INTERNATIONAL STANDARD

ISO 5667-7

First edition
1993-11-01

Water quality — Sampling —

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

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ISO 5667-7:1993
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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.

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International Standard ISO 5667-7 was prepared by Technical Committee ISO/TC 147, *Water quality*, Sub-Committee SC 6, *Sampling (general methods)*.

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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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International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

— *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.

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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.

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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]

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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.

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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.

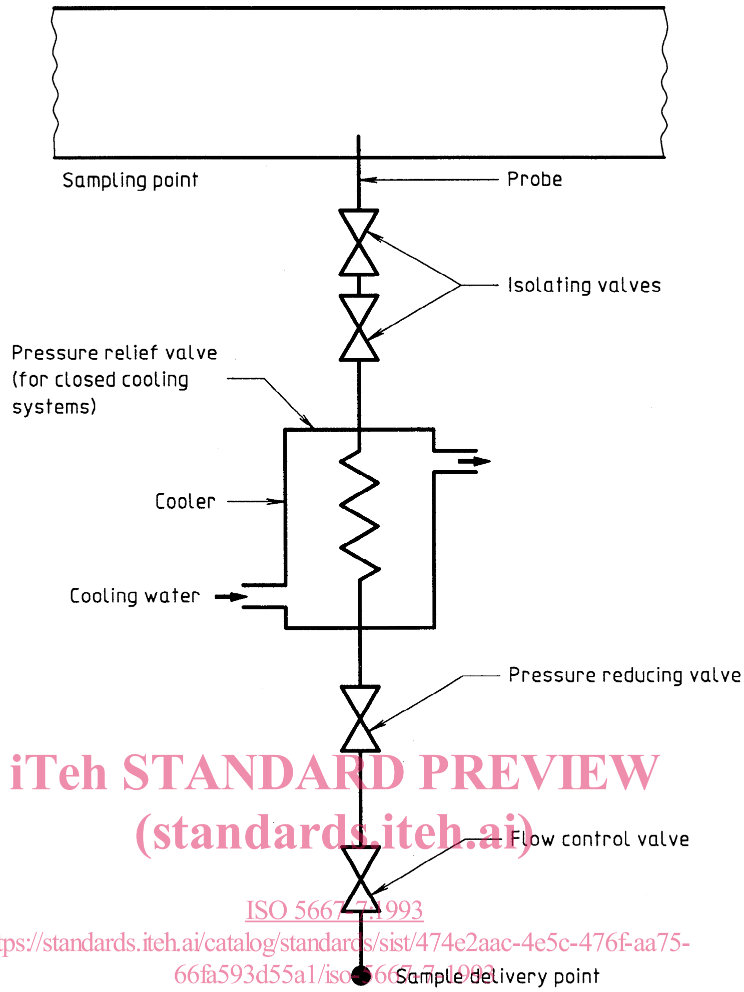

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Figure 1 — Schematic water sampling system

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.

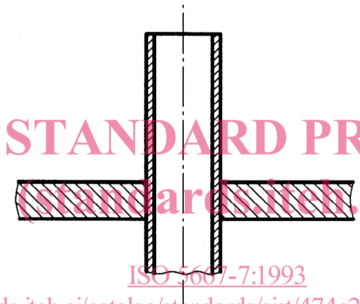

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Figure 2 — Example of a straight circular sampling probe for sampling soluble species

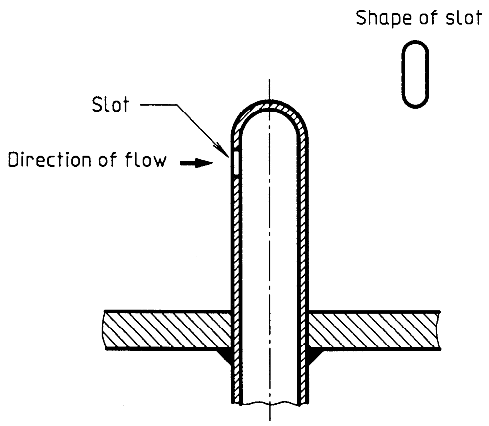

Figure 3 — Example of a directional sampling probe for sampling particulates in water

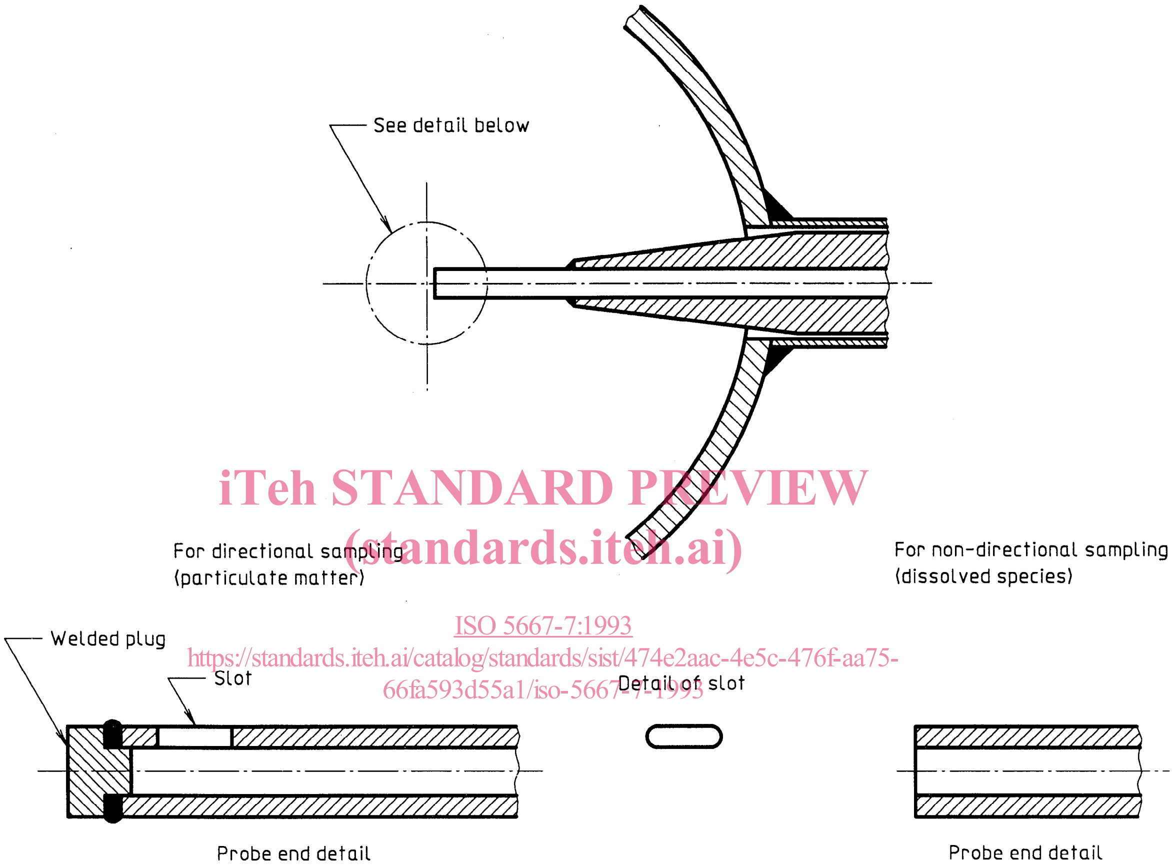

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Figure 4 — Example of a water sampling probe for both soluble and particulate sampling

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.

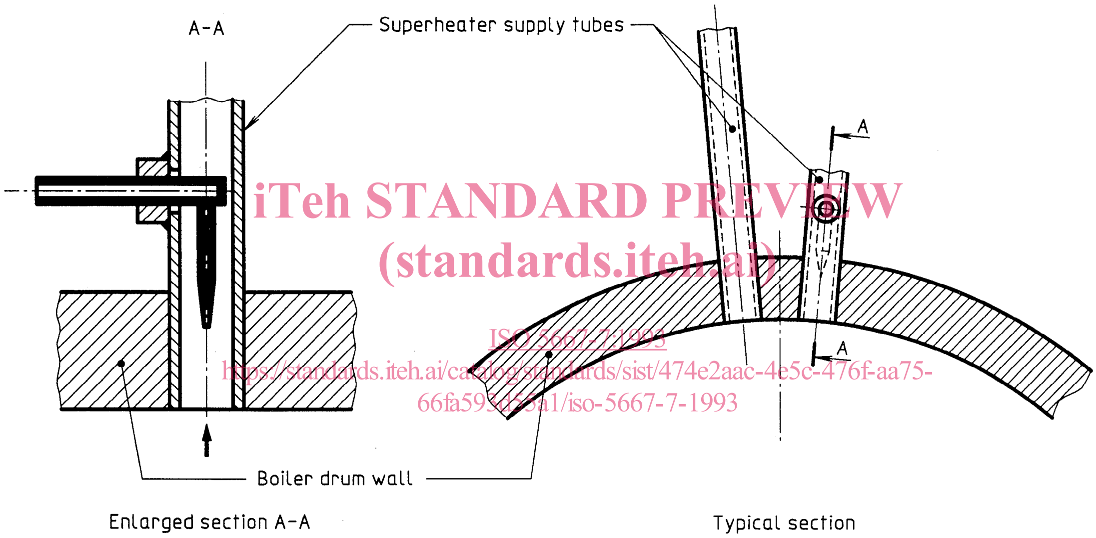

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Figure 5 — Examples of sampling probes for sampling saturated steam

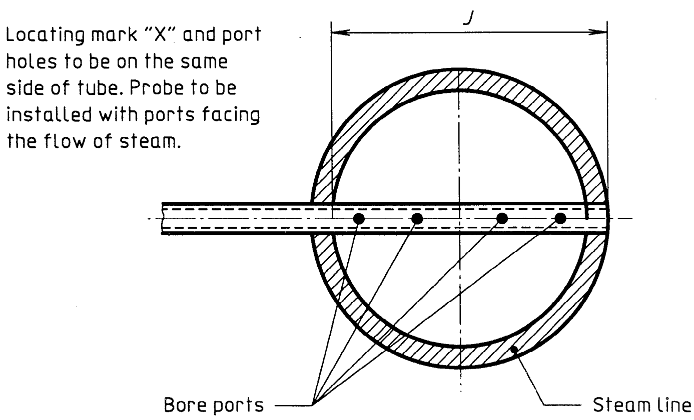
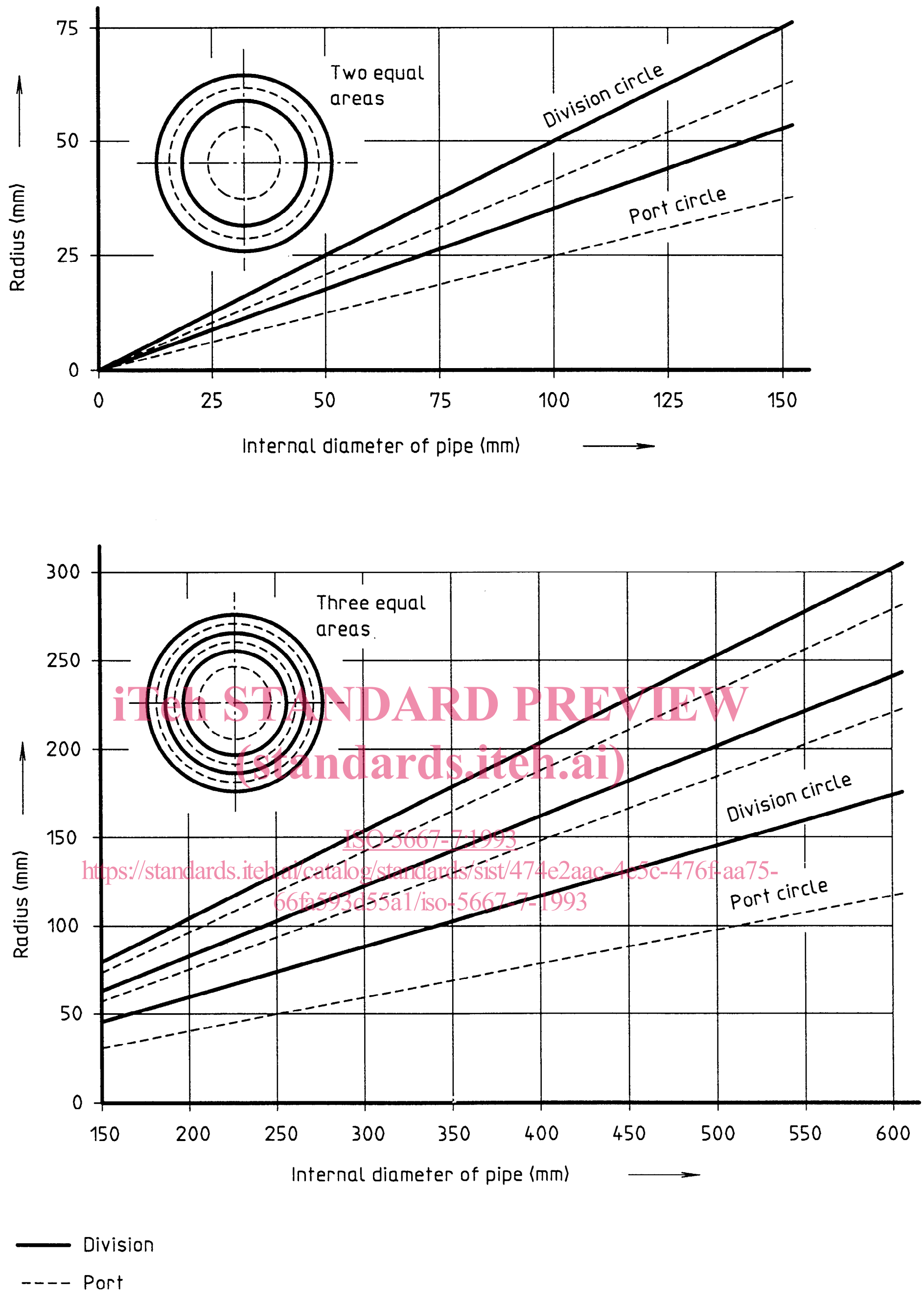


Figure 6 — Example of a steam sampling probe, multiport type



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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