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Water quality — Sampling —

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

Qualité de l'eau — Échantillonnage —

Partie 7: Guide général pour l'échantillonnage des eaux et des vapeurs dans les chaudières

Reference number
ISO 5667-7:1993(E)

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 5667-7 was prepared by Technical Committee ISO/TC 147, *Water quality*, Sub-Committee 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*

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- *Part 10: Guidance on sampling of waste waters*
- *Part 11: Guidance on sampling of groundwaters*
- *Part 12: Guidance on sampling of sediments*
- *Part 13: Guidance on sampling of sludges*

Annexes A, B and C of this part of ISO 5667 are for information only.

Introduction

This part of ISO 5667 is one of a group of standards dealing with the general aspects of sampling (parts 1 to 3) and the sampling of specific types of water (from part 4 onwards). It should be read in conjunction with ISO 5667-1, ISO 5667-2 and ISO 5667-3.

The terminology used is in accordance with the various parts of ISO 6107.

Water quality — Sampling —

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

1 Scope

This part of ISO 5667 recommends procedures and equipment for sampling water and steam in boiler plants including examples of sampling apparatus, to provide samples for physical and chemical analysis that are representative of the main body of water or steam from which they are taken.

The procedures for sampling water apply to

— raw water;

— make-up water;

— boiler feed water;

— condensate;

— boiler water;

— cooling water.

The procedures for sampling steam cover both saturated and superheated steam.

This part of ISO 5667 does not apply to the sampling of water and steam in nuclear power plants.

Figures 2 to 6 are only given as examples of sampling apparatus.

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

ISO 5667-2:1991, *Water quality — Sampling — Part 2: Guidance on sampling techniques.*

ISO 5667-3:1985, *Water quality — Sampling — Part 3: Guidance on the preservation and handling of samples.*

ISO 6107-1:1986, *Water quality — Vocabulary — Part 1.*

ISO 6107-2:1989, *Water quality — Vocabulary — Part 2.*

ISO 8199:1988, *Water quality — General guide to the enumeration of micro-organisms by culture.*

3 Definitions

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

3.1 isokinetic sampling: A technique in which the sample from a water or steam stream passes into the orifice of a sampling probe with a velocity equal to that of the stream in the immediate vicinity of the probe. [ISO 6107-2]

3.2 sampler: A device used to obtain a sample of water or steam, either discretely or continuously, for the purpose of examination of various defined characteristic. [ISO 6107-2]

3.3 sampling point: The precise position within a system from which samples are taken. [ISO 6107-2]

3.4 sampling probe: That part of sampling equipment which is inserted into a body of steam or water and into which the sample initially passes. [ISO 6107-2]

3.5 sampling line: The conduit which leads from the sampling probe to the sample delivery point or the analysing equipment. [ISO 6107-2]

3.6 sample delivery point: The end of a sampling line, often remote from the sampling probe, from which a sample is removed, either discretely or continuously, for examination.

3.7 raw water: Water which has received no treatment whatsoever, or water entering a plant for further treatment. [ISO 6107-1]

3.8 make-up water: Water which has to be added to the system in order to make up for losses.

3.9 condensate: Condensed steam from power plants or processes, which is not mixed with any other water.

3.10 boiler water: The water present in a operational boiler.

3.11 feed water: The water consisting of the *condensate* (3.9) and the *make-up water* (3.8) and which passes through the feed pump or injector.

3.12 saturated steam: Steam having a temperature equal to the saturation temperature corresponding to its pressure.

3.13 superheated steam: Steam having a temperature above the saturation temperature corresponding to its pressure.

4 Sampling — General aspects

4.1 Introduction

A prerequisite of any sampling system is that it should extract a sample representative of the fluid in the given part of the circuit for subsequent analysis. Problems are most likely to arise when more than one phase is present.

4.2 Sampling system — General information

The sampling system for the collection of samples of water and steam consists of the following parts (see figure 1):

- the sampling probe;
- a sampling line, including valves and fittings;
- a cooler (this can be omitted when the sample temperature is permanently below 50 °C);
- a sample delivery point.

The design of the sampling system and the selection of materials are influenced by

- the analyses to be carried out and the required accuracies;
- the chemical composition of the water or steam to be examined;
- the temperature and pressure at the sampling point;
- the chemical composition of the cooling water.

For most applications, all the parts of sampling equipment in contact with the sample should be made of stainless steel, 18Cr8Ni. In some cases, other materials may be used, for example, copper for sampling from low pressure boilers. It is essential that these are suitable for the use for which they are required, and they should not interact with the constituents of the sample. The various parts of the sampling system are described in more detail in clause 5.

4.3 Sampling points — General guidelines

Sampling points should be positioned in those parts of the circuit where the composition, or changes in the composition, of the water or steam need to be determined.

Figure A.1 shows typical sampling locations in the steam/water circuit.

A sample point for a shell boiler should be located a minimum of 150 mm below the normal working level of the boiler. It is recommended that the sample should be taken during the normal boiler operations, but not when the boiler is being fired.

Whenever possible, samples should be taken from flowing systems. Stagnant areas should be avoided, unless samples are specifically required from such areas (e.g. wet stored boilers).

Where waters of different origin and composition are blended, or chemicals are added, sampling points should be positioned where complete mixing has taken place. In most cases, this can be achieved by sampling downstream of a turbulence promoter such as a valve, pump or pipe bend.

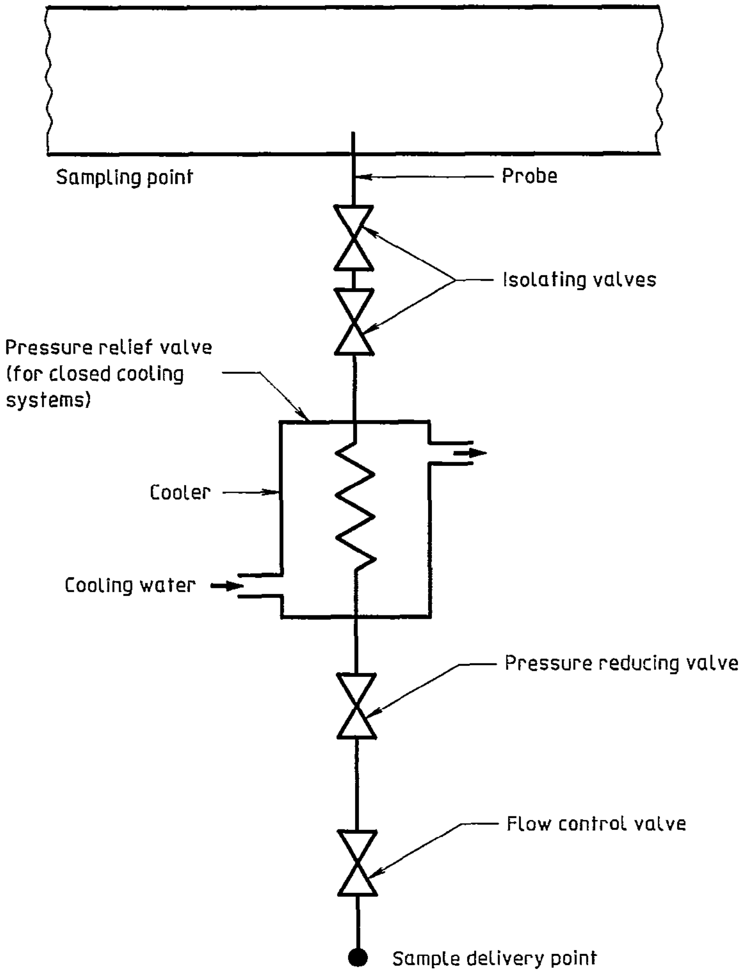


Figure 1 — Schematic water sampling system

To obtain a representative sample of particulate matter in water flowing in a pipe, it is necessary to

a) sample at a location where the particulate matter is uniformly distributed in the pipe;

b) withdraw a representative sample from the bulk fluid;

c) transport the sample in the sample line to the sample delivery point, with minimum changes in either the concentration or nature of the particulate matter.

To meet these criteria for systems with turbulent flow, the sampling points should preferably be installed in vertical pipework and the sample taken isokinetically. If this is not possible, sampling points should be positioned beside horizontal piping at least 10 internal pipe diameters downstream and 5 internal pipe diameters upstream of any flow disturbance such as pumps, valves and pipe bends. Further guidance on choosing sampling points is given in clause 6.

5 Sampling equipment

5.1 Materials

The materials selected for the sampling probe, including fittings, and the weld material used to install the probe should be compatible with the piping material and the fluid being sampled. The design of the welded joint and the welding and inspection procedures should comply with all applicable codes to ensure an adequate, reliable joint. The material used for the sampling probes should also be selected so that the sample is not contaminated by the material. For example, a system containing brass components would not be suitable if it was required to determine total copper.

5.2 Water sampling probes

For collecting samples of homogeneous water, an off-take connection as shown schematically in figure 2 is recommended.

When it is required to sample water containing particulate matter, ideally the sample needs to be taken isokinetically.

Representative sampling of particulate matter is important, for example, in the estimation of corrosion products in a system.

Experience has shown that, for some applications, a straight probe (off-take connection) will be sufficient. In other cases, the use of a directional probe will be necessary. The choice of either a straight or directional probe is best made by experimentation using both designs. The probe should face into the direction of flow. The directional probe should be used when sampling water containing particulate matter of a wide range of particle sizes. A straight probe should be considered when sampling water containing very fine particulate matter. A schematic arrangement of a directional probe for the isokinetic sampling of water is shown in figure 3.

Figure 4 shows an actual sampling system with the probe arrangements for both soluble and particulate sampling.

NOTE 1 Sometimes the use of a directional probe with the inlet slot facing away from the flow is suitable when sampling soluble species. In this case, ingress of particulates is minimized and thus deposition and the risk of blockage within the sample line is reduced. This is particularly applicable where long sample lines are used to carry samples to the on-line instrumentation.

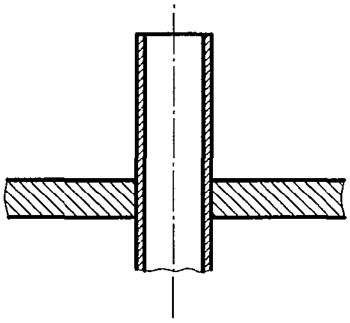


Figure 2 — Example of a straight circular sampling probe for sampling soluble species

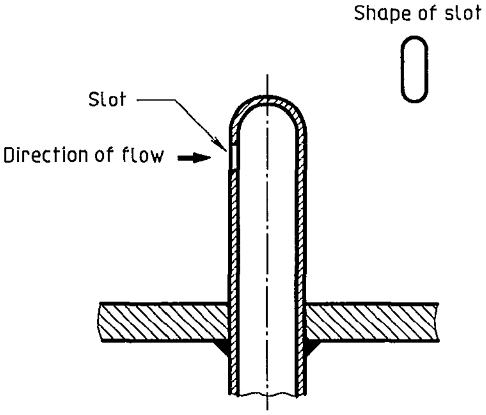


Figure 3 — Example of a directional sampling probe for sampling particulates in water

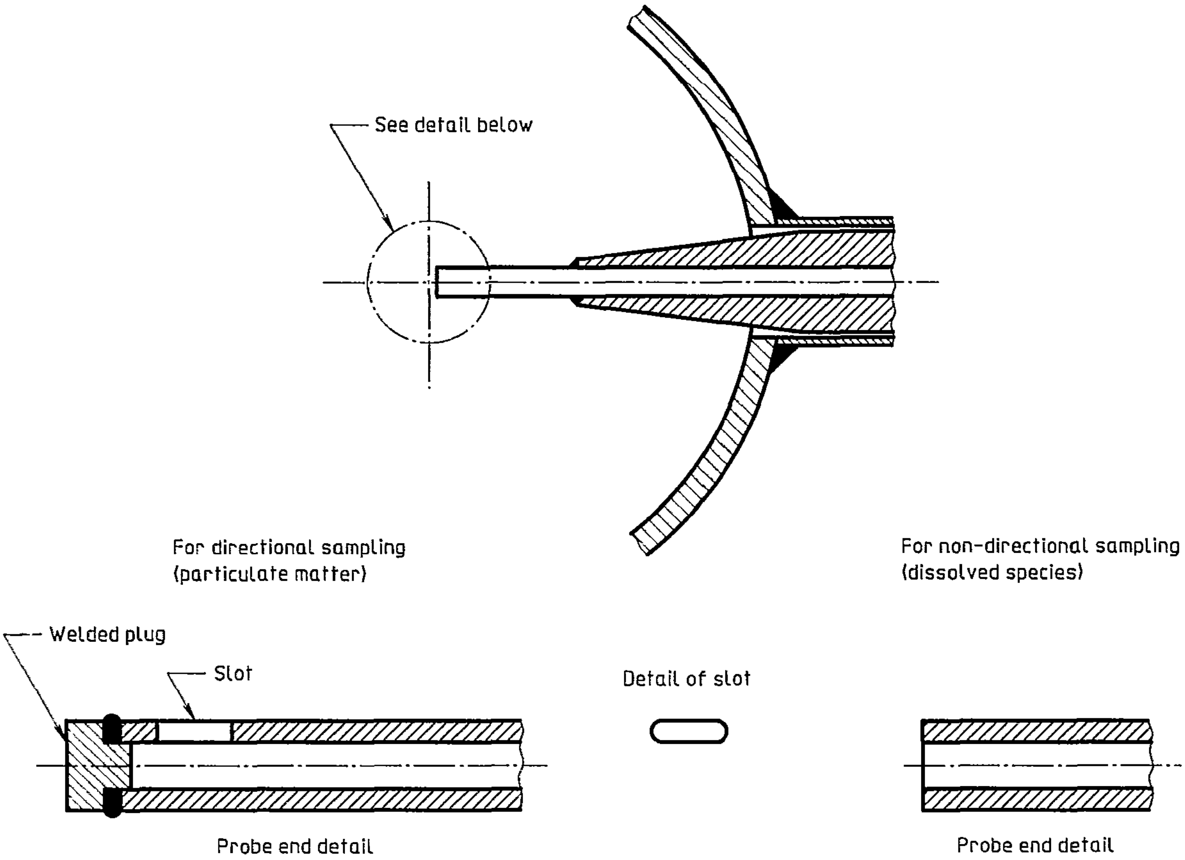


Figure 4 — Example of a water sampling probe for both soluble and particulate sampling

5.3 Steam sampling probes

Due to the multiphase nature of steam, both saturated and superheated steam should preferably be sampled isokinetically using directional probes (see clause 8). Both single and multiport probes are appropriate for steam sampling.

For sampling saturated steam in piping at an offtake connection close to the boiler drum or header, a single-port nozzle is recommended (see the examples shown in figure 5). The probe tip should face into the direction of steam flow.

For sampling both saturated and superheated steam in large pipelines a multiport probe is recommended (see figure 6). This probe, specially designed and proportioned for a specific condition, is inserted through the pipe wall and extends across the centre of the pipe.

The ports should face upstream in the pipe and the port holes should be spaced in such a way that each one samples from an equal area of pipe section (see figure 7).

For sampling superheated steam, a single-port sampler, such as that shown in figure 5, may be preferable as an alternative to the multipoint probe, when sampling from small diameter pipes or from large diameter pipes when the steam is considered to be homogeneously mixed. If the volume of sample obtained from a single probe is insuffficient, then a number of probes may be used and the samples combined to provide a single sample.

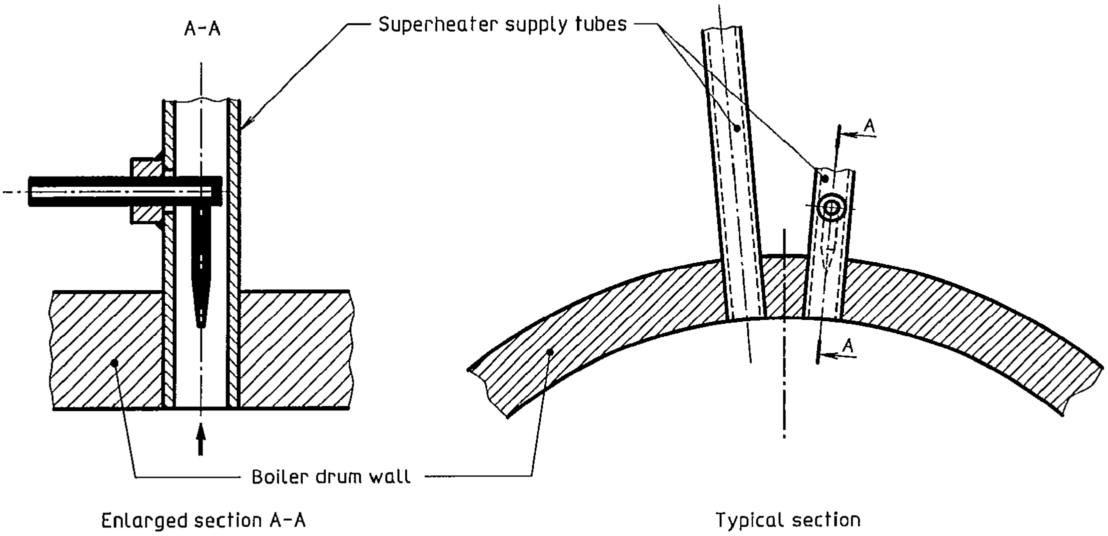


Figure 5 — Examples of sampling probes for sampling saturated steam

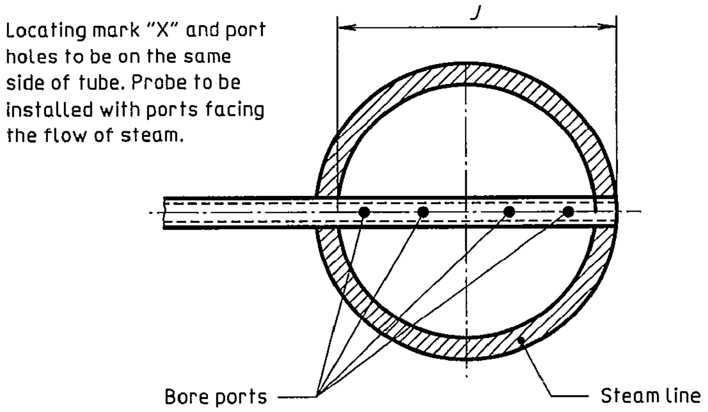
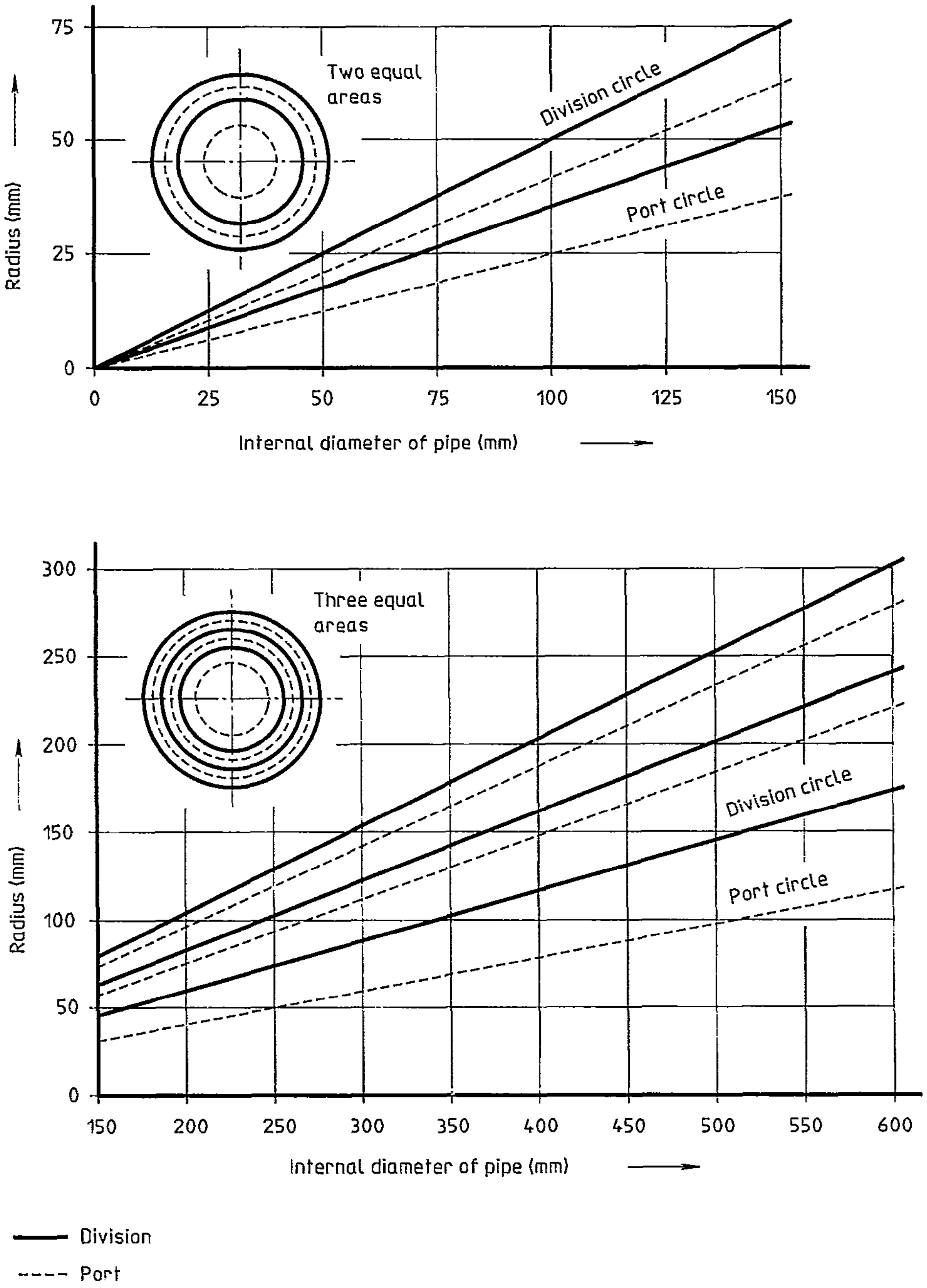


Figure 6 — Example of a steam sampling probe, multiport type



NOTE — Each port of a multiport sampling probe should withdraw a portion of the main stream equivalent to the area of the portion of the pipe in which it is located. For ports of equal size, this requires that the spacing should be such that the ports withdraw equal portions of the sample from equal areas of pipe section. The spacing of the ports may be determined according to figure 6.

Ideally, equal pressure drops should occur across each sampling port. To promote this condition, the total port area should be less than two-thirds of the internal cross-sectional area of the probe. The diameter of the bore of the probe should be sufficiently large to ensure that the steam entraps moisture with it.

The ratio of total port area should be equal to the ratio of the rate of sample flow to the rate of steam flow. Under this condition, the velocity of the steam entering the sampling port will be that of the steam flowing in the pipe and will represent isokinetic flow (see table 1).

Figure 7 — Radii of circles for dividing a circular pipe into annuli of equal areas

Table 1 — Recommended minimum mass flow through sampling probe for various steam pressures

Steam pressure kPa	Mass flow kg/s·m^2
500	13
1 000	20
2 000	26
3 000	31
4 000	35
5 000	38
6 000	40
7 500	43
10 000	46
12 500	48
15 000	49
17 500	49
20 000	49

5.4 Sampling lines

The sampling line should be as short as possible, to minimize sample delay time and deposition of particulate matter where a representative sample of this is required.

To further minimize the deposition of particulate matter it is necessary to

a) avoid long horizontal sections of pipework;

b) use pipework of sufficiently small bore, to ensure that the sample is transported under turbulent flow conditions with a Reynolds Number > 4 000;

c) choose sample control and isolating valves designed to minimized deposition of particulate matter in the valve itself: components with dead zones and complex flow paths should be avoided.

5.5 Valves

Valves should be installed in the sampling line for sample isolation, sample pressure reduction and flow control.

Two valves in series are required for sample isolation. They should be positioned as close as possible to the sampling probe. The configuration and rating of the valves should be suitable for the pressure of the system and meet the national safety requirements of the location. A regulating valve, for example a needle valve at the outlet of the sampling line, should be provided for flow control. For high pressure applications, a pressure reducing valve can be interposed between the sample isolating valves and the flow control valve. When a cooler is required (see 5.6), the pressure reducing valve should be fitted downstream of the cooler. When taking a sample, the isolating valve should be fully opened. The sample flow should be adjusted by the needle valve. Hence, the entire sampling line, including a possible cooler, should be of sufficient strength to withstand the full pressure of the system being sampled. A typical sampling arrangement is shown in figure 1.

5.6 Sample cooling

Cooling should generally be carried out for sample withdrawn from systems operating at temperatures greater than 50 °C. The temperature to which the sample is cooled depends upon the subsequent analysis. The cooler dimensions, cooling water flow rate and temperature should be chosen for the specific application. A final sample temperature in the range 25 °C to 30 °C is typical.

The coolers should be constructed of stainless steel, or another appropriate material, and the shell of sealed coolers should be fitted with a pressure-relief valve (see figure 1).

The coil of the cooler should be designed and constructed so as to be capable of operating at the full working pressure and temperature of the vessel or pipe from which the sample is being taken.

The cooling water should be of a quality such that no deposition or corrosion occurs within the cooler and is dependent upon the construction materials (see annex B).

Where instrumentation is fed directly from the sample delivery point, the installation of an automatic sample cut-off valve between the cooler and instrumentation should be considered. This valve will activate if the sample temperature increases to a predetermined value, as a result of loss of cooling water flow.

If there is no adequate supply of cooling water of acceptably low temperature, chiller systems should be considered.

Details of typical coolers are given in annex B .

5.7 Capillary samplers

As an alternative to the type of sampling system described in figure 1, a capillary device can be used for both soluble and particulate sampling. This comprises a single length of stainless steel capillary and uses the frictional drag on the internal surface of the capillary to control the sample flow rate and reduce the sample pressure without the use of valves. This has the advantage over conventional sampling systems for the representative sampling of particulates that the sites for particulate deposition and reentrainment are minimized.

Ideally capillaries of internal diameter 0,5 mm to 1,5 mm should be used for this application. Where cooling in addition to pressure reduction is required, a section of the capillary can be housed in an appropriate cooler. A schematic arrangement of an example of a capillary sampler is shown in figure 8.

5.8 Sample containers

Reference should be made to ISO 5667-2 and ISO 5667-3 for detailed instructions on sample container selection and cleaning procedures.

5.8.1 Unless otherwise specified, samples should be taken in clean, tightly-stoppered containers or bottles to minimize contamination from the atmosphere, by handling and by leaching from the containers.

5.8.2 Containers and stoppers should be cleaned prior to use by treatment with a warm diluted hydrochloric acid solution [$c(\mathrm{HCl}) = 1$ mol/l], and subsequently thoroughly rinsed with deionized water. Before samples are taken, containers and stoppers should be rinsed with the water to be examined. They should also be tested before use for adequate cleaning, by carrying out "blank" determinations.

NOTE 2 If trace chloride measurement is required, HNO_3 should be substituted for HCl.

5.8.3 Polyethylene or similar plastics containers should be used for the determination of ionic species. Borosilicate glass containers are recommended for the sampling and storage of water samples for determination of dissolved oxygen and organic constituents. For bacteriological examination, sterile bottles should be used, and reference should be made to ISO 8199.

6 Sampling locations

6.1 Introduction

The design of the steam/water circuit will determine how the general guidelines outlined in clause 4 can best be applied. In some cases, it may be necessary to consult appropriate specialists about the positioning and design of samplers. Due regard should be given to the positioning of sampling equipment, so that operators can safely reach sampling devices and isolating valves. Where appropriate, pipework should be thermally insulated to avoid heat injuries to workers.

The principal sampling points in the steam/water circuit are shown in figure A.1 and described in 6.2 to 6.7.

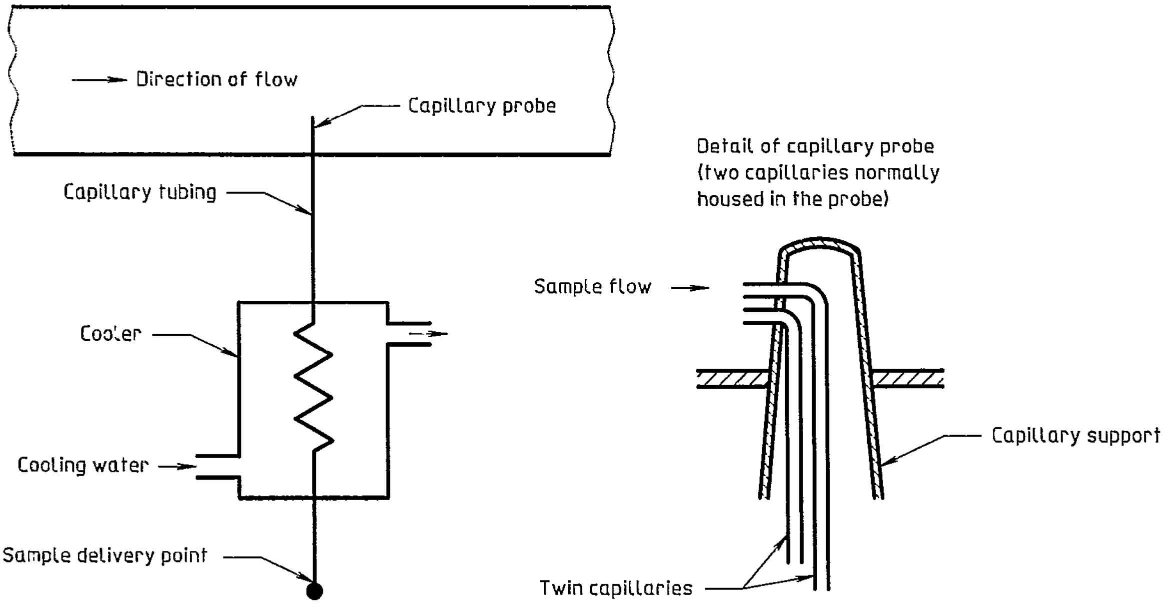


Figure 8 — Typical capillary sampler arrangement

6.2 Make-up water

After treatment by deionization, both the electrical conductivity and the soluble silica content of the make-up water may require to be monitored. A probe, of the design shown in figure 2, is recommended for this application.

6.3 Feedwater

Samples may be required from a number of locations in the condensate and feedwater system. These include the extraction pump discharge, de-aerator inlet, de-aerator outlet and boiler inlet. Sampling for soluble and possibly particulate matter will be required. A probe, of the design shown in figure 2, is recommended for sampling soluble materials. A probe, of the design shown in figure 2 or figure 3, is recommended for sampling particulate matter (see 5.2).

6.4 Boiler water

The composition of boiler water may show significant variation within the boiler. The sampling point location is therefore of major importance and needs to be such that the sample is unaffected by incoming feedwater or unseparated steam.

For boilers of the natural circulation type, representative samples should be taken from downcomers. In boilers of the forced circulation type, samples should be taken from the discharge side of the circulating pump in operation. Alternatively, samples may be obtained from suitably positioned sampling probes in the boiler drum or continuous blowdown lines.

However, because of the difficulty in ensuring that samples taken from the boiler drum are representative, this location should only be used if the preferred locations are unavailable.

If sampling for soluble material is the prime consideration, a probe of the design shown in figure 2 is recommended. A probe, of the design shown in figure 2 or figure 3, is recommended for sampling particulate matter (see 5.2).

Sampling from once-through watertube boilers is not possible.

6.5 Steam

Boiler water carry-over due to insufficient steam/water separation is assessed by the sampling and analysis of saturated steam. In addition, sampling and analysis of superheated steam is required to assess deposition in the superheater and carry-over to the turbine. Both superheated and saturated steam should be considered to contain particulate matter and should be sampled isokinetically with directional probes (see 5.2 and clause 8).

6.6 Return condensate

Sampling points should be located in the main condensate return line and in the return line from each unit. When condensate is derived from other sources, sampling points should be established for them.

A probe, of the design shown in figure 2, is recommended for this application.

6.7 Cooling water

Cooling water systems show wide variation in design (open/closed systems with cooling towers or surface coolers) and water origin (open water, borehole water, or condensate).

No specific recommendations can be given but, as a minimum requirement, sampling points should be established with reference to the guidance of ISO 5667-1 on this matter.

7 Collection of water samples

7.1 Sampling frequencies and programmes depend on several factors, such as

— changes in operating parameters;

— addition of chemicals;

— degree of chemical control required.

General guidance on the design of sampling programmes is given in ISO 5667-1 and should be followed whenever possible.

7.2 Sample containers should be filled completely. This is of special importance when dissolved oxygen, hydrazine, sulfite, carbon dioxide, free available chlorine, iron(II) and ammonium, and also electrical conductivity, pH and alkalinity are to determined. In these cases, a tube or hose of inert material should be connected to the sampling line and inserted into the bottom of the container. Before sampling, it is essential to check that the outside surface of the sampling tube or hose is clean.

7.3 Samples should have a volume that is adequate to carry out all the required analyses. A volume of 0,5 l to 1 l is generally satisfactory.

7.4 When taking particulate samples, it is preferable to have sample points running continuously at the isokinetic flow rate. If this is operationally inconvenient, the valve should be opened and operated at full flow to remove any deposited material and adjusted after approximately 10 min to the isokinetic flow rate. A sample should then be taken after no further visible change in its appearance occurs, and no sooner than 30 min after adjustment to isokinetic flow. The timing of this sampling procedure can be optimized for a specific sampling point, following appropriate simple investigations to determine how quickly the particulate concentration reaches a steady value.

The sample flow rate should be determined as follows:

$$f = \frac{a}{A} \cdot F$$

where

f is the sample flow rate, in kilograms per second;

F is the plant water flow rate, in kilograms per second;

a is the area of the sampling port, in square metres;

A is the area of the water pipe, in square metres.

8 Collection of steam samples

8.1 For the collection of representative saturated and superheated steam samples, accurate isokinetic sampling is a prerequisite.

The sample flow rate should be determined as follows:

$$f = \frac{a}{A} \cdot F$$

where

f is the sample flow rate, in kilograms per second;

F is the steam flow rate, in kilograms per second;

a is the total area of the sampling port(s), in square metres;

A is the area of the steam pipe, in square metres.

NOTE 3 Beyond the inlet port(s), the velocity of sample flow should be kept high to minimize loss of solid and liquid steamborne impurities. This is especially important if the flow through the probe is vertically upward. The minimum mass flow through the probe for various steam pressures is included in table 1.

9 Preservation of samples

For the preservation and on-site pretreatment of samples for laboratory analysis, reference should be made to ISO 5667-3.

10 Sample identification and records

For identification of the sample and interpretation of the analytical results, detailed data, such as water type, sampling point, date, time, temperature, pressure, and name of the person taking the sample, should be noted on site on a sampling form.

Sample preservation should also be noted. If, for instance, an acid is used for preservation (see ISO 5667-3), the type, quantity and concentration should be reported. If applicable, it is recommended that the presence of water treatment chemicals in sample circuits, should be reported.

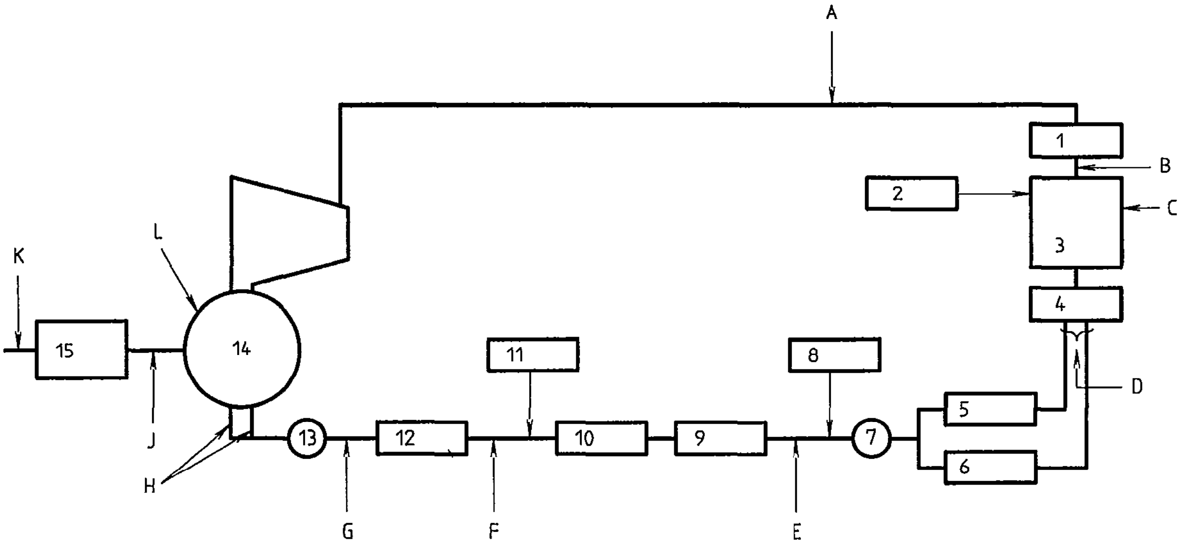
Furthermore, samples should be properly labelled and packed for shipment, if necessary.

Reference should be made to annex C for a recommended example of a report form for the sampling of water and steam in boiler plants.

Annex A
(informative)

Sampling points in boiler plants

A.1 Typical sampling locations in a steam/water circuit are shown in figure A.1 and the corresponding typical sample conditions at those locations are given in table A.1.



1 Superheater
2 Dosing
3 Boiler
4 Economizer
5 High pressure heaters
6 High pressure heaters
7 Feed pump
8 Dosing
9 De-aerator
10 Low pressure heaters
11 Dosing
12 Condensate polishing plant
13 Extraction pump
14 Condenser
15 Make-up plant

A Superheated steam
B Saturated steam
C Boiler water
D Economizer inlet
E De-aerator outlet
F Polishing plant outlet
G Extraction pump discharge
H Condenser outlets or compartments
J Make-up
K Make-up to reserve feed water
L Inter-tube plate drain

Figure A.1 — Location of principal sampling points

Table A.1 — Typical sample conditions at various sampling points in steam and water circuits

Sampling point location	Temperature °C	Pressure MPa
Make-up plant	< 30	0,1
Extraction pump discharge	20 to 45	0,4
Condensate polishing plant	35 to 50	1 to 3
De-aerator inlet	90 to 120	1
De-aerator outlet	140 to 180	1
Boiler economizer inlet	180 to 260	17 to 20
Boiler water	345 to 355	16 to 19
Saturated steam	345 to 355	16 to 19
Superheated steam	550 to 570	16 to 19

Annex B
(informative)

Coolers

B.1 For sample temperatures above 50 °C, sample cooling is required to minimize interaction between components in the sample and to provide a safe sampling environment.

For most applications, the aim should be to reduce the final sample temperature to 25 °C ± 2 °C. With these criteria, a high proportion of sample sources will require cooling prior to sampling and subsequent analysis.

For some applications where samples have to be cooled from a high temperature, or where an accurate control over the final sample temperature is required, for example for on-line electrical conductivity monitoring, two coolers in series may be required. Designating these as the initial and final cooler, the initial coolers should be located downstream of, and as close as practicable to, the sample isolation valves. The final cooler will normally be located close to the point of manual sampling or on-line instrumentation.

The cooler should contain a stainless steel 316, Inconel 600 or Monel 400 coil housed in a stainless steel body designed so that the flow of cooling water is opposite to the flow of sample in the coil. The size of the cooler and coil will be determined by its intended duty.

The cooler shell should be fitted with a safety relief valve, as a precaution against coil failure and subsequent over-pressurisation of the shell. To limit the size of the pressure relief valve, a flow control orifice can be located in the sample line upstream of the cooler.

Cooling water supplies should be from a suitably demineralized water source, which may be chemically conditioned to provide protection against corrosion. The mains water of towns should not be used for this purpose without a prior agreement between the user and the cooler manufacturer.

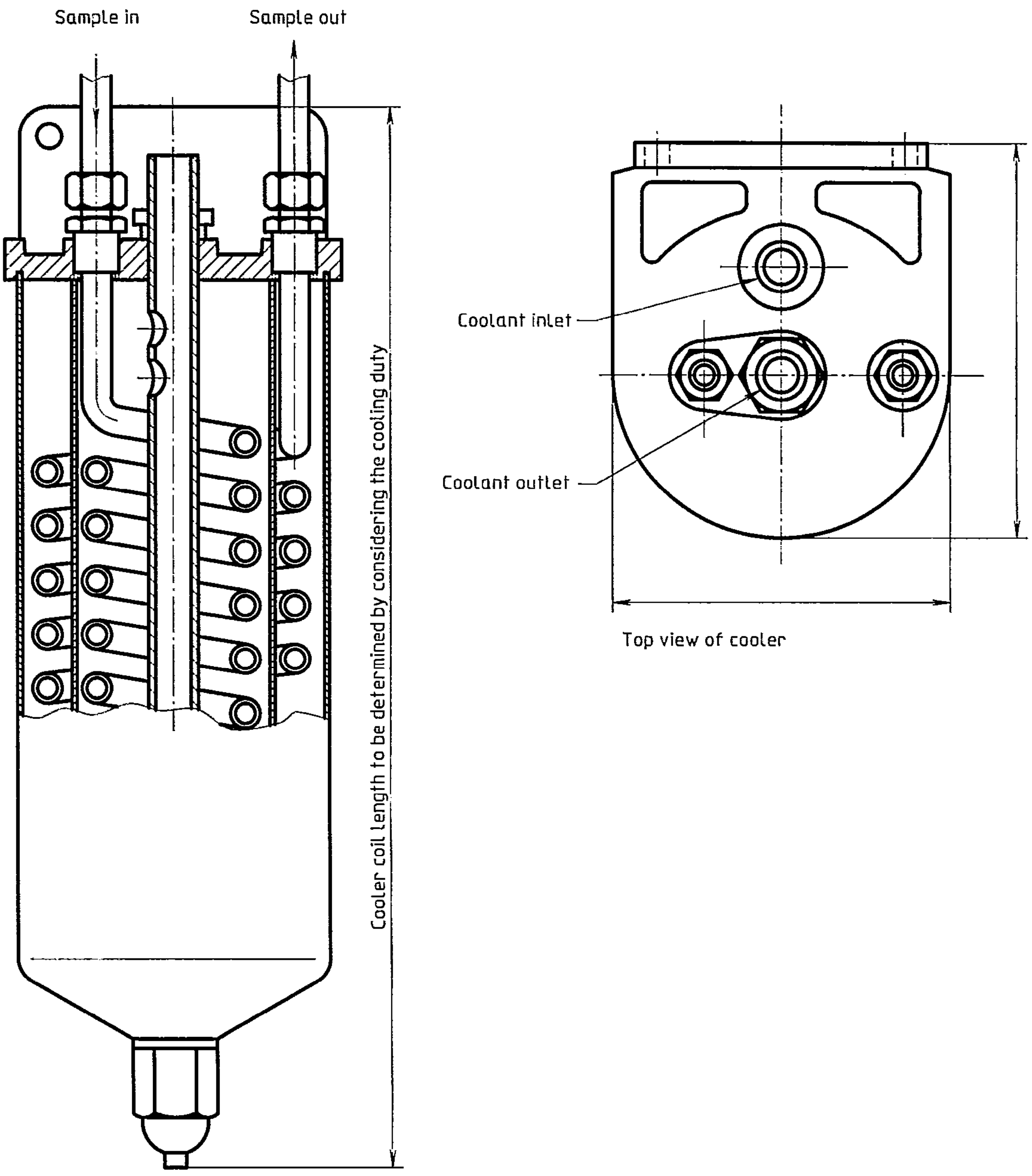
An appropriate design of cooler is shown in figure B.1.

Table B.1 indicates typical design parameters for initial and final cooling duties.

Coolers for shell and hot water boilers are generally less complex and may not require a large volume of demineralized water for cooling.

Table B.1 — Operating parameters of a sample cooler

Cooler			Initial	Final
Sample inlet conditions	Water	Flow (kg/s)	0,34	0,34
		Temperature (°C)	355	100
		Pressure (MPa)	19	19
	Steam	Flow (kg/s)	0,17	0,17
		Temperature (°C)	570	100
		Pressure (MPa)	19	19
Sample outlet temperature (°C)			< 50	25 ± 2
Temperature water inlet temperature (°C)			< 30	< 20
Temperature water outlet temperature (°C)			< 70	



Top view of cooler

Cooler shell — Constructed entirely of stainless steel

Coil — Constructed of stainless steel, Inconel 600 or Monel 400

Safety relief valve — To be fitted to the cooler or cooling water shell or on the cooling water outlet pipework

Figure B.1 — Example of a typical sample cooler

Annex C
(informative)

Report — Sampling of water and steam in boiler plants

Reason for sampling: ....
....
Identification of sampling point: ....
Type of water/steam sampled: ....
Pressure: ....
Temperature: ....

Date: day .... month .... year ....
Time: start .... end .... of sampling

Name of person taking the sample: ....
Sampling method: ....
Sampling preservation method: ....
Observations at the sampling point: ....
Sampling containers: ....
Sampling labels: ....

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Descriptors: boilers, water, steam, quality, sampling, sampling equipment, general conditions.

Price based on 16 pages