}{n} \tag{1}$$

where

n is the number of samples;

A is a random number in the interval between $-\frac{365}{n}$ and 0.

Formula (2) indicates the week number during which the sampling should take place. The day of each week should be determined so that samples are taken on every weekday.

$$B+\frac{52}{n}, B+\frac{52\times 2}{n}, B+\frac{52\times 3}{n}, \ldots, B+\frac{52\times n}{n} \tag{2}$$

where

n is the number of samples;

B is a random number in the interval between $-\frac{52}{n}$ and 0.

Similar formulae can be used for other periods, for example, one month, three months, six months, etc. The period chosen should cover any seasonal variations.

After determining the intervals and the day or week number, it should be ensured that the sampling does not lead to any risk of systematic error, for example by always taking samples on one day, or by systematically omitting weekdays.

5 Sampling at specific locations

The concentration profiles of dissolved substances and suspended solids measured in an effluent are often heterogeneous because they depend on the hydraulic conditions and transport conditions of the solid phase in the body of water. Observations are:

— A vertical gradient of concentration, due to the flow velocities or the shear stresses near the bottom are low;

— A very dense layer at the interface between the deposit of the bottom and the water circulating in the structure;

— An increase of the concentration near the walls;

— An increase of the concentration near the surface of the flow due to the presence of floating matter.

It is therefore necessary to define carefully the positioning of the sample taken within the body of water. To take a sample theoretically representative of the average concentration of the measured section, it is advisable to place the sampling point about halfway up the water column and at a sufficient distance from the walls and deposits to avoid measurement bias.

5.1 Sampling from sewers, channels and manholes

A location should be chosen where the effluent has a high turbulent flow to ensure good mixing. Often accessibility, lack of site security, or power unavailability may preclude the use of the best sites.

Since effluent channels are generally designed to cope with both effluent and storm-water discharge conditions and/or for higher flows than those actually occurring, laminar flow may often occur. In the absence of a location with turbulent flow conditions at permanent sampling location, such conditions should be induced by restricting the flow, for example with a baffle or weir. The restriction should be made in such a way that sedimentation upstream of the restriction does not occur (e.g. foresee enlargement of the downstream effluent channel compared to the upstream channel, to avoid any pressure increase of the effluent downstream).

The sampling intake point should always be located downstream from the restriction and, as a general rule, it should be located at least three times the pipe diameter, or width of the channel, downstream of the restriction. The inlet of the sampling probe should preferably face the direction of flow but may face downstream if too many blockages result.

The exact location of the sampling point should be evaluated with respect to variations in water level, types and concentrations of the determinands, etc. The sampling point should be at a minimum distance from the bottom and walls to avoid sample contamination by deposits or the biofilms that develop. Generally, a sampling point between one third and one half of the effluent water depth below the surface of the water may be recommended.

Whenever practicable, permanent sampling locations should be established, care being taken to ensure reproducible sampling conditions.

Before proceeding with the sampling of industrial discharges and if the information is accessible, the conditions inside the plant (e.g. processes and production rates) should be noted and recorded along with any potential hazards.

5.2 Sampling from waste water treatments plants

When choosing sampling locations for waste water treatment plants, it is again important to refer to the objective of the data collection programme, of which the sampling is a part.

Typical objectives are:

— control of the performance of the entire treatment plant: samples should be collected at the main inlet and main outlet points;

— control of the operation of individual processing units, or groups of units: samples should be collected at the inlet and outlet of the units in question.

When sampling at the waste water treatments plants, the importance, the relevance of any bypass flow should be evaluated, and sampling of such flows may also be needed for the sampling to be representative for the overall effluent.

When sampling at the inlets of plants, the objective of the sampling programme should be carefully considered. In some situations, there may be a need to sample raw sewage in the mixture with recirculated processing liquid (e.g. in the assessment of primary sedimentation tank loadings and efficiency). In other cases, it may be necessary to exclude the effect of these liquids (e.g. when collecting data designed to assess domestic/industrial loadings to a plant or to assist in industrial effluent control).

Representative sampling is often facilitated by using locations downstream of a measuring flume or weir (see also 5.1).

When sampling effluents from processes employing more than one individual treatment unit (e.g. several sedimentation tanks), care should be exercised in ensuring that the sample is representative of the overall effluent stream rather than any one specific treatment unit (unless that unit forms the basis of a specific study).

Frequent reviews of a plant's sampling locations need to be made to ensure that any relevant changes in the operation of unit processes are considered when sampling. For example, the percolating filter operation may be changed from a "single-pass" operation to a "recirculation" or "alternating-double filtration" operation. Treatment plant operation may involve changes in the manner in which feed or return liquors are introduced to the plant (e.g. return of sewage from storm tanks, changes in the position at which processing liquors are returned to the treatment plant).

Whenever sampling waste waters, great care should be exercised to overcome or minimize the substantial heterogeneity caused by suspended solids that are often present. Similarly, thermal stratification of separate industrial effluent streams may be found when sampling effluents or discharges from industrial processes, and measures have to be taken to promote the mixing of such streams before sampling.

5.3 Sampling from industrial sites

Sampling liquid effluents involves sampling a certain representative amount before and/or after they are transferred to discharge channels or collectors.

The sampling method depends on the type of discharge or transfer taking place. The following should therefore be distinguished:

— planned discharges, which require a preceding inspection before the discharge takes place. These may be, for example, discharges from facilities' liquid effluent tanks prior to their transfer to general collectors or buffer pools before being discharged into the environment (refer to 7.4);

— permanent discharges, which concern effluents that are continuously discharged. They are monitored based on sequential or continuous sampling of the discharged effluent. These may be, for example, discharges from an effluent collector at the outlet of a nuclear site or a rainwater collector, prior to discharge into the environment.

As such, the kind of sampling and the creation of representative samples shall be adapted to suit the type of discharge and its potential heterogeneity (e.g. the presence of suspended matter or any density or thermal stratification).

For this, and to guarantee the representative nature, the samples shall be produced:

— ensuring sampling only takes place after obtaining suitable effluent homogeneity;

— ensuring there is no change to the nature of the effluent or cross-contamination; and

— taking account of the volumes of the tanks, the flow rates and the flow conditions in the lines, to enable quantification of the discharges from the facility in question (see Annex A, Figure A.1 for an example of tank sampling).

Sampling may be performed based on several configurations, depending on the facilities:

— in a tank prior to its discharge (see Annex A, Figures A.1 and A.3);

— in a continuous or discontinuous flow in a line or a discharge channel (see Annex A, Figure A.1).

5.4 Sampling from cooling systems

The selection of sampling points in industrial cooling processes using water as a coolant depends on the cooling water system to be tested.

In continuous-flow cooling systems, fresh water (ground water, bank filtrate, surface water) or saline water are used in one or repeated flow. The sampling points are located both in front and behind the aggregates, which shall be cooled.

During cooling via primary and/or secondary circuit, two cooling circuits are coupled to one another, wherein a closed secondary circuit is re-cooled with a primary circuit. The primary circuit can consist of a continuous cooling system, an open or closed recooling plant or a refrigerating plant (e.g. brine cooling). The sampling site should be on the return side and on a well through-flow site of the circulatory system.

In many cases, the cooling water is precooled in an open system by evaporation cooling, whereby water losses due to evaporation, spraying and desludging (desalination) will be replaced by fresh water. In the closed recooling process, the cooling water flows through pipes, which are cooled from outside by air or water. The methods of open and closed recooling can be combined. The sampling site is located on the return side of the circulatory system.

Representative sampling locations throughout the system shall be defined for periodic microbiological/hygiene checks. Microbiological sampling guidance is given in ISO 19458. The sample is preferably taken from the circulating water between the running pump at the spraying/trickling stage. A sampling facility (sampling tap allowing disinfection, preferably by flaming, and draining) is to be provided at this location. Allow the water to drain for at least 30 s before sampling. Sampling shall be performed in such a manner that results are not distorted by biocide dosage. The sampling location shall be upstream of the point of biocide dosage.

If sampling is not possible at this location, the sample can be taken from the sprayed water or by bail sampling from the circulating-water basin[3].

Special cooling processes are usually used when the medium to be cooled is very hot (e.g. waste heaters, heat pumps) or when very low flow temperatures are required (e.g. brine cooling). For special cooling processes in the high temperature range (temperature > 100 °C), ISO 5667-7 shall apply.

6 Main types of waste water sampling

6.1 Spot sampling

In the case of spot sampling (refer Annex B), it is possible to implement:

a) direct sampling in the waste water body:

   1) directly by using laboratory bottles;

   2) using a ballasted sample collector equipped with laboratory bottles;

   3) using an automatic sampler.

b) indirect sampling in the waste water body:

   1) using a sampling rod equipped with a collection container;

   2) using a bucket or other equipment.

NOTE Spot samples are usually taken manually, but may be taken by automatic sampling equipment or by event-triggered automatic samplers.

6.2 Composite sampling

Composite sampling consists of several discrete samples. It can be done automatically or manually (refer Annex B).

For automatic composite sampling, there are several types of composite sample (see ISO 5667-1). It is possible to implement:

— constant volume variable time sampling (C.V.V.T)

— constant time variable volume sampling (C.T.V.V)

