INTERNATIONAL STANDARD

ISO 15080

First edition
2001-09-15

Nuclear facilities — Ventilation penetrations for shielded enclosures

Installations nucléaires — Traversées de ventilation pour enceintes blindées

Reference number
ISO 15080:2001(E)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15080 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

Annex A forms an integral part of this International Standard. Annexes B and C are for information only.

Introduction

This International Standard provides guidance and recommendations for the design, mounting and assembly of static penetration systems used for ventilation purposes in shielded enclosures. It gives general requirements on the material to be used, the construction of the different types of penetrations which can be used, the way of mounting and assembling and, finally, standard dimensions for some typical equipment.

Nuclear facilities — Ventilation penetrations for shielded enclosures

1 Scope

This International Standard specifies the requirements for the construction and the installation of radiobiological shielding devices used as ventilation passages through shielded enclosures with concrete or leaded walls to protect against gamma radiation.

This International Standard applies to all shielded containment enclosures used for handling radioactive products or material emitting penetrating radiation (gamma or neutrons) in such quantities and of such emission rate that these products must be handled remotely behind a shielding wall. Typically, the enclosures considered cover all types of nuclear fuel cycle installations: reprocessing plants, hot activity laboratories, plutonium solution handling facilities, shielded cells, waste storage installations, etc.

It could eventually be applied to particle accelerators, primary containment of research reactors, fusion research reactors, radiographic installations, neutron generators, etc.

However, pressurized vessels, sealed sources, transport packaging for radioactive materials, as well as enclosures, primary circuits and vessels of nuclear power plants have been deliberately excluded from the scope of this International Standard.

This International Standard specifies general and detailed principles which shall be respected when designing ventilation penetrations for shielded enclosures. These specifications can be divided more generally into two categories of guidance, which apply to the two following systems of ventilation penetrations for shielded enclosures already in use:

— the first corresponding to the most important conventional systems used worldwide, and

— the second corresponding to an alternative method, called the “cast iron helix technique”.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3452, *Non-destructive testing — Penetrant inspection — General principles.*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
containment enclosure
enclosure designed to prevent leakage of products contained in the internal environment under consideration into the external environment, or the penetration of substances of the external environment into the internal environment, or both simultaneously

NOTE This is a generic term to designate all kinds of enclosures, including glove boxes, or cells of different dimensions used for handling or storing radioactive materials by means of handling devices.

3.2
shielded enclosure
containment enclosed by an additional shielding wall intended to provide complementary shielding against penetrating radiation

NOTE This additional shielding wall can be integral with, mounted on, or independent of the containment enclosure wall. The choice and thickness of the protection material depend on the type of radiation (beta, gamma or neutron) and the type of handling required.

3.3
static service penetration
(for a shielded enclosure)
device used in a containment enclosure wall for the introduction or the extraction of fluids such as air, water, gas, water vapour, or the transmission of energy

3.4
ventilation penetration
(for a shielded enclosure)
device installed on a ventilation network and mounted on a shielded enclosure wall, intended to ensure the shielding continuity of the enclosure wall and the required passage of the air or gas through this enclosure wall

4 Design of ventilation penetrations

4.1 General principles

The general and detailed design principles for ventilation penetrations for shielded enclosures, specified in this International Standard, can be divided more generally into two categories of guidance, which apply to the two following systems of ventilation penetrations for shielded enclosures already in use:

- the first corresponding to the most important conventional systems, which are used worldwide, and
- the second corresponding to an alternative method, which is called the “cast iron helix technique”.

Ventilation penetrations for shielded enclosures shall be designed to maintain the quality of the containment and the efficiency of the shielding of the shielded enclosure, in order to protect the operators against ionizing radiation and radioactive contamination.

The quality of the containment shall be particularly good where the level of internal radioactive contamination of the shielded enclosure is high. In this last case, the junction between the wall penetrations and the inner line of the shielded enclosure shall be leaktight.

Static penetrations shall be carried out in order to reproduce the shielding efficiency ensured by the structure of the shielded enclosure. When a local lessening of the shielding is unavoidable, additional shielding shall be placed on the radiation leakage line, inside, outside or directly included in the enclosure wall.

This additional shielding shall ensure that the cross-section of the shielding efficiency of the wall penetration taken in all directions provides the same level of shielding in units of mass as the shielding wall.

The design of the additional shielding is dependent upon:

— the intensity and the position of the source (or sources) of radiation;

— the diameter of the wall penetrations;

— the thickness of the shielding wall.

The design of the additional protection shall be conducted on a case-by-case basis.

When neutrons are simultaneously emitted with gamma radiation, it is necessary, depending on the neutron energy, to add an additional shielding material more effective for neutrons. Special calculations shall be made for the dimensioning of the systems ensuring the wall penetrations.

The designer could refer to the manual on safety aspects of the design and equipment of Hot Laboratories (see reference [3] in the Bibliography).

4.2 Conventional ventilation penetrations

Where the ventilation duct crosses the wall directly, it is necessary to add shielding in order to minimize radiation leakage (see Figure 1).

Shielding shall be designed to prevent direct streaming through the ventilation penetration. The duct shall not be located on the direct path of the radiation compared to the position of the operators.

Where the ventilation duct penetrates the wall in a zigzag, the duct-mounting appliance shall be enclosed in a material providing the same level of protection as the shielding wall. In general, the material shall be at least three times more dense than the wall, if it is made in concrete with a density of 2,2 t/m^3 (see Figure 2).

Annex C gives other examples of conventional duct penetrations for shielded enclosures.

4.3 Cast iron helix technique

4.3.1 General considerations

In this solution (see Figure 3), the ventilation duct consists of a helix mounted on a metallic housing. The minimum density of the helix shall be approximately three times greater than that of the wall in order to maintain the same level of protection as the shielding wall. In general, this solution does not require additional shielding.

The helixes are made from a metallic material (e.g. cast iron, stainless steel, lead). For neutron shielding, the helix can be eventually made from a plastic material (e.g. propylene, polyethylene).

4.3.2 Characteristics

Because of their helical shape, these protection helixes can ensure the following:

a) shielding continuity with an attenuation against gamma radiation equivalent to that of the wall to be penetrated;

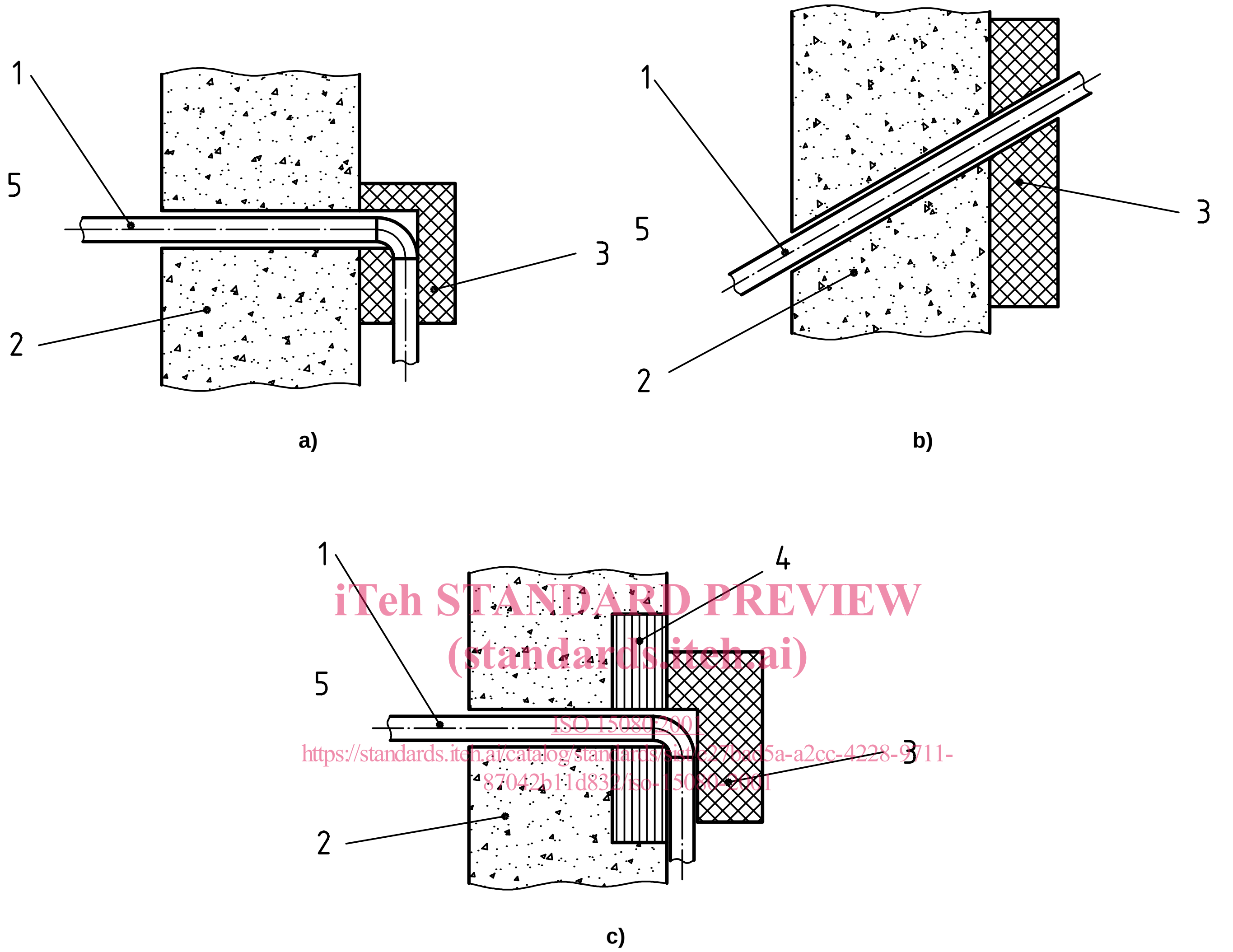
b) the passage of air or gas through the wall with the creation of a very small pressure drop.

When the walls are made of materials with a density greater than 2,2 t/m^3, the use of the helix requires adaptations to reconstitute protection equivalent to straight-through passages (see 4.3.4.2).

The design of the additional protection shall be conducted on a case-by-case basis.

4.3.3 Design of the helix systems

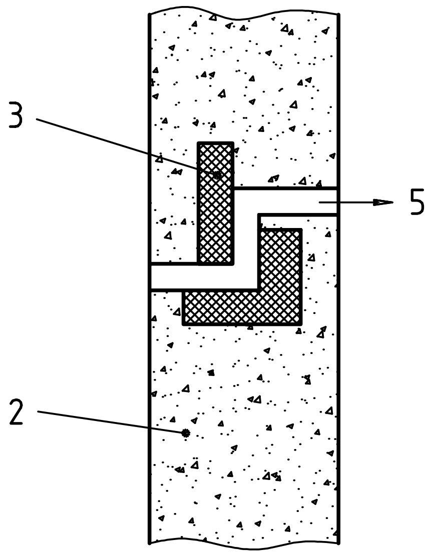
The protection helix contains one or several elements assembled into a steel housing forged and generally ended by connection flanges [see Figures 3b) and 4)].



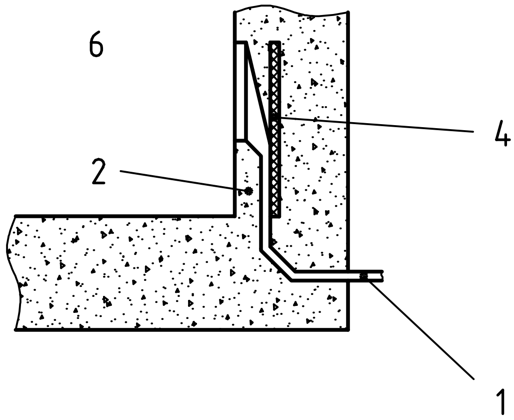
Key

1 Ventilation duct
2 Concrete wall
3 Additional shielding
4 Additional shielding (cast iron or lead)
5 Inside enclosure

Figure 1 — Examples of conventional ventilation penetrations with additional shielding placed outside the shielding wall



a)



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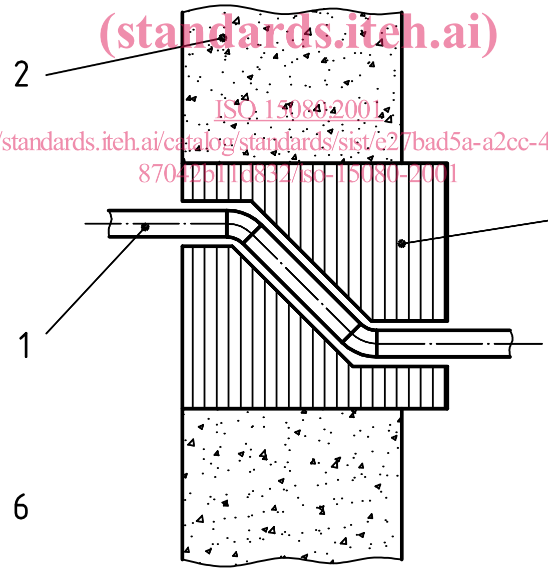
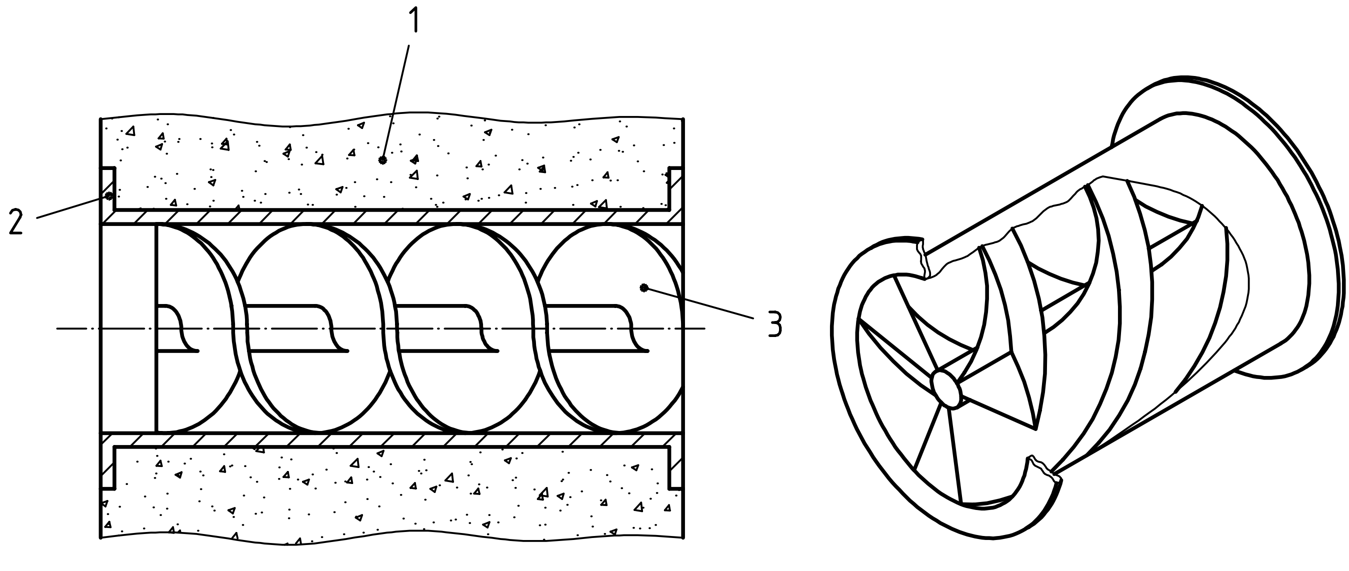


c)

Key

1 Ventilation duct
2 Concrete wall
3 Additional shielding
4 Additional shielding (lead or steel)
5 Outside enclosure
6 Inside enclosure

Figure 2 — Examples of conventional ventilation penetrations with additional shielding placed inside the shielding wall



Key

1 Concrete wall
2 Housing
3 Helix

Figure 3 — Helix system

The helix elements are cast with three, four or five threads of trapezoidal cross section, with a conventional external diameter of 300 mm, 500 mm or 750 mm. Other diameters can be fabricated.

The housings made of sheet steel constitute the shell of the helix. The housings can have treaded flanges used for connecting air ducts.

The helix is fastened to the housing with pins or by mechanical means (threaded fastenings).

The design elements are described in annexes A and B.

