

# INTERNATIONAL STANDARD

# ISO 15080

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## **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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## 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<sup>3</sup> (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:

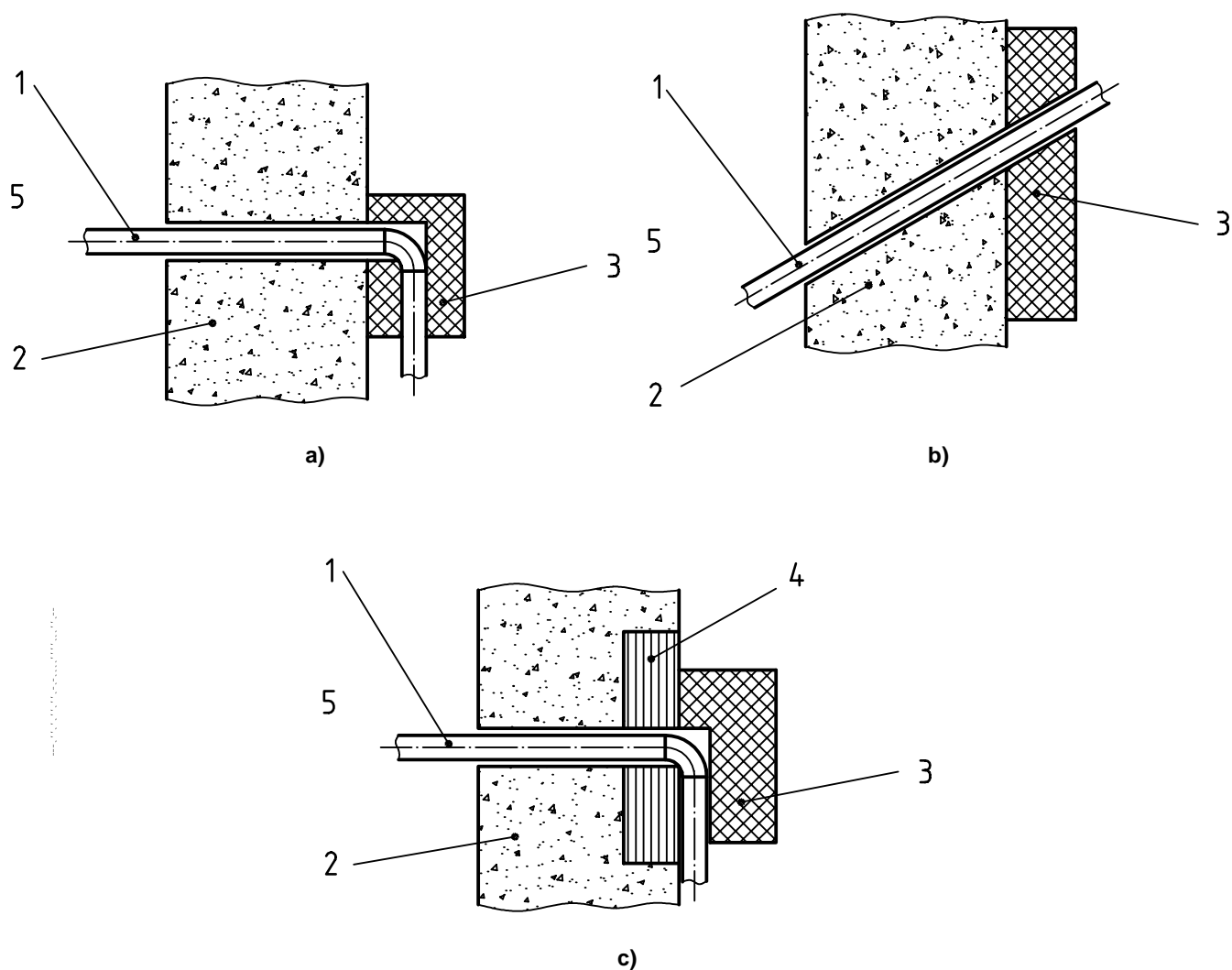
- a) shielding continuity with an attenuation against gamma radiation equivalent to that of the wall to be penetrated;
- b) the passage of air or gas through the wall with the creation of a very small pressure drop.

When the walls are made of materials with a density greater than 2,2 t/m<sup>3</sup>, 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

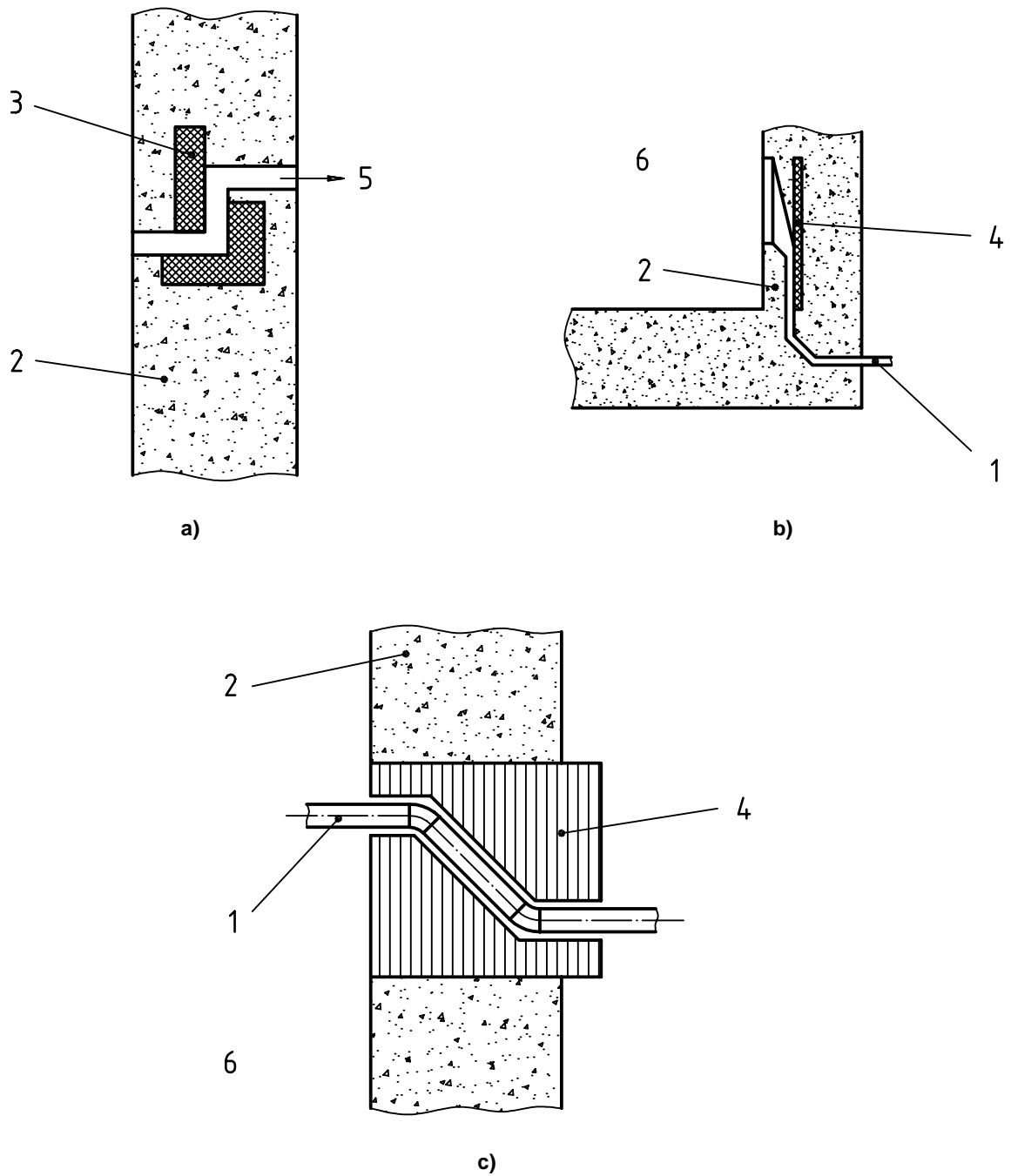
The protection helix contains one or several elements assembled into a steel housing forged and generally ended by connection flanges [see Figures 3b) and 4)].



**Key**

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

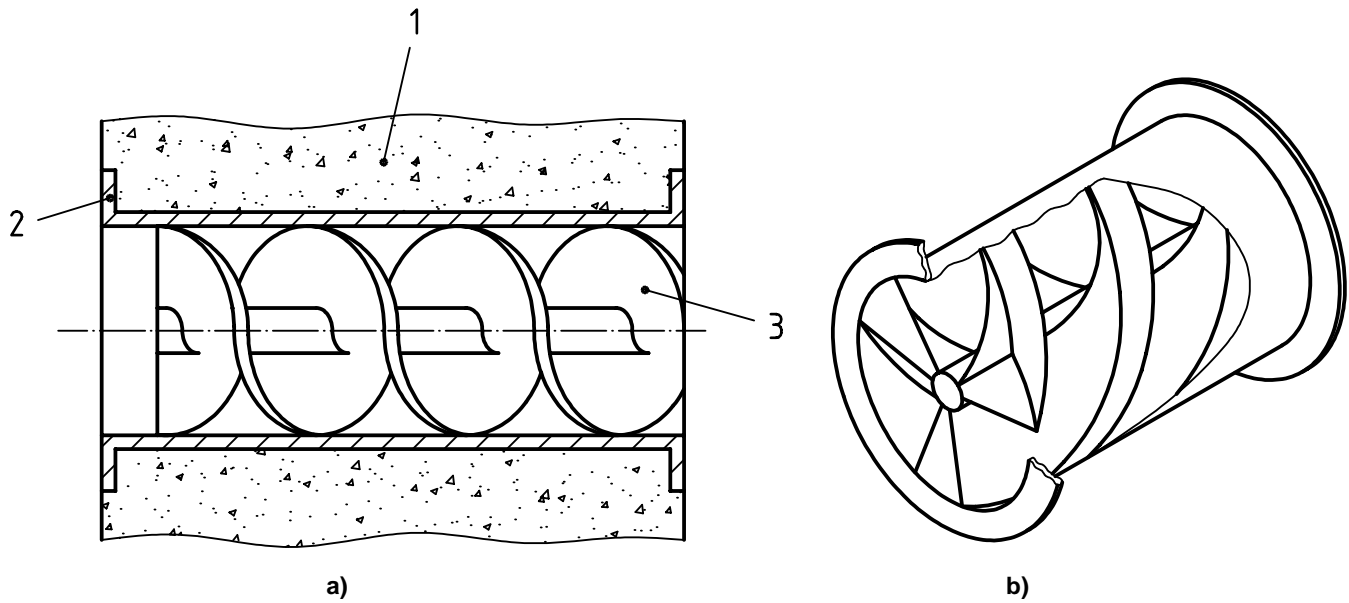
**Figure 1 — Examples of conventional ventilation penetrations with additional shielding placed outside the shielding wall**



**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

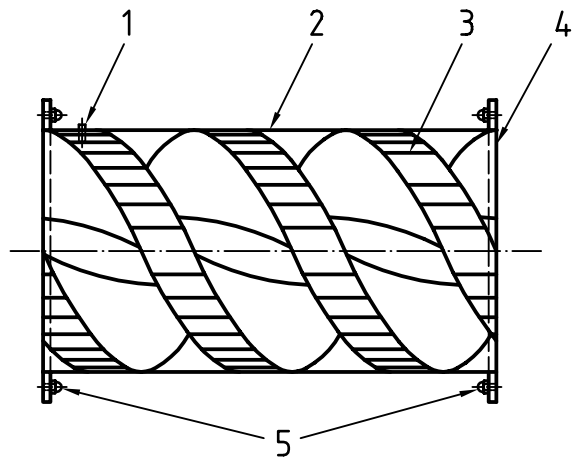
**Figure 3 — Helix system**

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.

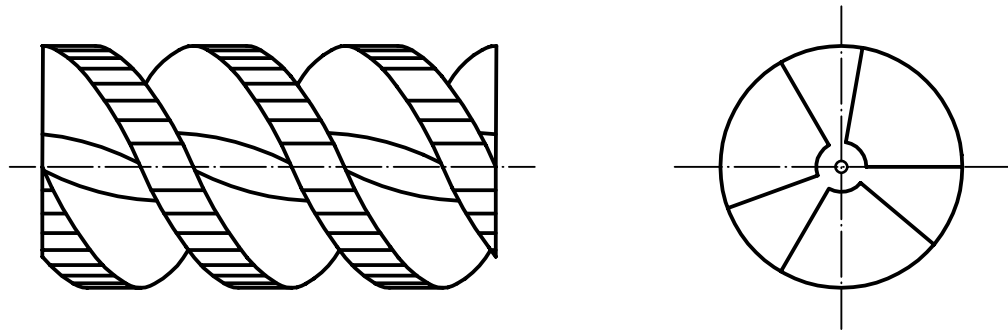
The housings made of sheet steel constitute the shell of the helix. The housings can have treaded flanges used for connecting air ducts.

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

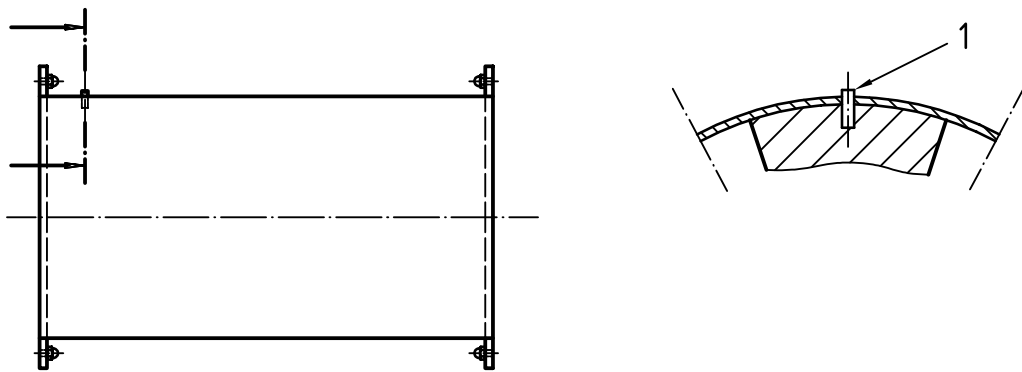
The design elements are described in annexes A and B.



a) Cross-section of a helix set in its housing



b) Helix



c) Housing

**Key**

- 1 Pin
- 2 Housing
- 3 Helix
- 4 Flange
- 5 Blind nuts

**Figure 4 — Helix elements (example with 3 threads)**

#### 4.3.4 Principles of installation

##### 4.3.4.1 General

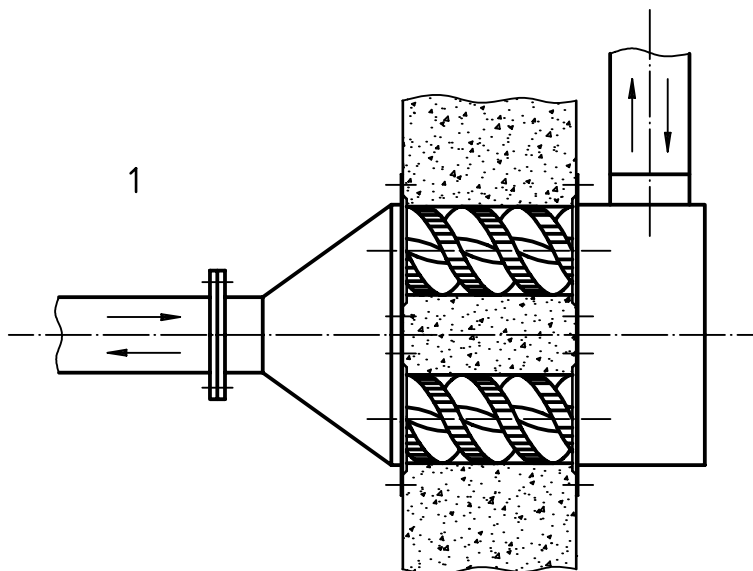
The protection helixes shall be installed horizontally or vertically. In certain special cases, the helix can be inclined.

The helix-housing unit or units can be placed in the wall prior to the pouring of the concrete. Units may also be placed in channels formed in the wall and then cemented into place. Inlet and/or outlet ventilation connections as shown in Figures 5 and 6 can be mounted on the helix.

When a high ventilation flow is required, one or several units can be mounted in parallel as shown in Figure 5.

The means for supporting the protection helix for pouring the concrete shall in no case damage the materials or the coating of the helix and housings.

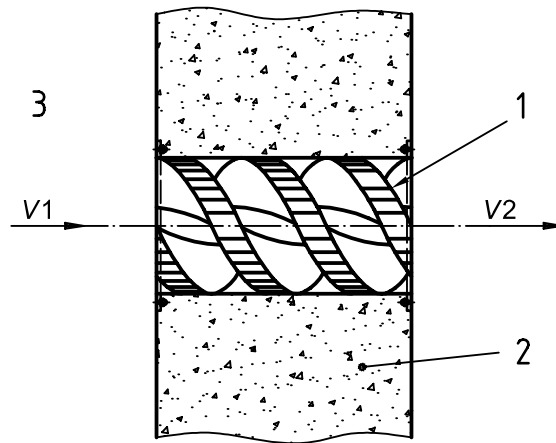
During the pouring of concrete, care shall be taken to avoid the introduction of concrete or water into the helix and the blind nuts.



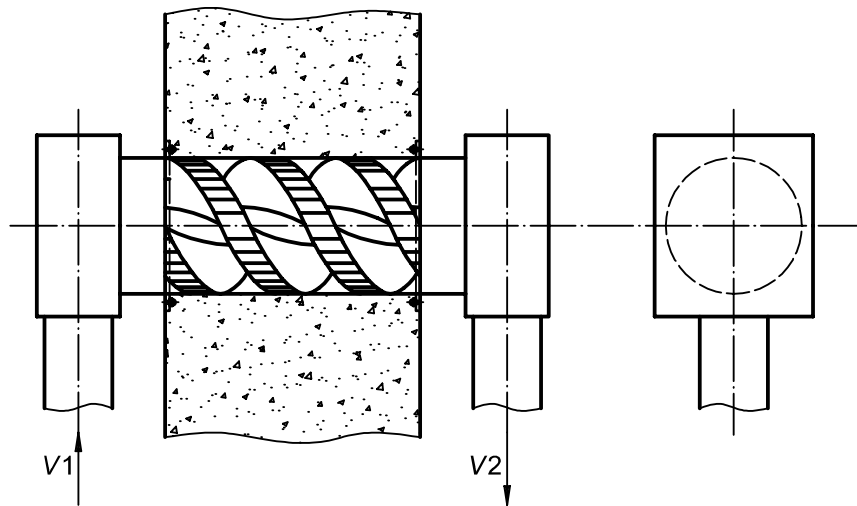
#### Key

- 1 Inside or outside the enclosure

Figure 5 — Example of an arrangement with several helix units



a) Inlet and outlet without connection



b) Inlet and outlet connection

**Key**

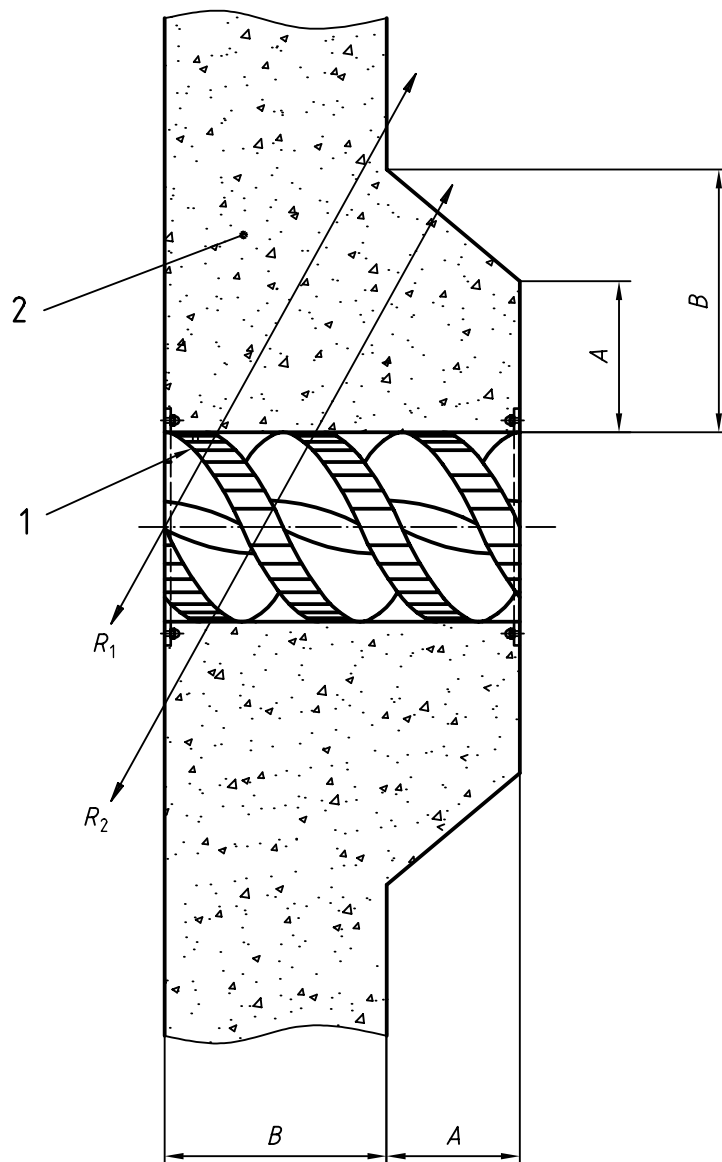
- 1 Helix
- 2 Concrete wall
- 3 Inside enclosure

**Figure 6 — Helix examples with and without inlet and outlet connections****4.3.4.2 Special cases**

In the following cases, an increase of the thickness of the wall in the area around the helix shall reconstitute the equivalent to  $R_1$ .

The two cases considered in Figure 7 take into account the installation of a ventilation helix in a wall:

- whose thickness is less than the minimum length of the helix allowed by the design,
- whose average density is higher than  $2,2 \text{ t/m}^3$  so that the helix length is greater than the wall thickness.



**Key**

- 1 Helix
- 2 Concrete wall

**Figure 7 — Fitting of a helix of length greater than that of the wall to be penetrated**



## Annex A (normative)

### Specifications for the design of cast iron helixes

#### A.1 Material of manufacture

##### A.1.1 Helix

For the essential factors such as mechanical resistance, machining, homogeneity and radiation attenuation behaviour, the use of cast iron with lamellar graphite of grade FGL 200 in accordance with the standard NF A 32-101 is recommended for the helix unit.

##### A.1.2 Housing

The housings and flanges are generally made of non-alloy carbon steel S 235J of minimum quality 2 in accordance with to the standard NF EN 10025, or of austenitic stainless steel in accordance with standards EN 10088/2 or EN 10088/3, X2 CRNI 18,09 or ANSI 304 depending on the gamma radiation level inside the enclosure. The grade shall be resistant to the corrosive characteristics of the air or the gas carried and chosen in accordance with the internal covering of the enclosure.

The housings are produced entirely by a mechanical-welded process. The welds shall be continuous, perfectly penetrated and caulked. The welders shall be trained and qualified professionals in accordance with national standards (e.g. NF EN 287).

The assembly systems (blind nuts, devices to maintain the helix elements in the housing, etc.) shall be made of a steel grade compatible with those used in the manufacture of the housings and flanges.

##### A.1.3 Coating

After sanding or shot blasting, the helix can be painted.

The coating shall be resistant to the corrosive characteristics of the air or gas in contact with the helix and with the intensity of the gamma radiation inside the enclosure. If the absorbed dose by the housing-parts in contact with the gamma radiation is higher than  $1,5 \times 10^6$  Gy, the housings shall be made out of austenitic stainless sheet.

##### A.1.4 Helix/Housing assembly

Each helix is delivered set in its housing. Assembly shall be carried out by introducing the helix in the housing.

#### A.2 Dimensional specifications

##### A.2.1 General data

The helix shall have a length

- equal to the thickness of the wall of the shielded enclosure in which it is fixed, when it is made of concrete of density  $2,2 \text{ t/m}^3$  or less, and
- greater than the thickness of the wall when the wall is in heavy concrete or when the minimal wall thickness is less than the minimal length of the helix.

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The choice is made between the three following conventional types of helix, which are available:

- Ø 300 of minimum length 450 mm,
- Ø 500 of minimum length 600 mm,
- Ø 750 of minimum length 800 mm.

The final selection shall be made taking the following factors into account:

- a) the required air flow;
- b) the admissible pressure drop;
- c) the surface available and the thickness of the wall;
- d) the space available inside and outside the wall for connecting the ventilation ducts.

These four requirements can be met by selecting one or several devices.

These rules only represent an approximate approach for the pre-dimensioning of the protection efficiency of the helix.

The second objective is to maintain the same radiation attenuation efficiency as that of the wall. To achieve this, the calculations of the final dimensions shall take into account:

- a) the location of the radiation source relative to the passage and its diameter;
- b) the energy spectrum of the radiation source;
- c) the dimensions and volume of the enclosure;
- d) the accessibility and the time of presence of the operators.

Depending on the results, these calculations will enable the protection efficiency to be determined or the additional shielding to be defined as necessary.

The protection helix shall be manufactured to meet the operating constraints of the shielded enclosure to which it belongs, particularly those concerning air or gas specifications, sealing conditions and the requirements of construction and security, etc.

The dimension data shall be noted in the characteristic boards (see annex B).

## A.2.2 Standardized dimensions

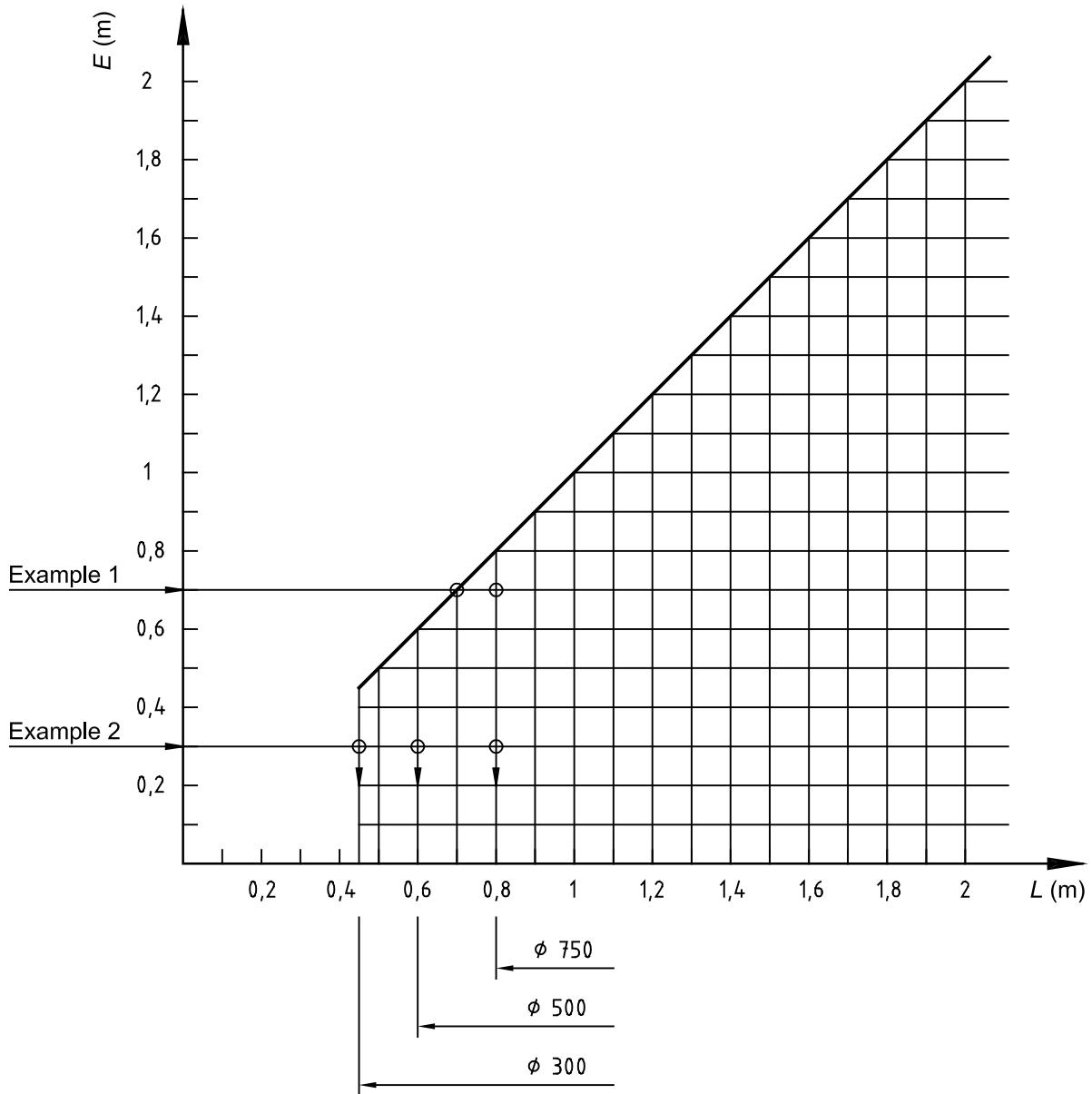
The normal dimensions of cast iron helixes are given in Table A.1.

**Table A.1 — Standardized dimensions of cast iron helixes**

Description	Type Ø 300	Type Ø 500	Type Ø 750
<b>Helix</b> (in cast iron)			
Nominal diameter	300 mm	500 mm	750 mm
Standard length, multiple of	100 mm	100 mm	100 mm
Theoretical minimum length to be installed	450 mm <sup>a</sup>	600 mm	800 mm
Maximum length advised	2 200 mm	2 200 mm	2 200 mm
Pitch of helix	600 mm	800 mm	1000 mm
Number of threads at $L_{\min}$	3	4	5
Thickness of a thread on axis	60 mm	60 mm	60 mm
Diameter of core	50 mm	80 mm	110 mm
Minimum weight of an element per linear metre without housing (relative density: 7)	155 kg	430 kg	880 kg
Useful cross-section for air flow	0,034 m <sup>2</sup>	0,104 m <sup>2</sup>	0,300 m <sup>2</sup>
<b>Housing</b> (in non-alloyed carbon steel or stainless steel)			
Recommended thicknesses	2 mm	2 mm	3 mm
<p><sup>a</sup> This dimension can be obtained from an element of length 500 mm machined to 450 mm</p> <p>NOTE Dimensional tolerances of helix for machining:</p> <p>— for the diameter:        0    mm                                       -0,3 mm</p> <p>— for the length:         0    mm                                       -2    mm</p> <p>Play between helix and housing:</p> <p>— less than 0,5 mm along the radius</p> <p>Dimensional tolerances for housings:</p> <p>— for the length:         0    mm                                       +2    mm</p>			

**A.2.3 Determination of the minimum length of the helix**

Figure A.1 shows the chart for calculating the helix length relative to the thickness of wall for a concrete density of 2,2 t/m<sup>3</sup>.



$L_{min}$  in metres, is the minimum length of the helix;

$E$ : in metres, is the thickness of concrete wall of density 2,2 t/m<sup>3</sup> necessary for protection against gamma radiation;

Ø 300, Ø 500 and Ø 750 are the helix diameters, in millimetres.

**Figure A.1 — Chart for calculating the helix length relative to the thickness of wall for a concrete density of 2,2 t/m<sup>3</sup>**

## A.2.4 Examples of calculation of the length of the helix depending on the thickness of the wall

EXAMPLE 1: Wall thickness  $E = 0,7$  m

Diameters of the helix  $\varnothing 300$  mm and  $\varnothing 500$  mm:  $L_{\min} = 0,70$  m

Diameter of the helix  $\varnothing 750$  mm:  $L_{\min} = 0,80$  m

EXAMPLE 2: Wall thickness  $E = 0,3$  m

Diameter of the helix  $\varnothing 300$  mm:  $L_{\min} = 0,45$  m

Diameter of the helix  $\varnothing 500$  mm:  $L_{\min} = 0,60$  m

Diameter of the helix  $\varnothing 750$  mm:  $L_{\min} = 0,80$  m

## A.2.5 Determination of the helix pressure drop

### A.2.5.1 Evaluation of the pressure drop coefficients

The total helix pressure drop is the sum of the linear pressure drop (coefficient  $K_1$ ) and the particular pressure drop (coefficient  $K_2$ ) at the inlet and the outlet of the helix.

These pressure drops are linked and take into account the gyratory flow of the helix geometry.

The test results gave average values equal to:

—  $K_1 = 0,76L$  ( $L$  in metres);

—  $K_2$  is the sum of the inlet coefficient ( $K_{21}$ ) and the outlet coefficient ( $K_{22}$ ), according to data given in Figure A.2 ( $K_2 = K_{21} + K_{22}$ )

These coefficients ( $K_{21}$  et  $K_{22}$ ) are approximations for calculating the pressure drop in ventilation ducts.

$$D_p = \rho \times S \times K \times Q^2 \times 10^{-6}$$

where

$D_p$  is the total helix pressure drop, in pascals (Pa);

$\rho$  is the density of air, in kilograms per cubic metre ( $\text{kg}\cdot\text{m}^{-3}$ );

$Q$  is the flow rate, in cubic metre per hour ( $\text{m}^3\cdot\text{h}^{-1}$ );

$K$  is the sum of the coefficients of pressure drop  $K_1 + K_2$ ;

$S$  is the specific coefficient for the diameter of the helix, in metres to the power minus four ( $\text{m}^{-4}$ );

$S = 34,2 \text{ m}^{-4}$  for a helix  $\varnothing 300$  mm,

$S = 5,5 \text{ m}^{-4}$  for a helix  $\varnothing 500$  mm,

$S = 1,0 \text{ m}^{-4}$  for a helix  $\varnothing 750$  mm ( $S$  is determined by calculation).

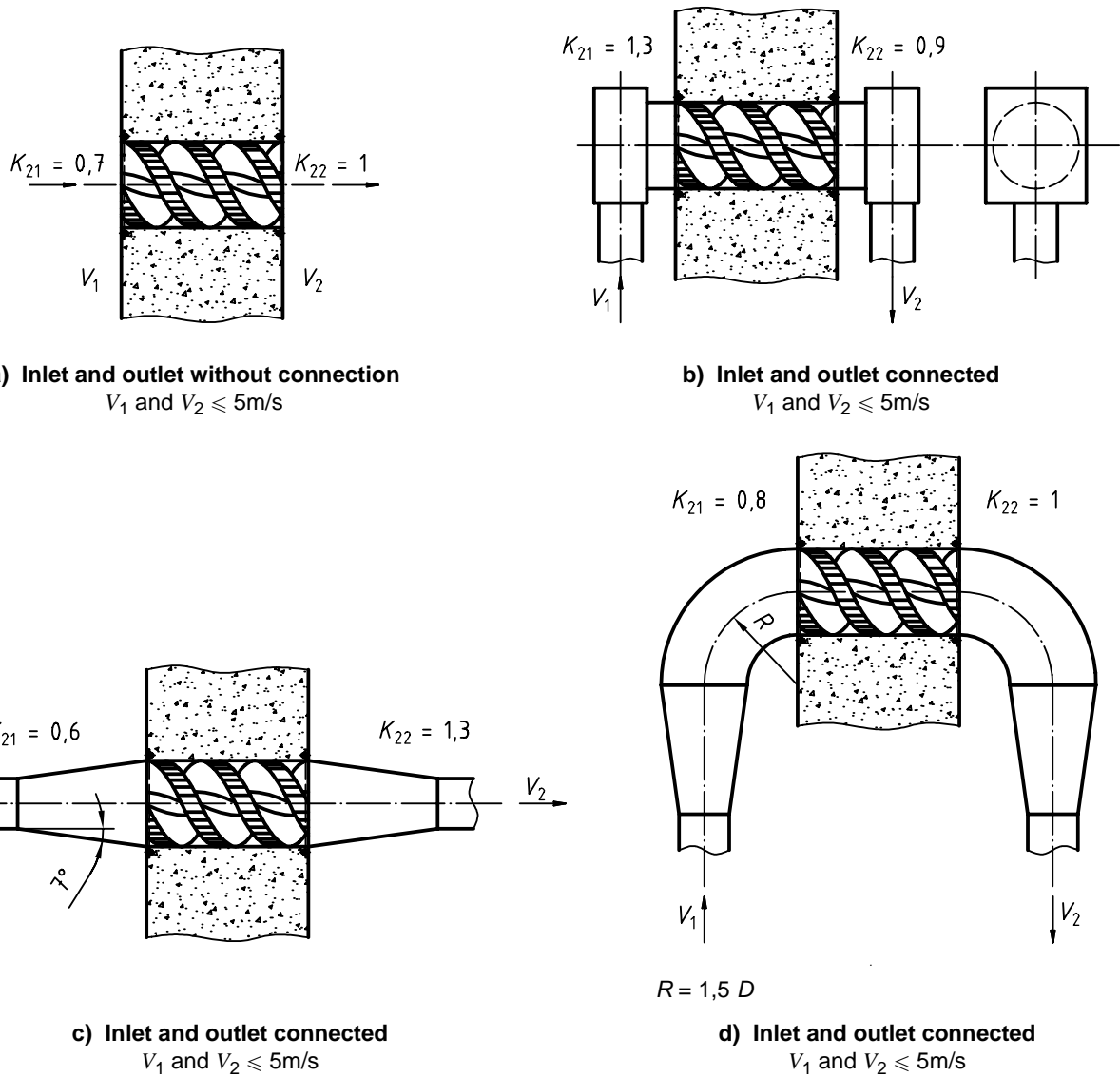
**A.2.5.2 Example of pressure drop  $D_p$**  (see Figure A.2)

Diameter of the helix:  $\varnothing$  500 mm

Length of the helix: 1,3 m

Air flow rate:  $1\,300\text{ m}^3\cdot\text{h}^{-1}$

$D_p = 1,8\text{ daPa}$



**Figure A.2 — Diagram for calculation of coefficients of pressure drop  $K_{21} + K_{22}$**

## Annex B (informative)

### Rules for the definition of cast iron helixes

Table B.2 gives characteristic boards. Table B.1 gives explanations of the references in Table B.2.

**Table B.1 — Explanation of the references given in Table B.2**

Reference	Designation
<b>1</b>	<b>General data</b>
11	Identification of the assembly: An assembly comprises one or several units. A unit is made up of one helix and one housing.
111	Functional reference: The reference is unique for an assembly and should appear on each unit.
112	Free.
113	Reference for embedded parts: This reference is unique and shall be placed on each unit.
121	Identification of the upstream premise: Indicate the reference of the premise.
122	Identification of the downstream premise: Indicate the reference of the premise.
13	Number of the ventilation plan: This is a guide plan of the ventilation which shows the protection helix.
<b>2</b>	<b>Specifications of the wall to be crossed</b>
21	Location.
211	Wall (W): put an X in the corresponding column.
212	Floor (F): put an X in the corresponding column.
221	Nature of the wall: Heavy concrete: put HC in the corresponding column and state the relative density. Ordinary concrete: put OC in the corresponding column.
222	Stainless steel coating, if present: Put an X in the corresponding column if such exists in the enclosure.
23	Minimum thickness of walls to ensure protection against gamma radiation: Elements provided by calculation: Values for ordinary concrete.
24	Thickness of the wall to be crossed: Elements given on the structural guide plans.

Reference	Designation
<b>3</b>	<b>Manufacturing specifications</b>
31	Number of units: State the number of units in a set.
32	Nominal diameter of each unit.
321	∅ 300 mm: put an X.
322	∅ 500 mm: put an X.
323	∅ 750 mm: put an X.
33	Helix part.
331	Cast iron screw. The helix is made entirely in cast iron: put an X.
332	Length: Indicate the total length of the helix in millimetres.
34	Housing parts.
341	Non-allow carbon steel; put an X in the corresponding column.
342	Stainless steel: put an X in the corresponding column.
343	Length of the housing: put an X in the corresponding column. Indicate the total length in millimetres.
35	Mass per unit in kilograms: See Table 1 for the helix and add the calculated weight of the housing.
36	Plan: A guide plan for the manufacture and installation shall be attached depending on the requests for services.
<b>4</b>	<b>Aerodynamic specifications</b>
41	Location in the ventilation network.
411	Blowing; put an X in the column S. Indicate the flow for an identified assembly.
412	Extraction; put an X in the column E.
413	Transfer: put an X in the column T.
42	Flow rate in cubic meters per hour.
43	Pressure drop: Indicate the pressure drop in decapascals.
<b>5</b>	<b>Observations</b> Complementary data (special coating, resistance to earthquakes, temperature, etc.).



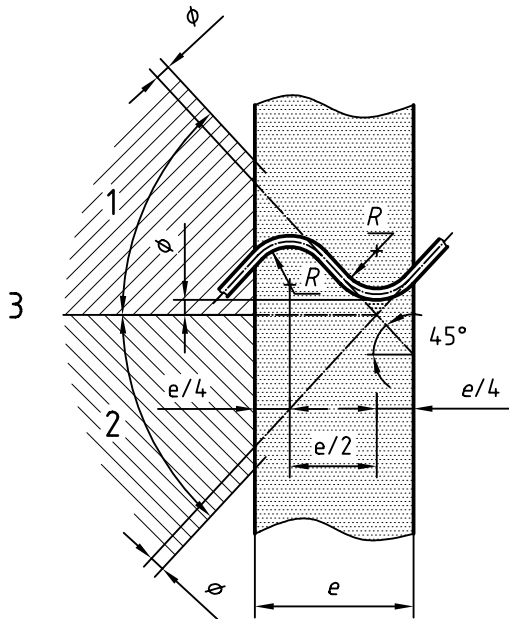
Table B.2 — Characteristic boards

1	2	3	4	5
Common data	Crossed wall	Specifications characteristics	Aerodynamic characteristics	Observations
Reference	Civil Eng.	Production in mm	Network	Pressure drop
Functional reference	Embossed	Nominal Ø	S	Flow (m <sup>3</sup> /h)
11	W	Ø 300 mm	401	42
112	F	Ø 500 mm	412	413
113	C	Ø 750 mm	413	43
121	E	Ø 300 mm	414	44
122	T	Ø 500 mm	415	45
123	S	Ø 750 mm	416	46
124	B	Ø 300 mm	417	47
125	A	Ø 500 mm	418	48
126	I	Ø 750 mm	419	49
127	L	Ø 300 mm	420	50
128	O	Ø 500 mm	421	51
129	N	Ø 750 mm	422	52
130	M	Ø 300 mm	423	53
131	P	Ø 500 mm	424	54
132	Q	Ø 750 mm	425	55
133	R	Ø 300 mm	426	56
134	S	Ø 500 mm	427	57
135	T	Ø 750 mm	428	58
136	U	Ø 300 mm	429	59
137	V	Ø 500 mm	430	60
138	W	Ø 750 mm	431	61
139	X	Ø 300 mm	432	62
140	Y	Ø 500 mm	433	63
141	Z	Ø 750 mm	434	64
142	AA	Ø 300 mm	435	65
143	AB	Ø 500 mm	436	66
144	AC	Ø 750 mm	437	67
145	AD	Ø 300 mm	438	68
146	AE	Ø 500 mm	439	69
147	AF	Ø 750 mm	440	70
148	AG	Ø 300 mm	441	71
149	AH	Ø 500 mm	442	72
150	AI	Ø 750 mm	443	73
151	AJ	Ø 300 mm	444	74
152	AK	Ø 500 mm	445	75
153	AL	Ø 750 mm	446	76
154	AM	Ø 300 mm	447	77
155	AN	Ø 500 mm	448	78
156	AO	Ø 750 mm	449	79
157	AP	Ø 300 mm	450	80
158	AQ	Ø 500 mm	451	81
159	AR	Ø 750 mm	452	82
160	AS	Ø 300 mm	453	83
161	AT	Ø 500 mm	454	84
162	AU	Ø 750 mm	455	85
163	AV	Ø 300 mm	456	86
164	AW	Ø 500 mm	457	87
165	AX	Ø 750 mm	458	88
166	AY	Ø 300 mm	459	89
167	AZ	Ø 500 mm	460	90
168	BA	Ø 750 mm	461	91
169	BB	Ø 300 mm	462	92
170	BC	Ø 500 mm	463	93
171	BD	Ø 750 mm	464	94
172	BE	Ø 300 mm	465	95
173	BF	Ø 500 mm	466	96
174	BG	Ø 750 mm	467	97
175	BH	Ø 300 mm	468	98
176	BI	Ø 500 mm	469	99
177	BJ	Ø 750 mm	470	100
178	BK	Ø 300 mm	471	101
179	BL	Ø 500 mm	472	102
180	BM	Ø 750 mm	473	103
181	BN	Ø 300 mm	474	104
182	BO	Ø 500 mm	475	105
183	BP	Ø 750 mm	476	106
184	BQ	Ø 300 mm	477	107
185	BR	Ø 500 mm	478	108
186	BS	Ø 750 mm	479	109
187	BT	Ø 300 mm	480	110
188	BU	Ø 500 mm	481	111
189	BV	Ø 750 mm	482	112
190	BW	Ø 300 mm	483	113
191	BX	Ø 500 mm	484	114
192	BY	Ø 750 mm	485	115
193	BZ	Ø 300 mm	486	116
194	CA	Ø 500 mm	487	117
195	CB	Ø 750 mm	488	118
196	CC	Ø 300 mm	489	119
197	CD	Ø 500 mm	490	120
198	CE	Ø 750 mm	491	121
199	CF	Ø 300 mm	492	122
200	CG	Ø 500 mm	493	123
201	CH	Ø 750 mm	494	124
202	CI	Ø 300 mm	495	125
203	CJ	Ø 500 mm	496	126
204	CK	Ø 750 mm	497	127
205	CL	Ø 300 mm	498	128
206	CM	Ø 500 mm	499	129
207	CN	Ø 750 mm	500	130
208	CO	Ø 300 mm	501	131
209	CP	Ø 500 mm	502	132
210	CQ	Ø 750 mm	503	133
211	CR	Ø 300 mm	504	134
212	CS	Ø 500 mm	505	135
213	CT	Ø 750 mm	506	136
214	CU	Ø 300 mm	507	137
215	CV	Ø 500 mm	508	138
216	CW	Ø 750 mm	509	139
217	CX	Ø 300 mm	510	140
218	CY	Ø 500 mm	511	141
219	CZ	Ø 750 mm	512	142
220	CA	Ø 300 mm	513	143
221	CB	Ø 500 mm	514	144
222	CC	Ø 750 mm	515	145
223	CD	Ø 300 mm	516	146
224	CE	Ø 500 mm	517	147
225	CF	Ø 750 mm	518	148
226	CG	Ø 300 mm	519	149
227	CH	Ø 500 mm	520	150
228	CI	Ø 750 mm	521	151
229	CJ	Ø 300 mm	522	152
230	CK	Ø 500 mm	523	153
231	CL	Ø 750 mm	524	154
232	CM	Ø 300 mm	525	155
233	CN	Ø 500 mm	526	156
234	CO	Ø 750 mm	527	157
235	CP	Ø 300 mm	528	158
236	CQ	Ø 500 mm	529	159
237	CR	Ø 750 mm	530	160
238	CS	Ø 300 mm	531	161
239	CT	Ø 500 mm	532	162
240	CU	Ø 750 mm	533	163
241	CV	Ø 300 mm	534	164
242	CW	Ø 500 mm	535	165
243	CX	Ø 750 mm	536	166
244	CY	Ø 300 mm	537	167
245	CZ	Ø 500 mm	538	168
246	CA	Ø 750 mm	539	169
247	CB	Ø 300 mm	540	170
248	CC	Ø 500 mm	541	171
249	CD	Ø 750 mm	542	172
250	CE	Ø 300 mm	543	173
251	CF	Ø 500 mm	544	174
252	CG	Ø 750 mm	545	175
253	CH	Ø 300 mm	546	176
254	CI	Ø 500 mm	547	177
255	CJ	Ø 750 mm	548	178
256	CK	Ø 300 mm	549	179
257	CL	Ø 500 mm	550	180
258	CM	Ø 750 mm	551	181
259	CN	Ø 300 mm	552	182
260	CO	Ø 500 mm	553	183
261	CP	Ø 750 mm	554	184
262	CQ	Ø 300 mm	555	185
263	CR	Ø 500 mm	556	186
264	CS	Ø 750 mm	557	187
265	CT	Ø 300 mm	558	188
266	CU	Ø 500 mm	559	189
267	CV	Ø 750 mm	560	190
268	CW	Ø 300 mm	561	191
269	CX	Ø 500 mm	562	192
270	CY	Ø 750 mm	563	193
271	CZ	Ø 300 mm	564	194
272	CA	Ø 500 mm	565	195
273	CB	Ø 750 mm	566	196
274	CC	Ø 300 mm	567	197
275	CD	Ø 500 mm	568	198
276	CE	Ø 750 mm	569	199
277	CF	Ø 300 mm	570	200
278	CG	Ø 500 mm	571	201
279	CH	Ø 750 mm	572	202
280	CI	Ø 300 mm	573	203
281	CJ	Ø 500 mm	574	204
282	CK	Ø 750 mm	575	205
283	CL	Ø 300 mm	576	206
284	CM	Ø 500 mm	577	207
285	CN	Ø 750 mm	578	208
286	CO	Ø 300 mm	579	209
287	CP	Ø 500 mm	580	210
288	CQ	Ø 750 mm	581	211
289	CR	Ø 300 mm	582	212
290	CS	Ø 500 mm	583	213
291	CT	Ø 750 mm	584	214
292	CU	Ø 300 mm	585	215
293	CV	Ø 500 mm	586	216
294	CW	Ø 750 mm	587	217

## Annex C (informative)

### Examples of design of conventional penetrations

#### C.1 Double bend penetration for single tube



**Key**

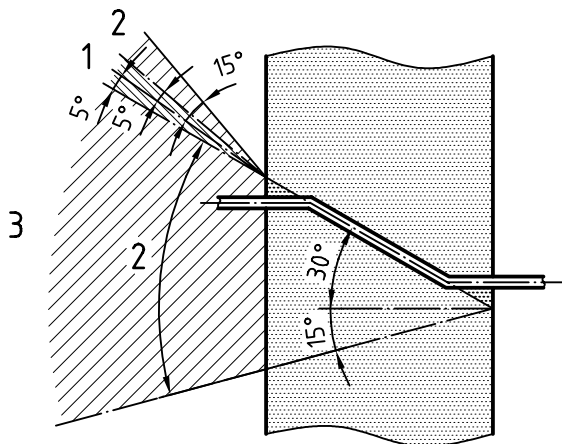
- 1 Zone ①: Location of the radioactive source non authorized.
- 2 Zone ②: Location of the radioactive source authorized, if the minimum oblique thickness of the shielding crossed is  $> e$ , taking into account the nominal diameter of the tube ( $\varnothing N$ ) and the nominal wall thickness.
- 3 Inside enclosure.

$\varnothing N$ : Nominal diameter of the tube.

$e$ : Thickness of the wall.

**Figure C.1 — Example of double bend penetration for single tube**

#### C.2 Oblique penetration for single tube



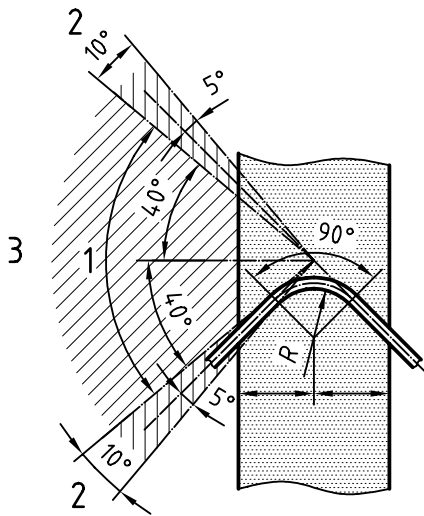
**Key**

- 1 Zone ①: Location of the radioactive source non authorized.
- 2 Zone ②: Location of the radioactive source authorized, if the nominal diameter of the tube is  $< 40$  mm.
- 3 Inside enclosure.

$\varnothing N$ : Nominal diameter of the tube.

**Figure C.2 — Example of oblique penetration for single tube**

### C.3 Simple bend penetration for single tube



#### Key

- 1 Zone ①: Location of the radioactive source authorized, if the nominal diameter of the tube is < 25 mm.
- 2 Zone ②: Location of the radioactive source authorized, if the nominal diameter of the tube is < 40 mm.
- 3 Inside enclosure.
- ØN: Nominal diameter of the tube.

Figure C.3 — Example of simple bend penetration for single tube

## Bibliography

- [1] CEA Document, Guide CETREVE: *Principles of ventilation of nuclear plants*, Volume III B: *Detailed technical specifications — Protection helix, Code 280, folio 1/4 to 4/4*.
- [2] SGN Document, SV 6201 rev. A: *Ventilation penetrations — Radiological protection — Rules for definition and manufacturing*.
- [3] IAEA Document, *Manual on safety aspects of the design and equipment of Hot Laboratories*, No. 30, Vienna, 1969.
- [4] NF M 62-233, *Penetrations for shielded enclosures — Protection against gamma radiation — Requirements for cast iron screws used for ventilation*.
- [5] NF EN 473, *Non destructive inspection — Certification of agents — General regulations*.
- [6] NF A 32-101, *Foundry products — Casting in iron with lamellar graphite*.
- [7] EN 287, *Approval testing of welders — Fusion welding*.
- [8] EN 10025, *Hot rolled products of non-alloy structural steels — Technical delivery conditions*.
- [9] EN 10088/2, *Stainless steel — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes*.
- [10] EN 10088/3, *Stainless steel — Part 3: Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes*.
- [11] NF M 62-101, *Fundamental principles for protection in the design and construction of installations in which non-sealed radioactive sources are used*.
- [12] NF A 00-501-0, *Foundry products — General technical conditions for orders and supplies — Part 0: All alloys*.
- [13] NF A 00-501-2, *Foundry products — General technical conditions for orders and supplies — Part 2: Castings in cast iron*.



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