INTERNATIONAL STANDARD

ISO 11933-3

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Components for containment enclosures —

Part 3:
Transfer systems such as plain doors, airlock chambers, double door transfer systems, leaktight connections for waste drums

Composants pour enceintes de confinement —

Partie 3: Systèmes de transfert tels que portes, sas, doubles portes de transfert étanche, connexions étanches pour fûts de déchets

Reference number
ISO 11933-3:1998(E)

Contents

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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.

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 11933-3 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

ISO 11933 consists of the following parts, under the general title *Components for containment enclosures*:

— *Part 1: Glove/bag ports, bungs for glove/bag ports, enclosure rings and unterchangeable units*

— *Part 2: Gloves, welded bags, gaiters for remote-handling tongs and for manipulators*

— *Part 3: Transfer systems such as plain doors, airlock chambers, double doors for leaktight transfer, leaktight connections for waste drums*

— *Part 4: Ventilation and air cleaning systems, such as filters, traps, pressure regulators, safety and control devices*

— *Part 5: Penetration for electrical and fluid circuits*

Annexes A and B of this part of ISO 11933 are for information only.

Introduction

A great number of components or systems used for achieving leaktight transfer functions in containment enclosures are presently offered on the market. These equipment or systems

— may have different geometrical dimensions;

— may differ by their design criteria;

— may require holes of different diameters to be installed on the containment enclosure wall;

— may be attached to the wall by different methods;

— may use different mounting techniques for their corresponding leaktightness.

These components or systems are generally not mutually compatible, but nevertheless often have the same performance level; therefore it was not possible to select only one system or component as the International Standard.

As a consequence, the aim of this part of ISO 11933 is to present general principles of design and operation, and to fully describe the most common systems or components in use in order to:

— avoid new parallel systems or components based on identical principles and differing only in details or geometric dimensions;

— make possible interchangeability between existing devices;

— demonstrate consistency among the various parts of the same system such as the basic elements (described in ISO 11933-1), the associated leaktight components (described in ISO 11993-2) or the transfer systems (described in this part of ISO 11933).

Components for containment enclosures —

Part 3:
Transfer systems such as plain doors, airlock chambers, double door transfer systems, leaktight connections for waste drums

1 Scope

This part of ISO 11933 specifies the designations and characteristics of the various transfer systems which can be mounted on containment enclosures either used alone or placed behind a shielding wall.

These transfer systems may also be used directly on shielding walls made of metal (carbon steel or stainless steel) or of concrete.

The systems covered by this part of ISO 11933 are

— plain doors,

— airlock chambers,

— double door transfer systems,

— leaktight connections for waste drums.

Some of these systems, such as plain doors, airlock chambers or double door transfer systems can be used in addition to components defined in ISO 11933-1 or ISO 11933-2 (glove/bag ports, bungs for glove/bag ports, support rings, welded bags, etc.).

Large size doors and airlock chambers, used for personnel or large equipment, are not within the scope of this part of ISO 11933.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11933. 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 11933 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 7212:1986, *Enclosures for protection against ionizing radiation — Lead shielding units for 50 mm and 100 mm thick walls.*

ISO 9404-1:1991, *Enclosures for protection against ionizing radiation — Lead shielding units for 150 mm, 200 mm and 250 mm thick walls — Part 1: Chevron units of 150 mm and 200 mm thickness.*

ISO 10648-1:1997, *Containment enclosures — Part 1: Design principles.*

ISO 10648-2:1994, *Containment enclosures — Part 2: Classification according to tightness and associated checking methods.*

ISO 11933-1:1997, *Components for containment enclosures — Part 1: Glove/bag ports, bungs for glove/bag ports, enclosure rings and interchangeable units.*

ISO 11933-2:1997, *Components for containment enclosures — Part 2: Gloves, welded bags, gaiters for remote-handling tongs and for manipulators.*

3 Definitions

For the purposes of this part of ISO 11933, the following definitions apply.

3.1
plain door
a device used to close an opening in a containment enclosure or in an airlock chamber. The plain doors may be leaktight and/or shielded

3.2
airlock chamber
an isolated volume used to introduce equipment or materials into a containment enclosure or to transfer such equipment or materials from a containment enclosure to another without breaking the leaktightness or the shielding of the enclosure. It constitutes a barrier against spread of contamination and/or introduction of external air pollution. Two types of airlock chambers are considered below

3.2.1
leaktight airlock chamber
this kind of airlock chamber is used to maintain or protect the purity of the atmosphere of the containment enclosure and/or to avoid the spread of contamination during transfer of materials or equipments

3.2.2
shielded airlock chamber
this kind of airlock chamber comprises shielded walls and doors, for use with shielded containment enclosures

3.3
double door transfer system
a system which allows the connection of a container to an enclosure in such a way that during the transfer and after the transfer, minimum contamination may occur on the external parts of the door of the enclosure and on the door of the container (for further details see clause 7)

3.4
leaktight connection for waste drums
a transfer system, based on the principle of the double door transfer system, used to transfer contaminated materials between a containment enclosure and a waste drum

NOTE In this system, the containment enclosure and the waste drum may or may not be shielded.

4 Designation

The designation of the transfer systems for containment enclosures consists of its name written in full, reference to this part of ISO 11933 and the reference number as explained in 4.1.

4.1 Explanation of the reference number

The reference number consists of a four digit number fixed by the Series Allocation shown in table 1. These series allocations are in accordance with other series allocations given in ISO 11933-1 and ISO 11933-2. This may be followed by one or several alphanumerical marks characterizing the mounting procedure and/or the material of construction. (See also tables 2 through 13.)

4.1.1 Series allocation

Series allocations corresponding to the component described in this part of ISO 11933 are given in table 1. The differentiation between the various types of components in the same family is explained in clauses 5, 6, 7 and 8.

Table 1 — Series allocation

Transfer system	Series	Clause
Plain doors		
— circular doors	1400 - 1419	5
— rectangular doors	1420 - 1439	5
Airlock chambers		
— introduction airlock chamber, with circular cross-section [1)]	1500 - 1519	6
— introduction airlock chambers, with rectangular cross-section [1)]	1520 - 1539	6
— enclosure linking or introduction airlock chambers, with circular cross-section [2)]	1540 - 1559	6
— enclosure linking or introduction airlock chambers, with rectangular cross-section [2)]	1560 - 1579	6
Double door transfer systems		
— type 1 [3)]	1600 - 1619	7 / 7.2
— type 2 [3)]	1620 - 1639	7 / 7.3
Leaktight connections for waste drums		
— type 1 [3)]	1650 - 1659	8 / 8.3
— type 2 [3)]	1660 - 1669	8 / 8.4

1) Simple introduction airlock chambers (with opening at one end).
2) Airlock chambers for linking an enclosure to another or for introduction (stiff simple or T shape).
3) For definition, see clauses 7 and 8.

4.1.2 Alphabetical codes corresponding to the mounting procedures

The equipment can be mounted on the containment enclosure wall by different techniques.

The letter codes for the mounting procedure are the following:

— B for bonded types,

— W for welded types,

— T for threaded types.

4.1.3 Alphabetical codes corresponding to the construction materials

The equipment can be manufactured using different materials.

The letter codes for the material used are the following:

— M for polymethyl methacrylate (PMMA),

— V for polyvinyl chloride (PVC),

— X for stainless steel,

— O for carbon steel,

— A for light alloy,

— C for polycarbonate (PC),

— E for polyethylene (PE),

— P for polypropylene (PP),

— S for glass,

— Z for other materials.

In this part of ISO 11933, widely used materials will be designated by their standard abbreviations as listed above.

4.2 Designation — Examples and explanation

4.2.1 Plain doors

Designation example: ISO Plain door 1401 V m.

In the case of circular components, the last digit(s) of the reference numbers of the plain door is (are) the same as the last digit(s) of the reference numbers of the airlock chambers on which this door is intended to be mounted. These digits correspond to the useful diameter of the two systems: plain door and airlock chambers, according to the explanations given in clauses 5 and 6.

This (these) last digit(s) of the reference number may also correspond to the useful diameter of the equivalent glove/bag port receiving the corresponding circular plain door, as defined in ISO 11933-1. Such circular doors may also be called bungs, in accordance with ISO 11933-1.

The correlation between the reference numbers of circular plain doors and the useful diameters of glove/bag port receiving the plain doors is defined in the table 2.

Table 2 — Correlation between the reference numbers of plain doors and the useful diameters of ports receiving plain doors

Dimensions in millimetres

Useful diameter of ports receiving the plain doors, *U*	156	180	186	200	249	254 [1)]	330	340	400
Reference number of plain door	1400	1401	1402	1403	1404	1405	1406	1407	1408
1) 254 mm = 10 in.									

In the case of rectangular components, the last digit of the reference number is correlated to the cross-section of the plain door (see clause 4). There is not necessarily a correlation between the last digits of reference numbers of rectangular plain doors and rectangular airlock-chambers of the same cross-section.

The alphabetical code indicates the following information.

The first code letter indicates the material of manufacture; in accordance with the explanations given in 4.1.3.

The second code letter indicates the way of locking the door:

— g for a door locked with an inflatable seal,

— m for a door locked with mechanical compression of the seal.

4.2.2 Airlock chambers

Designation example: ISO Airlock chambers 1522 W X s.

In the case of circular components, as explained in 4.2.1, the last digits of the reference numbers of the airlock chambers are the same as the reference numbers of the plain doors which are intended to be mounted on them (see also 4.2.1 and clause 5).

The last digit(s) correspond(s) to the useful diameter of the two related transfer components: airlock chamber *and* plain door, according to table 3.

Table 3 — Correlation between the reference numbers of plain doors/airlock chambers and the useful diameters of related transfer systems

Dimensions in millimetres

Useful diameter of transfer system, U	156	180	186	200	249	254	330	340	400	350
Reference number of plain door	1400	1401	1402	1403	1404	1405	1406	1407	1408	1413
Reference number of airlock chamber	1500 or 1540	1501 or 1541	1502 or 1542	1503 or 1543	1504 or 1544	1505 or 1545	1506 or 1546	1507 or 1547	1508 or 1548	1513 or 1553

In the case of rectangular components, the last digit(s) of the reference number is (are) correlated to the cross-section of the airlock chamber (see clause 5). There is not necessarily a correlation between the last digits of the reference numbers of rectangular airlock chambers and rectangular plain doors of the same cross-section.

The alphabetical code indicates the following information.

The first code letter indicates the mounting procedure on the containment wall, in accordance with 4.1.2.

The next code letter indicates the material of manufacture, in accordance with explanations given in 4.1.3.

The last code letter indicates the type of use:

— s for a simple airlock chamber,

— a for a ventilated airlock chamber,

— v for a vacuum airlock chamber.

4.2.3 Double door transfer systems

Designation example: ISO Double door transfer system 1602 X t.

The last digit of the reference number indicates:

— either the reference number of the associated shielding aperture brick (see ISO 7212),

— or the reference number of the associated enclosure ring (see ISO 11933-1),

— or an arbitrary chosen number, in other cases.

The alphabetical code indicates the following information.

The first code letter indicates the material of manufacture in accordance with the definitions given in 4.1.3.

The last code letter indicates the mode of locking or unlocking the double door transfer system:

— m for manual locking,

— t for remote locking.

4.2.4 Leaktight connections for waste drums

Designation example: ISO Leaktight connection for waste drums 1651 X O.

The last digit of the reference number corresponds to a useful diameter of the drum.

The alphabetical code indicates the following information.

The first code letter indicates the material of manufacturing of the double door transfer system used in accordance with the definitions given in 4.1.3.

The second code letter indicates the material of manufacturing the drum in accordance with the definitions given in 4.1.3.

5 Plain doors

5.1 General

5.1.1 Application

Equipment and/or material are transferred into or out of containment enclosures during normal or special operations through special apertures closed by plain doors (see figure 1).

Plain doors can also be mounted on airlock chambers (see clause 6).

The type of door and the way of mounting shall be chosen in accordance with

— the leaktightness requirements of the containment enclosure or the airlock chamber on which the door is intended to be mounted (see requirements in ISO 10648-2),

— the dimensions of the object to be transferred.

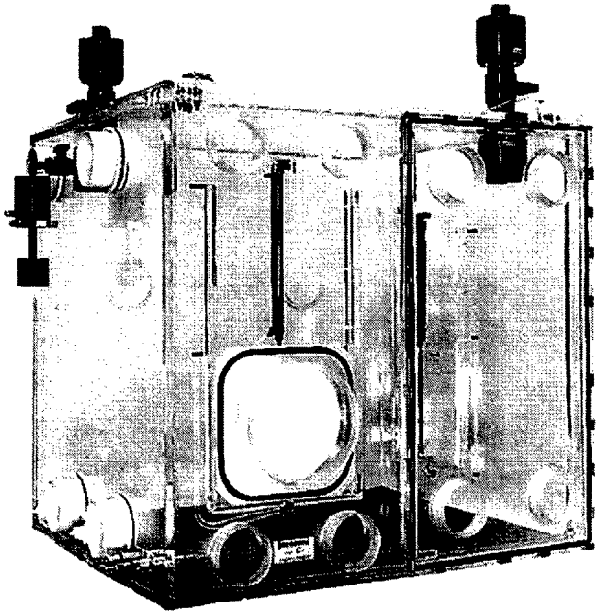


Figure 1 — Door for containment enclosures

5.1.2 Precautions for opening the doors

Plain doors are only allowed to be used for the transfer of non-contaminated equipment. Other type of systems (welded bags, double door transfer systems, etc.) should be used for contaminated objects.

The ventilation system of the containment enclosure shall be designed with respect to the size of the door. When the door is open, the direction and velocity of the air flow shall be inward to ensure no spread of possible contamination present in the enclosure or in the airlock chamber.

In designing plain doors, the following criteria shall be taken into account:

— simple and quick operation,

— size in accordance with the equipment to be introduced or removed,

— position providing ease of access to the equipment,

— profile and surface minimizing deposit of contamination and allowing ease of decontamination.

In the case of two motorized plain doors mounted on the inlet and outlet parts (that connected with the enclosure) of an airlock chamber, the two doors should be interlocked to prevent them from opening simultaneously [see figure 3 b)].

5.1.3 Choice of the leaktight system (way of locking)

5.1.3.1 Doors with an inflatable seal [see figure 2 a)]

These doors are generally made of PVC or metal (light alloy or stainless steel).

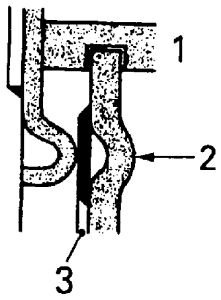
The seal may be inflated by pneumatic or hydraulic means, according to the safety requirements.

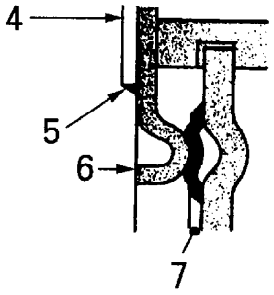
They need an external permanent source of pressure supply.

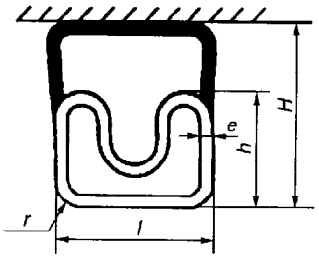
5.1.3.2 Doors with a mechanical compression of the seal [see figure 2 b)]

These doors are generally made of metal (stainless steel or light alloy). They are usually associated with metal or partially metal leaktight enclosures.

This kind of door presents the advantage of being simple and cheap.







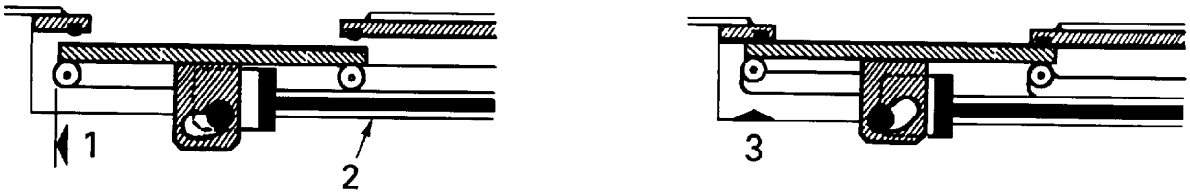
Key
1 Groove
2 Door with inflatable seal
3 Deflated seal
4 Leaktight wall
5 Weld
6 Padded door-frame
7 Inflated seal

Case 1: Seals allowing mounting by bounding in a rectangular casing

a) Inflatable seal

Unlocked door

Locked door



Key
1 Stop
2 Jack
3 Locking

b) Mechanical compression of the seal

Figure 2 — Examples of ways of locking the doors

5.2 Description

5.2.1 Shape

Plain doors may be square, circular or rectangular.

The choice is made according to the objects to be transferred and to the design of the enclosure wall.

5.2.2 Assembly

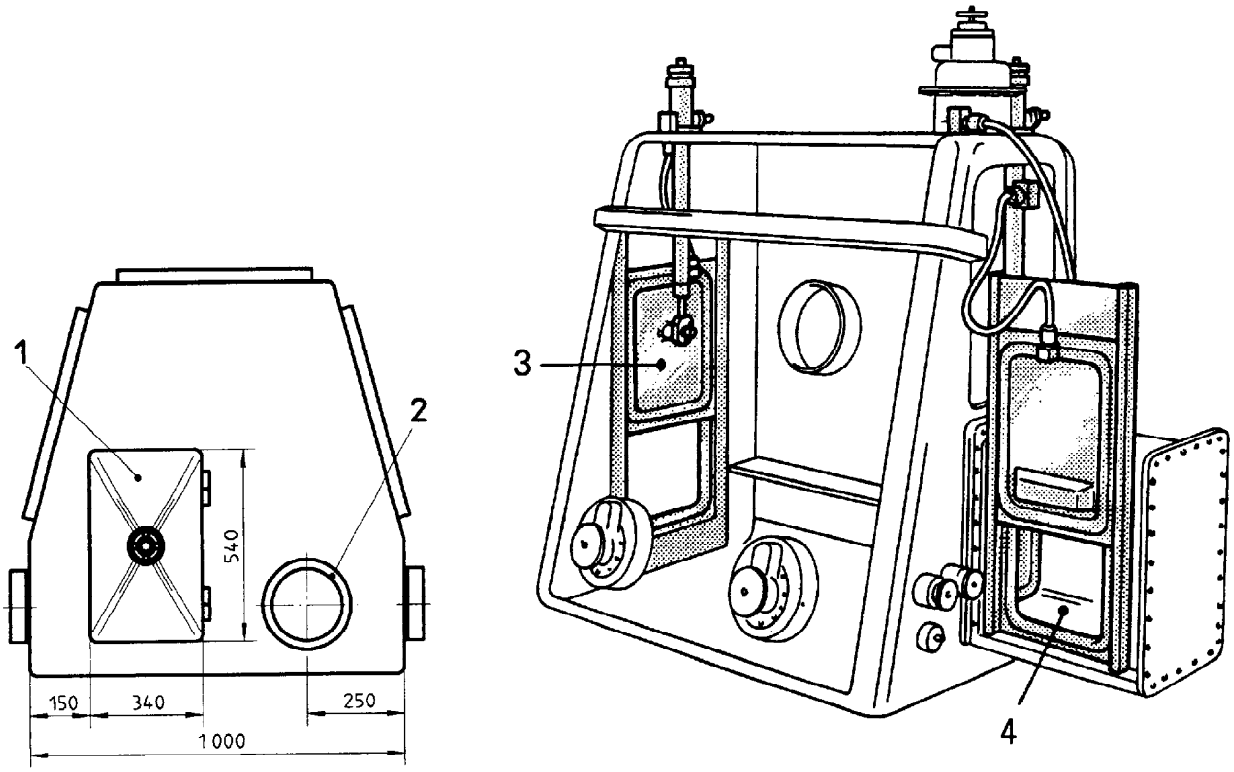
Plain doors are generally mounted either on the lateral faces or on the back face of the enclosure wall [see figure 3 a)]. They are also used as closing elements for airlock chambers [see figure 3 b)].

Opening of doors can be provided in different ways:

— hinged doors [see figure 3 a)],

— sliding doors [see figure 3 b)],

Dimensions in millimetres



Key

1 Rectangular door
2 Glove / bag port
3 Door directly mounted on the face of the enclosure
4 Door used as the closing element of an interlock-chamber

a) Directly on the enclosure wall **b) Directly or as closing element of an airlock chamber**

Figure 3 — Different ways of mounting the doors

In the case of non-shielded containment enclosures, the doors may be mounted either on the transparent or on the non-transparent faces.

In the case of shielded containment enclosures, it is recommended to mount the doors on metal parts fully integrated to the enclosure structure.

The additional shielding material for gamma or neutron radiations may be either included as part of the door or added to it (see ISO 10648-1).

5.2.3 Materials

Plain doors may be made of metal (carbon steel, stainless steel, light alloy) or of plastic material (PVC, PMMA, PC). Generally, they are made of the same material as the enclosure wall on which they are intended to be mounted. The choice of plain door material also depends on

— the products handled in the enclosure,

— the toxicity of the atmosphere,

— the required leaktightness,

— the need to provide shielding or not,

— the ease of decontamination.

5.2.4 Seals

Plain doors are made leaktight by using elastomer seals.

Shape, size and nature of the seal are selected in accordance with the internal atmosphere of the enclosure and to the required leaktightness (see ISO 10648-2).

5.2.5 Dimensions

The standard dimensions of ISO plain doors are indicated in the following tables and figures:

— table 4 and figure 4 for circular doors,

— table 5 and figure 5 for rectangular doors.

Some of these doors may be identical to bungs for glove/bag ports and may have the same useful diameters; in such cases, their reference number could also be the same as defined in ISO 11933-1, according to their mode of locking and their design (see ISO 11933-1).

Other doors may be specially fabricated with respect to the general principles given in this part of ISO 11933.

Table 4 — Standard dimensions of circular plain doors

Dimensions in millimetres

References [1]	Useful diameter
1400 m t	156
1401 m t	180
1402 m t	186
1403 m t	200
1404 m t	249
1405 m t	254
1406 m t	330
1407 m t	340
1408 m t	400
1412 m t [2]	300
1413 m t [2]	350

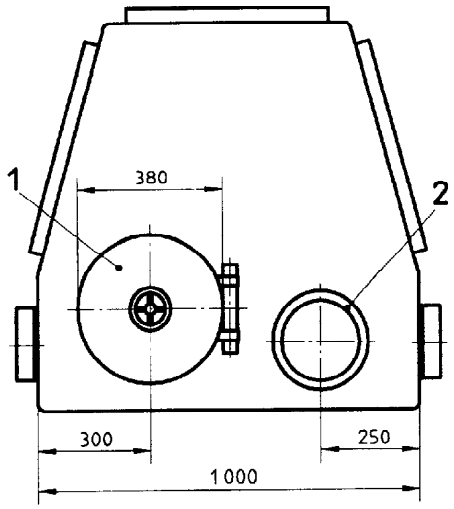
1) According to the rules given in clause 4; m and t are alphabetical indexes corresponding respectively to:

— the material of construction (m = P, V, M, X, O or A),

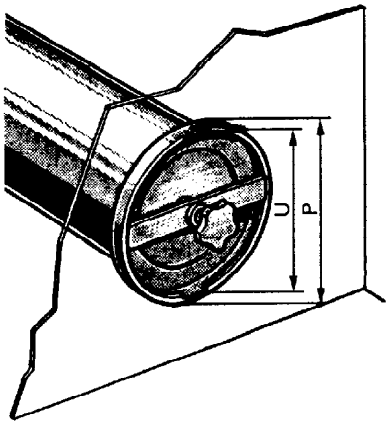
— the way of locking of the plain door (t = g or m).

2) For these special plain doors, there is no correspondence with bungs for glove/bag ports.

Dimensions in millimetres



a) **Example of a door opened with a hinge**



Key
1 Circular door
2 Transfer port

b) **Example of a door locked by a clamp plate system**

Figure 4 — Standard dimensions of circular plain doors

Table 5 — Standard dimensions of rectangular or square plain doors

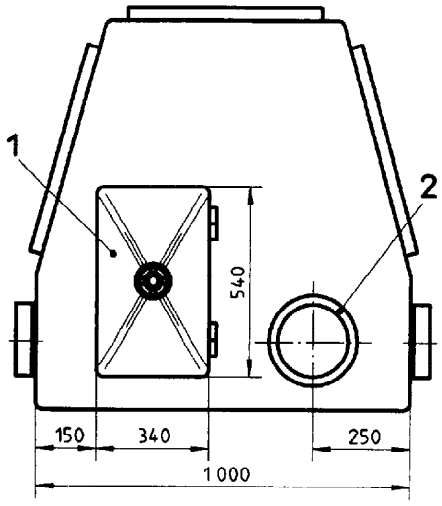
Dimensions in millimetres

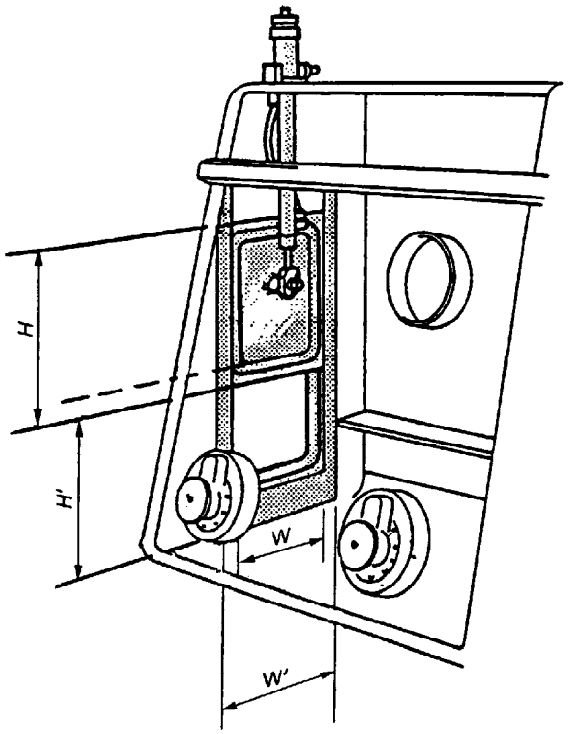
References[1)]	Useful cross-section $H \times W$ [2)]
1420 m t	140 × 140
1421 m t	200 × 200
1422 m t	230 × 230
1423 m t	230 × 300
1424 m t	270 × 190
1425 m t	330 × 240
1426 m t	300 × 500
1427 m t	350 × 350
1428 m t	360 × 420
1429 m t	360 × 420
1430 m t	500 × 300
1431 m t	540 × 340

1) According to the rules given in clause 4; m and t are alphabetical indexes corresponding respectively to:
— the material of construction (m = P, V, M, X, O or A),
— the way of locking the plain doors (t = g or m).

2) See figure 5.

Dimensions in millimetres





Key
1 Rectangular door
2 Transfer port

a) Example of a door opened with a hinge

b) Example of a door opened by sliding up and down

Figure 5 — Standard dimensions of rectangular or square plain doors

5.2.6 Examples

Examples of typical plain doors are described in annex A.

6 Airlock chambers (see figure 6)

6.1 General

An airlock chamber is used to introduce (see note 1 below) an object into a containment enclosure or to transfer such an object from one containment enclosure to another without breaking the leaktightness or the shielding of the enclosure. It is a barrier against spread of contamination, and/or the entering of air in order to maintain the purity of the internal atmosphere.

The type of airlock chamber shall be chosen in accordance with the leaktightness class of the containment enclosures (see ISO 10648-2).

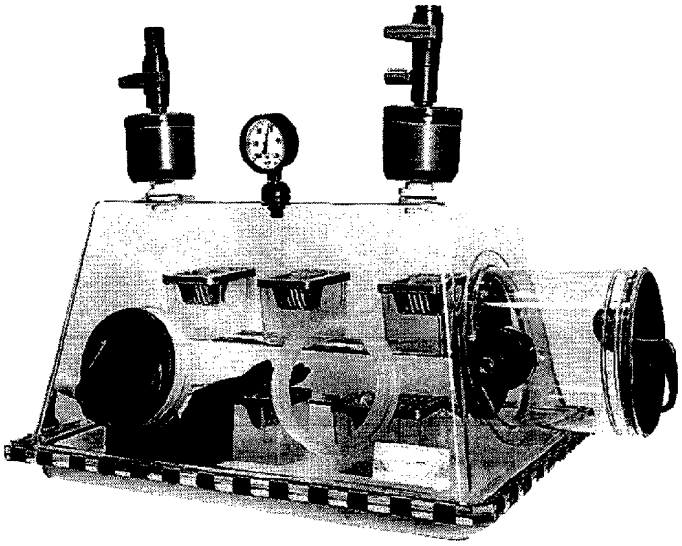
Airlock chambers perform the following functions.

The introduction of an object into the containment enclosure. In this case, the airlock chamber is designated as an *introduction airlock chamber.*

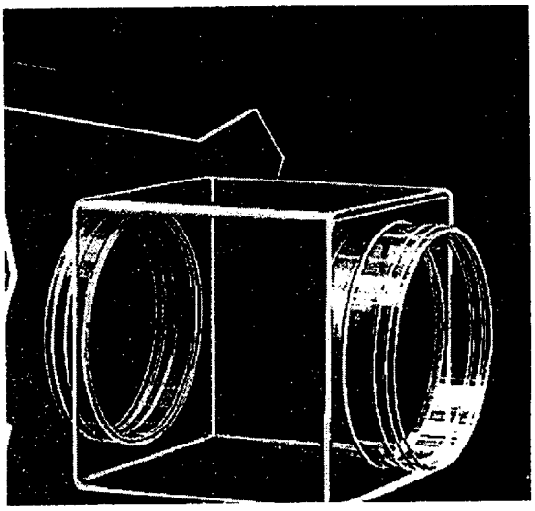
The transfer of any object from one containment enclosure to another. In this case, the airlock chamber is designated as a *transfer airlock chamber* or *linking airlock chamber* (see note 2 below).

NOTE 1 In normal use, an airlock chamber should not be allowed to be used for extracting any contaminated objects out of a containment enclosure. For these operations, welded bags or containers mounted on double door transfer systems must be used.

NOTE 2 Some airlock chambers may simultaneously provide transfer and introduction functions. In this case, they are designated as *transfer and/or introduction airlock chambers*. Figures 6a and 6b show these different functions.



a) Introduction airlock chamber



b) Transfer airlock chamber

Figure 6 — General view of an airlock chamber

6.2 Various types of airlock chambers

Only rigid airlock chambers are considered in this part of ISO 11933. It does not cover supple airlock chambers corresponding to welded bags which are described in ISO 11933-2.

6.2.1 Classification according to the ventilation mode

There are three types of airlock chambers (see figure 7), classified according to their level of protection against the spread of contamination or the introduction of external air pollution. All types may be shielded or not.

6.2.1.1 **Simple airlock chambers** [see figure 7 a)]

Simple airlock chambers provide an intermediate buffer volume between the enclosure and the external volume (or between two enclosures).

6.2.1.2 **Ventilated or flushed airlock chambers** [see figure 7 b)]

Ventilated or flushed airlock chambers, equipped with HEPA filters (High Efficiency Particulate Air Filter[1)]), in order to prevent any spread of contamination, are intended to be ventilated during their use according to the following recommendations:

— when the external door is opened, no air circulation is needed through the external HEPA filter and the airlock chamber;

1) HEPA filter (high efficiency particulate air filter): a fibrous filter used for collecting aerosol particles from a flow stream. A HEPA filter collects at least 99,97 % of aerosol particles of 0,3 µm diameter and is designated to collect greater fractions of aerosol particles with diameter either larger or smaller than approximately 0,3 µm.

— when the internal door is opened, air is introduced through the external HEPA filter and flushed to the internal volume of the containment enclosure.

6.2.1.3 Vacuum airlock chambers [see figure 7 c)]

These types of airlock chambers are mainly used with enclosures containing an inert and/or controlled atmosphere (nitrogen, argon, helium, etc.). Vacuum airlock chambers are used to introduce products or materials into the containment enclosure without modifying its internal atmosphere.

To operate the airlock chamber, an appropriate primary vacuum is established in the chamber before any transfer into the containment enclosure is attempted. When the vacuum is established, the airlock chamber is filled with the same inert or controlled atmosphere that is used in the containment enclosure.

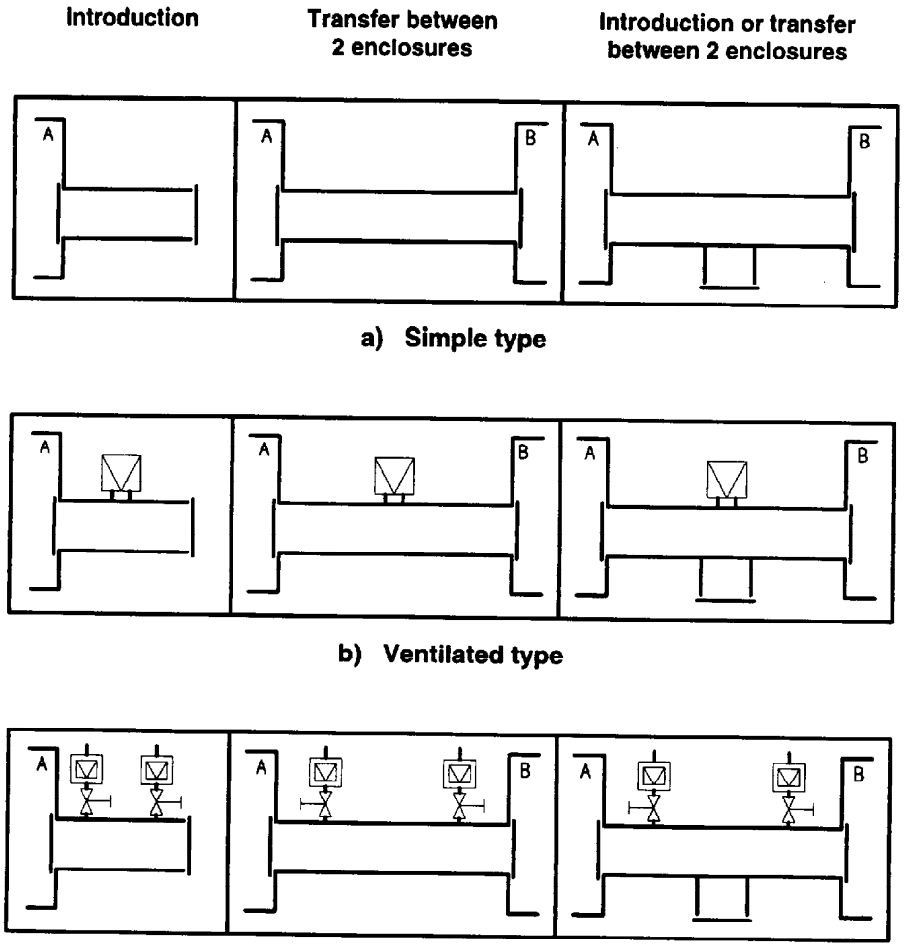


Figure 7 — Various types of airlock chambers

6.2.2 Classification according to the geometrical shape

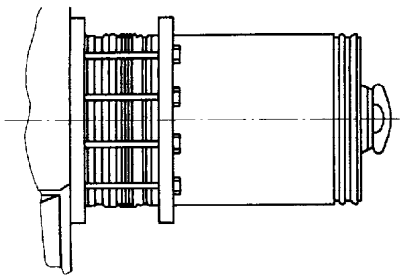
In principle there are 4 kinds of airlock chambers (see figure 8):

a) Straight airlock chambers

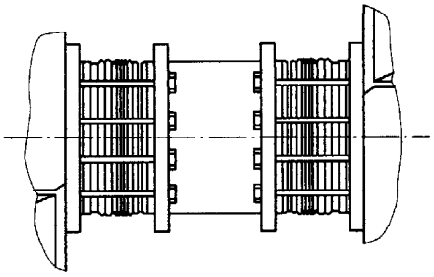
b) T-shape airlock chambers

c) Cross airlock chambers

d) Angle airlock chambers

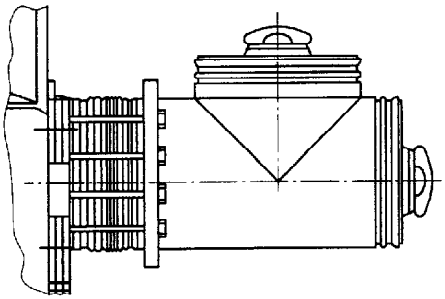


Straight airlock chamber for transfer between operating room and containment enclosure

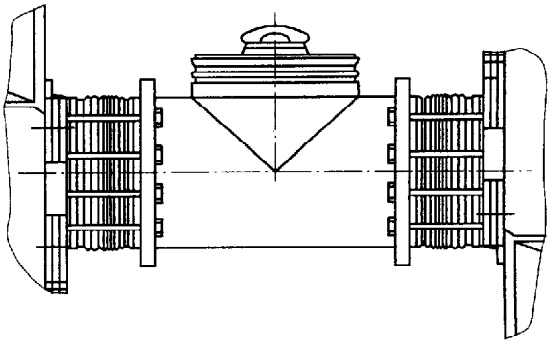


Straight airlock chamber for transfer between two containment enclosures

a) Examples of straight airlock chambers

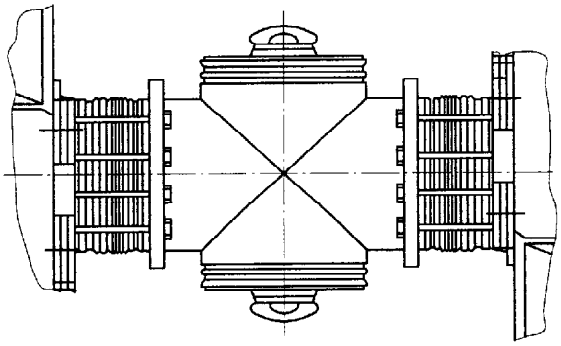


T-shaped airlock chamber for transfer between operating room and containment enclosure or between two containment enclosures

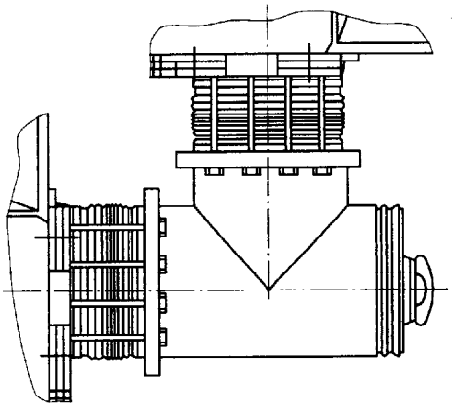


T-shaped airlock chamber for transfer between operating room and containment enclosure

b) Examples of T-shaped airlock chambers



Cross airlock chamber for transfer between operating room and containment enclosure or between two containment enclosures



Angle airlock chamber for transfer between operating room and containment enclosure or between two containment enclosures

c) Example of a cross airlock chamber

d) Example of an angle airlock chamber

Figure 8 — Different profiles of airlock chambers

6.3 Precautions to be taken during use of an airlock chamber

Airlock chambers are generally used to introduce non-contaminated objects into the containment enclosure. They shall be kept clean, and their volume shall be chosen in accordance with the dimensions of the equipment to be transferred. They shall not be used as a storage device. The opposite doors shall never be opened simultaneously.

6.4 Ventilation of airlock chambers

Ventilation of airlock chambers shall be carefully studied since this device shall allow transfer, without breaking the containment, from one enclosure to another or from operating room to containment enclosure.

According to the previous classification of airlock chamber types, the following recommendations should be respected.

— **For simple airlock chambers** [see figure 7 a)]: no additional ventilation system is needed.

— **For ventilated airlock chambers** [see figure 7 b)]: ventilation is provided through a filtered air inlet with or without an isolating valve. When the door between the airlock chamber and the containment enclosure is opened, the chamber volume is flushed by the air introduced through the HEPA filter and discharged through the containment enclosure.

— **For vacuum airlock chambers** [see figure 7 c)]: the air inlet and outlet shall be provided with an isolating valve and an HEPA filter. Operations are carried out in accordance with the recommendations given in clause 6.2.1.

The airlock chamber ventilation system design shall ensure that there will be no spread of contamination from containment enclosure to external atmosphere: during operation the airlock chamber shall be at a negative pressure with respect to the work area and the containment enclosure shall be at a negative pressure with respect to the airlock chamber. This ensures a flow of air from areas of lowest contamination to areas of highest contamination.

The air outlet system shall be connected to the extraction side of the ventilation system of the containment enclosure. The air flow rate is defined in accordance with the cross-section of the doors of the airlock chamber in order to ensure an appropriate air velocity at the openings, to prevent the spread of contamination.

6.5 Description

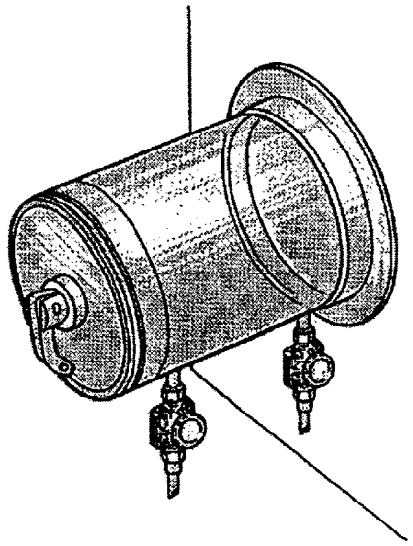
6.5.1 Shape

The cross-section of airlock chambers may be square, rectangular or circular. The shape is selected according to the objects to be transferred and to the design of the enclosure.

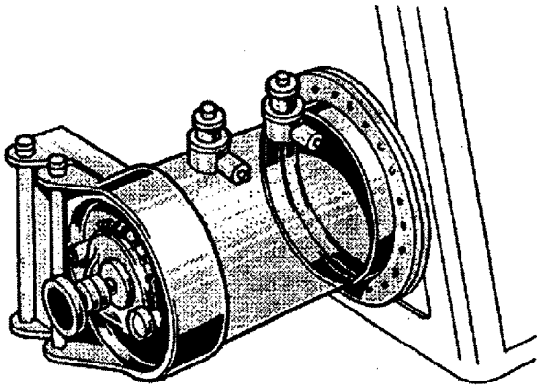
6.5.2 Assembly (see figure 9)

Airlock chambers are generally fastened to the lateral faces of enclosures. They are usually welded or bonded to the wall [see figures 9 c) and 9 a)]. Some models are screwed on a flange [see figure 9 b)] or mounted on bag ports of the containment enclosure, using screws and an additional bellows which allows disconnection of the airlock chamber from the containment enclosure without spread of contamination [see figure 9 d)]. For this last category of airlock chambers, the mounting parts are grooved like glove / bag ports and the plastic bellows is fixed on both sides.

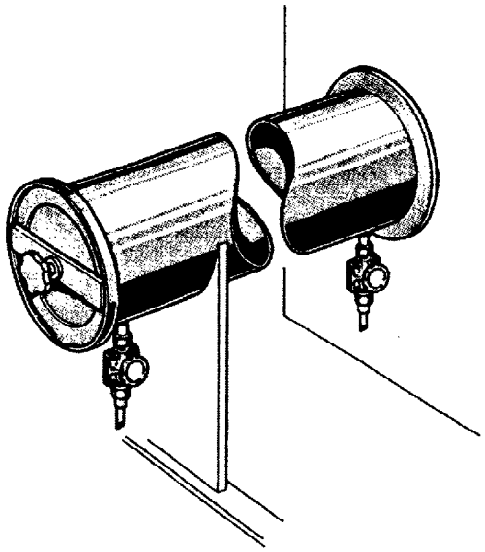
When an airlock chamber is removed, or two containment enclosures are disconnected, the ports should be closed according to the welded bag transfer method. For better stiffness of the assembly, it is recommended that the airlock chambers be mounted on rigid parts of the containment enclosure.



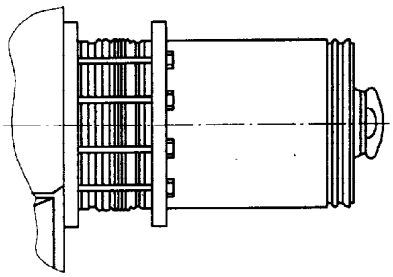
a) Bonded on a plastic wall



b) Threaded on a metal or plastic wall



c) Welded on a metal wall



d) Screwed and leaktightened with an additional bellows

Figure 9 — Various ways of assembling airlock chambers

6.5.3 Material

Airlock chambers may be made of metal (stainless steel or light alloys) or of plastic material (PVC, PMMA, PC). They are generally made of the same materials as the enclosure wall.

The choice depends on the nature of product manipulated, the toxicity of the atmosphere in the enclosure and of the leaktightness required. It also depends on whether or not the airlock chamber has to be shielded.

6.5.4 Doors for airlock chambers

Circular doors for airlock chambers may be either a bung for glove/bag port as described in ISO 11933-1 or a leaktightly mounted door designed in accordance with recommendations of clause 5 (especially when a vacuum airlock chamber is needed).

Square or rectangular doors for airlock chambers are identical to the doors described in clause 5. The same mounting recommendations should also be applied.

6.5.5 Dimensions

The standard dimensions of ISO airlock chambers are indicated in the tables 6 to 9, classified according to their function. Any other airlock chamber may be fabricated in accordance with the principles given in this part of ISO 11933.

6.5.5.1 Introduction airlock chamber (opening at one end) (see figure 10)

Cross-section of introduction airlock chambers may be square, rectangular or circular.

The standard dimensions of each category of ISO airlock chambers are indicated in the following tables (table 6 for circular airlock chambers and table 7 for square or rectangular airlock chambers).

Table 6 — Standard dimensions of introduction airlock chambers with circular cross-section

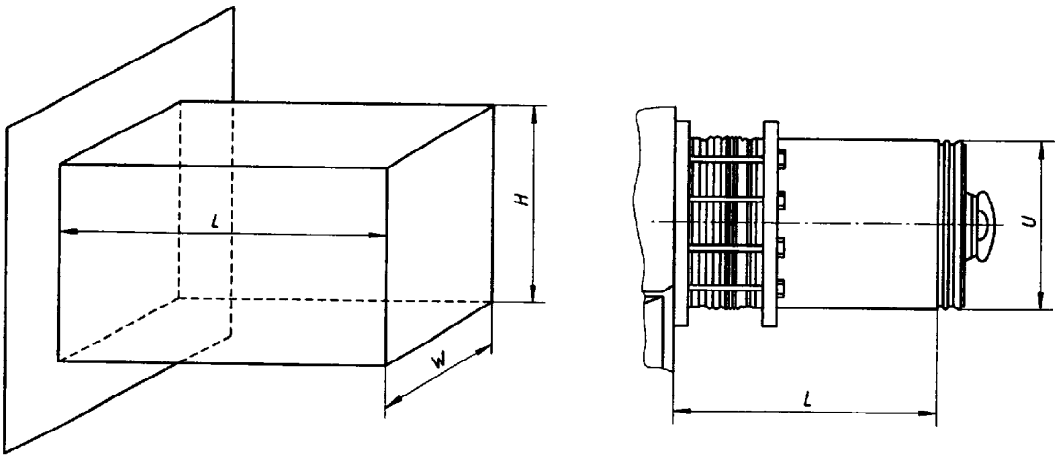
Dimensions in millimetres

References[1]	Useful diameter, U	Useful length, L[2]
1500 m n f	156	—
1501 m n f	180	300
1502 m n f	186	370
1503 m n f	200	370
1504 m n f	249	—
1505 m n f	254	350
1506 m n f	330	—
1507 m n f	340	450
1508 m n f	400	—
1510 m n f[3]	100	300
1511 m n f[3]	250	370
1512 m n f[3]	300	450
1513 m n f[3]	350	450

1) According to the rules given in clause 4; m, n and f are alphabetical indexes corresponding respectively to:
— the way of mounting the airlock chamber (m = B, W or T),
— the material of construction of the airlock chamber (n = M, V, X, A, O or P),
— the function of the airlock chamber (f = s, a or v).

2) Other lengths can be provided on special request.

3) For these airlock chambers, there is no correspondence with plain doors for glove/bag ports.



a) Rectangular airlock chamber

b) Circular airlock chamber

Figure 10 — Dimensions of introduction airlock chambers

Table 7 — Standard dimensions of introduction airlock chambers with square or rectangular cross-section

Dimensions in millimetres

References[1]	Useful cross-section $W \times H$	Useful length, L [2]
1520 m n f	190 x 200	370
1521 m n f	190 x 270	370
1522 m n f	240 x 260	370
1523 m n f	240 x 330	370
1524 m n f	250 x 350	460
1525 m n f	300 x 300	450
1526 m n f	350 x 350	500

1) According to the rules given in clause 4; m, n and f are alphabetical indexes corresponding respectively to:
— the way of mounting the airlock chamber (m = B, W or T),
— the material of construction of the airlock chamber (n = M, V, X, A, O or P),
— the function of the airlock chamber (f = s, a or v).

2) Other lengths can be provided on special request.

6.5.5.2 Airlock chambers for linking an enclosure to another and for introduction (see figure 11)

Their cross-sections may be square, rectangular or circular.

The standard dimensions of each category of ISO airlock chambers are indicated in the following tables (table 8 for circular airlock chambers and table 9 for rectangular or square airlock chambers).

Table 8 — Standard dimensions of linking or introduction airlock chambers with circular cross-section

Dimensions in millimetres

References[1]	Useful diameter, U	Useful length, L[2]
1540 m n f	156	—
1541 m n f	180	400
1542 m n f	186	390
1543 m n f	200	460
1544 m n f	249	—
1545 m n f	254	450
1546 m n f	330	520
1547 m n f	340	550
1548 m n f	400	—
1550 m n f [3]	100	350
1551 m n f [3]	250	370
1552 m n f [3]	300	520
1553 m n f [3]	350	570

1) According to the rules given in clause 4; m, n and f are alphabetical indexes corresponding respectively to:
— the way of mounting the airlock chamber (m = B, W or T),
— the material of construction of the airlock chamber (n = M, V, X, A, O or P),
— the function of the airlock chamber (f = s, a or v).

2) Other lengths can be provided on special request.

3) For these airlock chambers there is no correspondence with plain doors for glove/bag ports.

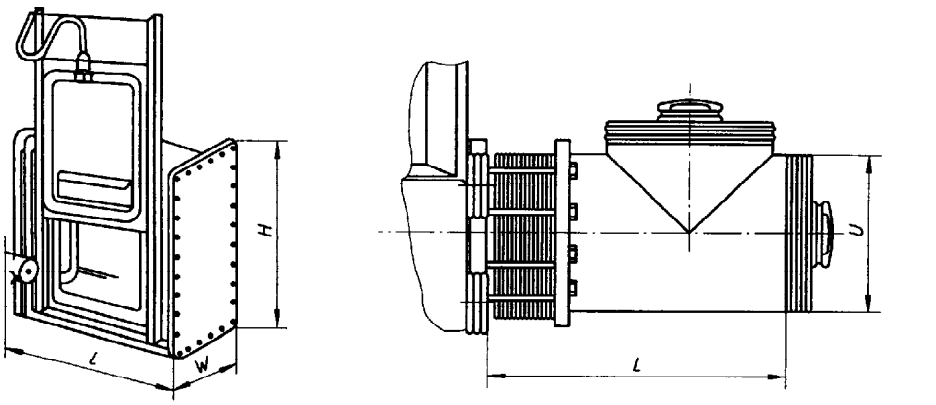
Table 9 — Standard dimensions of linking or introduction airlock chambers with square or rectangular cross-section

Dimensions in millimetres

References [1]	Useful cross-section $W \times H$	Useful length, L [2]
1560 m n f	190 × 200	370
1561 m n f	190 × 270	370
1563 m n f	240 × 260	370
1564 m n f	250 × 310	460
1565 m n f	300 × 300	450
1566 m n f	350 × 350	500

1) According to the rules given in clause 4; m, n and f are alphabetical indexes corresponding respectively to:
- the way of mounting the airlock chamber (m = B, W or T),
- the material of construction of the airlock chamber (n = M, V, X, A, O or P),
- the function of the airlock chamber (f = s, a or v).

2) Other lengths can be provided on special request.



a) Rectangular airlock chambers b) Circular airlock chambers

Figure 11 — Dimensions of T-shaped airlock chambers

6.5.6 Examples

Examples of typical airlock chambers are given in annex A.

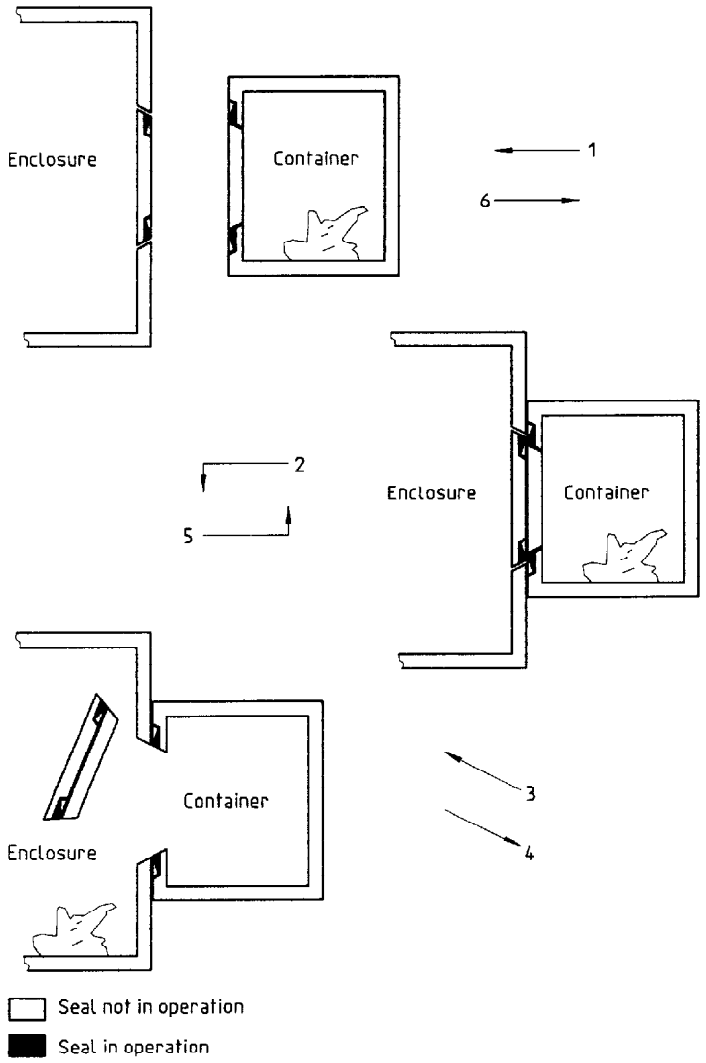
7 Double door transfer systems

Double door transfer systems are used with leaktight enclosures (shielded or unshielded). They allow the connection of leaktight containers or tunnels and provide constant leaktightness conditions during attachment and transfer processes. They are also used directly on shielded enclosures[2]. This system can be used either for horizontal or vertical transfer.

2) Special case of shielded enclosures in which it is necessary to use transfer systems (e.g. double door transfer system) similar to those of leaktight enclosures.

7.1 General

The general principle of the double door technique is the following: a leaktight connection of two doors is established between the enclosure door and leaktight container door simultaneous with the locking of the leaktight container onto the wall of the enclosure. This simultaneous connection allows the transfer of objects in or out of the enclosure to the leaktight container without breaking the containment (see figure 12).



1 to 6: Order of operations

Approach (or removal) of the leaktight container to (from) the enclosure wall.

Locking (or unlocking) of the leaktight container on the enclosure and connecting (or disconnecting) the two doors one with the other.

Putting the two connected doors into the enclosure in order to transfer the object into or out of the enclosure (or the reverse).

Figure 12 — Principle of double door transfer system

Unlocking of the leaktight container is done in a reverse manner. The space between the two doors is kept clean in order to protect the outer surfaces of the two doors against contamination and to allow further uses of the same leaktight container and of the containment enclosure door.

There are mainly two systems which differ in the seal profile and in the different way of obtaining leaktightness during locking of the container onto the containment enclosure wall:

— Type 1: Leaktightness by lip seal and opening by turning the leaktight container;

— Type 2: Leaktightness by flat seal and opening and closing by compression.

7.2 Type 1 double door transfer systems

7.2.1 General

In this system the containment enclosure includes an enclosure flange with locking ring and ramp and a sealed enclosure door, equipped with a lip seal (inner seal).

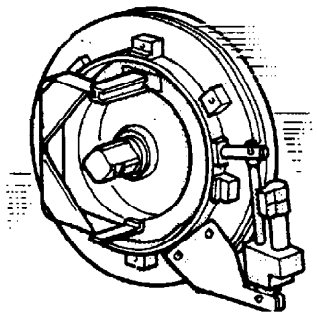
The leaktight container includes a container (or tunnel)[3] and a flange mounted on a body and a container door equipped with a lip seal (outer seal).

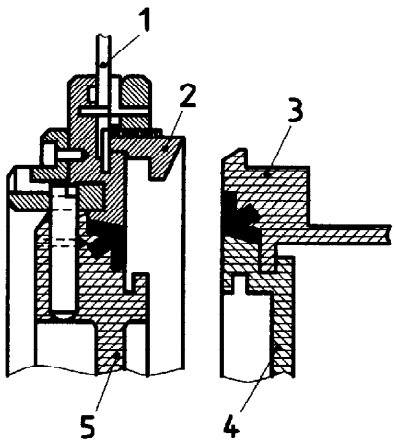
The whole assembly, including enclosure flange and leaktight door/container flange and container door, is called "Double door transfer system" (see figure 13).

The leaktight transfer between the enclosure and the container or tunnel is performed by locking the leaktight container to the containment enclosure; this operation also locks the two doors together.

Unlocking and opening of the double door may be carried out by hand or using a remote handling device in order to carry out a transfer without breaking the leaktightness (see procedure in figure 14).

The separation of the container or tunnel is achieved by reversing the operating procedure.





Key

1 Containment enclosure wall
2 Enclosure flange
3 Container body
4 Container door
5 Enclosure door

a) General view **b) Cross-section (partial)**

Figure 13 — Type 1 double door transfer system

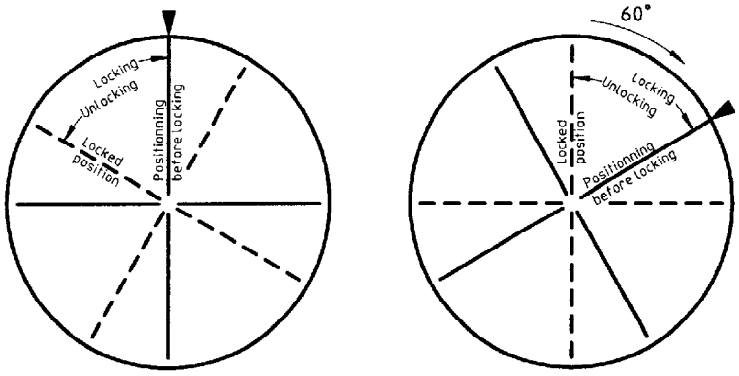
3) In the case of the connecting tunnel, the latter includes a tunnel flange mounted on a connecting body and a tunnel door identical to the container door.

7.2.2 Principle of use

The operations start and finish with a closed container and enclosure.

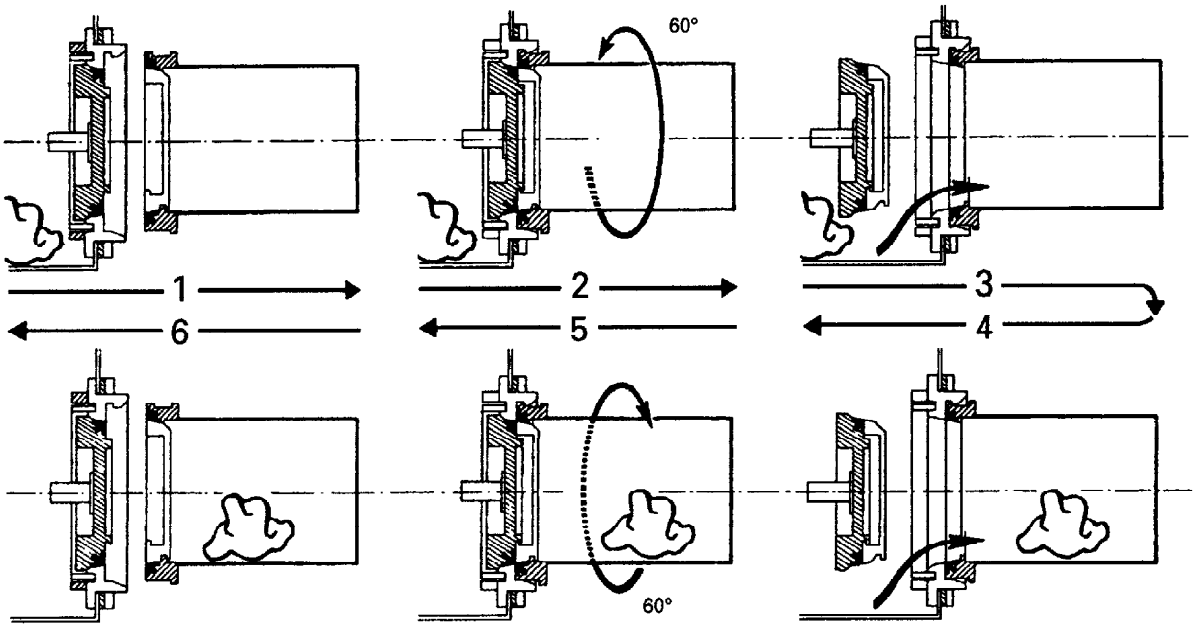
Operations 1 & 2: Approach and connect the leaktight container to the containment enclosure by turning it clockwise through 60°. A first resistance will be felt when the door knocks against the containment enclosure door, and a second resistance when the two doors interlock.

The angle of rotation is marked on the bottom of the leaktight container (see sketch opposite).

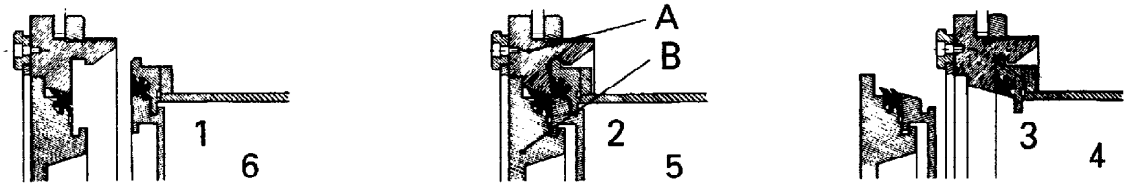


Operations 3 & 4: Open the interlocked doors and transfer the item for removal.

Operations 5 & 6: Turn the leaktight container counter-clockwise: this closes the containment enclosure, separates the container door from the enclosure door, locks the container door onto the container, and releases the latter from the door flange.



Details of figures 1 and 6 | Details of figures 2 and 5 | Details of figures 3 and 4



Starting or finishing
Presenting or removing the leaktight container.

Joining or interlocking
— of container and door flange A
— of container door and door B.

Opening or closing
Unlocking or locking of enclosure door and container door from/into container flange.

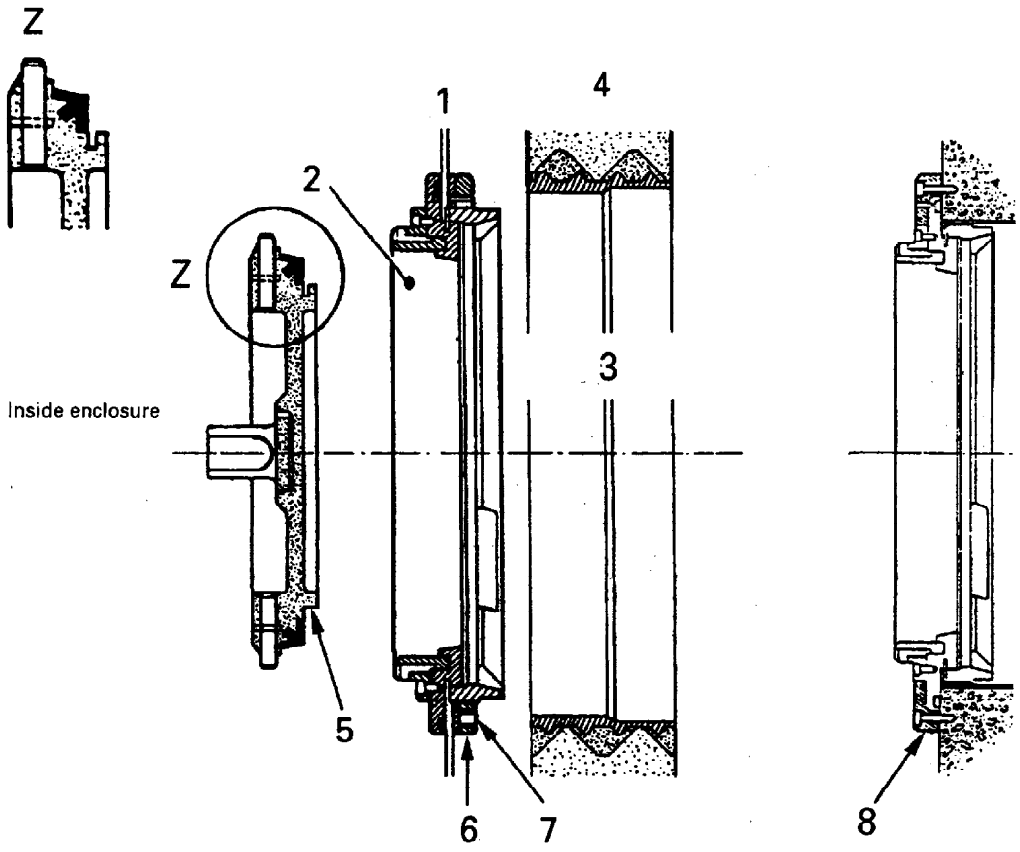
Figure 14 — Operating principle of a type 1 double door transfer system

7.2.3 Assembly

Enclosure flanges may be mounted either on a leaktight enclosure wall or on a shielding wall.

— On a leaktight wall: the flange is tightened manually from the outside of the enclosure onto the enclosure wall with an outer nut and completed with bearing screws [see figure 15 a)].

— On a shielding wall: the flange is held in place inside the enclosure by an additional ring which is screwed onto the shielding wall [see figure 15 b)].



Key

1 Leaktight wall
2 Flange
3 Associated lead aperture brick (see ISO 7212)
4 Shielding wall
5 Enclosure door
6 Outer nut
7 Bearing screw
8 Additional ring

a) On leaktight wall, associated or not with lead shielding wall

b) On shielding wall (lead, steel or concrete wall)

Figure 15 — Mounting of the flange

7.2.4 Material

Double door transfer systems of type 1 are generally made of stainless steel or polyethylene.

Seals are generally made of PVC.

7.2.5 Dimensions (see figure 16)

The standard dimensions of ISO double door transfer systems of type 1 are given in table 10.

Table 10 — Standard dimensions of type 1 double door transfer systems

Dimensions in millimetres

References[1]	Associated lead aperture brick[2]		Diameter of hole in containment enclosure	Outer diameter	Flange		
	Type	Diameter of hole through lead shielding, d_i	P	E	Useful diameter U	L_1[3]	D[3]
1600 x y	VO 200	170	158	182	105	53	33
1602 x y	VO 202	266	274	311	190	73	36
1604 x y	VO 204	366	354	388	270	77	37
1606 [4]	—	—	436	480	350	74	44

1) According to the rules given in clause 4; x and y are alphabetical indexes corresponding respectively to:
— the material of construction (x = X or E),
— the mode of manipulation of the double door transfer system (y = t or m).

2) Associated lead aperture bricks are described in ISO 7212 and ISO 9404-1.

3) See figure 16.

4) This transfer system is generally used for leaktight enclosures only. If shielding is required, it shall be made of lead, concrete or steel with an inside diameter of appropriate dimensions.

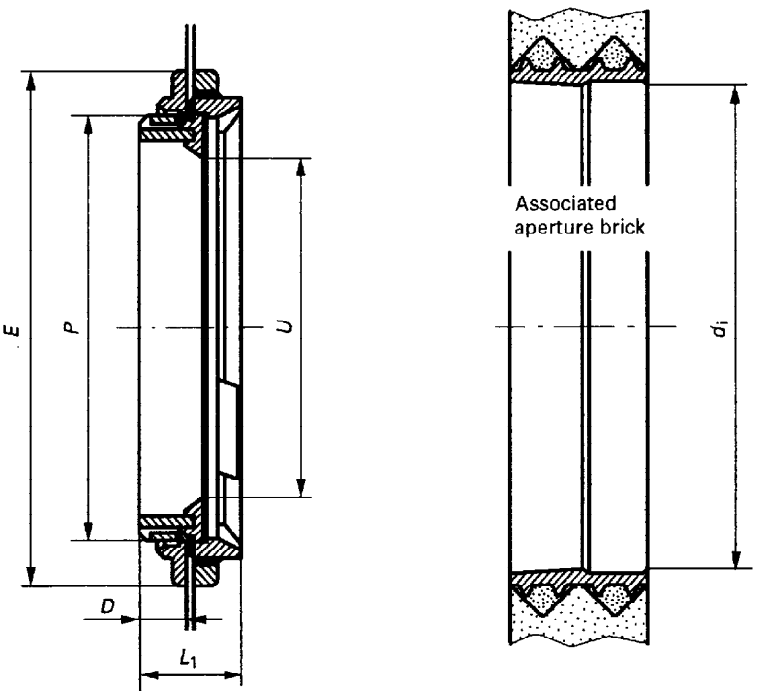


Figure 16 — Dimensions of type 1 double door transfer systems

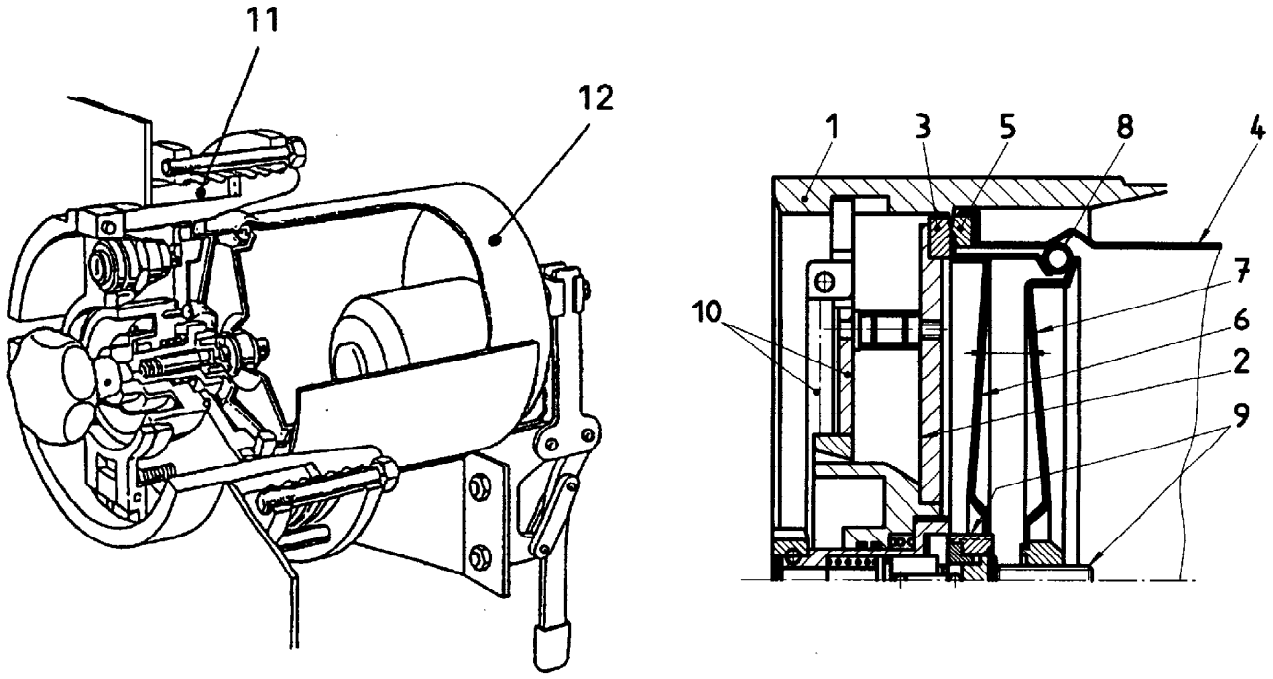
7.3 Type 2 double door transfer systems

7.3.1 General

A type 2 double door transfer system consists of an insert port, called "transfer port", which is fixed at the enclosure wall on a glove/bag port. The enclosure is sealed by a door (enclosure door) equipped with a flat seal (seal of enclosure door).

The leaktight container includes a flange mounted on a body (tube) equipped with a flat seal (seal of leaktight container), a container door consisting of an outer and inner part, a spring and a bolt.

The whole system, including transfer port, leaktight enclosure door/container and leaktight container door, is called "Double door transfer system" (see figure 17).



Key

1 Transfer port
2 Enclosure door
3 Seal of enclosure door
4 Leaktight container
5 Seal of leaktight container
6 Sealing door of leaktight container, outer part
7 Sealing door of leaktight container, inner part
8 Spiral spring with circular shape
9 Bolt with two oppositely directed threads
10 Lever for unlocking and locking the double door
11 Port
12 Container

a) Cutaway view **b) Cross-section**

Figure 17 — Type 2 double door transfer system

The leaktight transfer between the enclosure and the container is performed by locking the leaktight container to the containment enclosure and making a passage.

Locking of the leaktight container is carried out by pressing the container onto the insert port. A threaded shaft with a hand wheel is used for compressing when a shielded transport container is needed and a mechanism with a lever is used for unshielded containment enclosure applications [see figure 17a)].

7.3.2 Operation

The opening operation is performed by rotating a knob (for this requirement a bolt in the centre with left and right threads is operated) which permits unlocking the enclosure door and the container door or joining these two doors together.

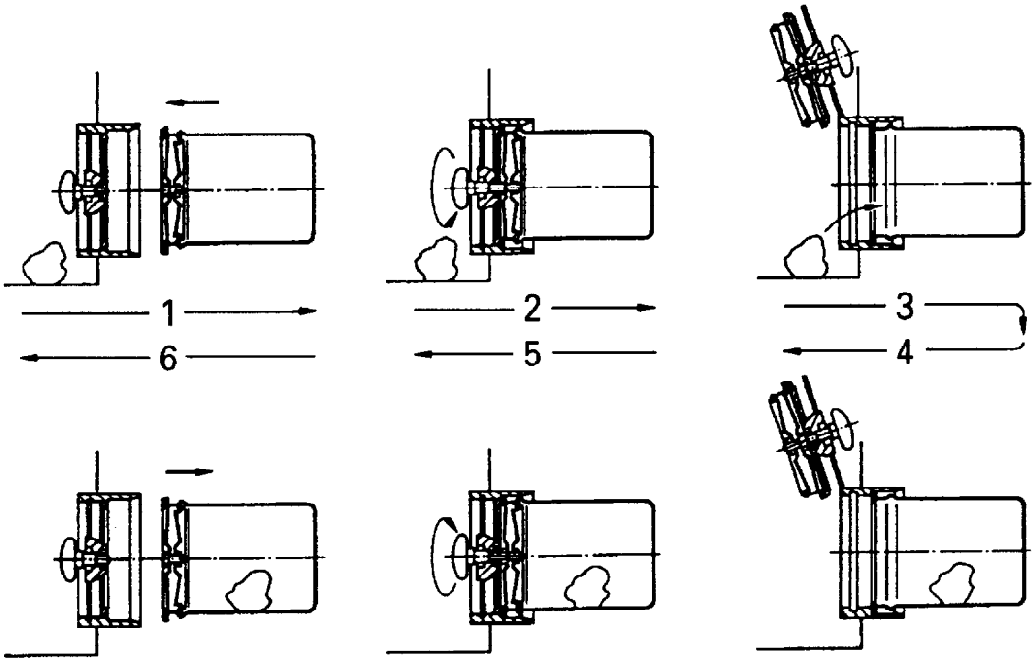
The double door is opened from inside the enclosure using either a remote handling tong or a master-slave manipulator in a shielded containment enclosure, or by hand in an unshielded enclosure.

A lever with a latch button, which consists of two links, attached with a hinge to the enclosure door is used for unlocking the double door from the transfer port. The double door can be opened either by swivelling on a hinge or by removal.

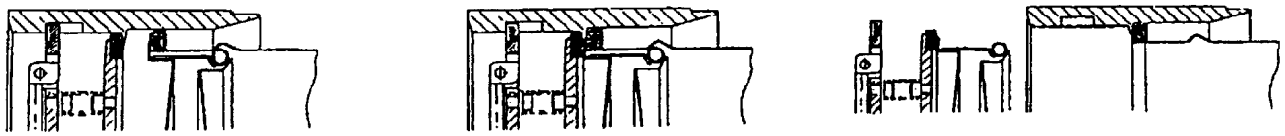
Then, objects can be taken out of the container or introduced into the container as required. This transfer is performed without breaking the leaktightness or the shielding (see procedure in figure 18). The separation of the container is achieved by a reverse operation procedure.

In order to ensure permanent tightness and a long life, the seals are only pressure loaded during coupling and uncoupling. Mechanical wear by friction forces shall be minimized.

For shielded containment enclosures, the leaktight container shall be inside a shielded transport container. When used with unshielded containment enclosures, the leaktight container is handled manually.



Details for steps 1 and 6 | Details for steps 2 and 5 | Details for steps 3 and 4



Starting (1) or finishing (6); Presenting or removing the container | After locking (2) or closing (5) | Opening (3) or closing (4), Double door is not swivelled

1 Approach of the leaktight container
2 After locking the container, rotate the knob until resistance is felt
3 Open the double door after unlocking
4 Put in the object or take it out respectively
5 Close the double door and rotate the knob
6 Lock the latch button and remove the leaktight container.

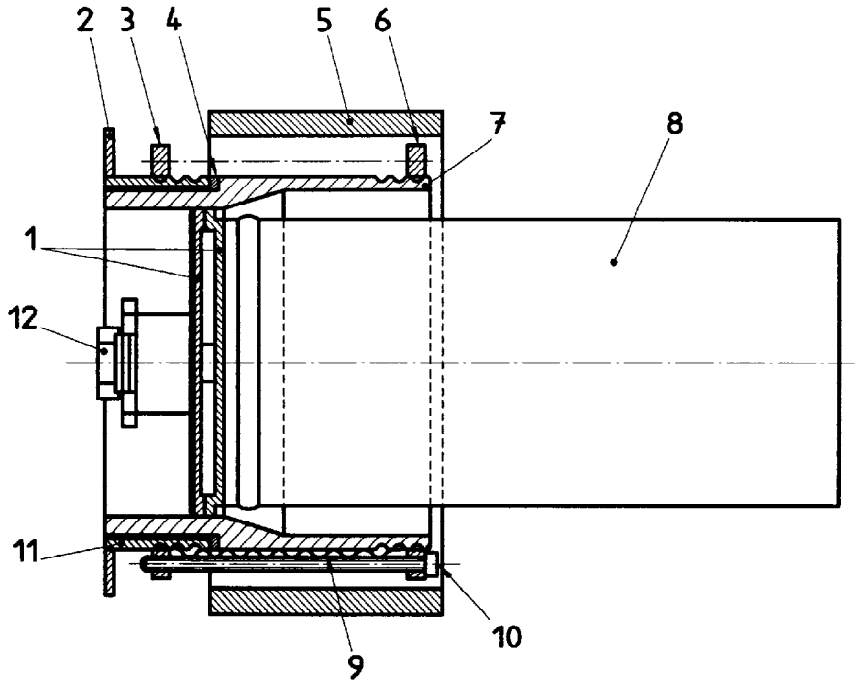
Figure 18 — Operating principle of a type 2 double door transfer system

7.3.3 Assembly

Type 2 double door transfer systems are mounted on glove/bag ports in an identical way to those defined in ISO 11933-1 by using an intermediate transfer port.

The transfer port is attached to the glove/bag port by locking rings, which fit into one groove of the glove/bag port. Leaktightness is ensured by using an O-ring seal.

There is a second locking ring on the transfer port fixed to it in the same manner. The transfer port is locked onto the glove/bag port by long bolts connecting these two locking rings. In addition there can be a plastic sleeve between the transfer port and the glove/bag port which allows changing the double door transfer system using the welded bag method (see figure 19).



Key

1 Double door
2 Containment enclosure wall
3 Locking ring on the glove/bag port
4 Seal
5 Lead shielding wall
6 Locking ring on the insert port
7 Transfer port
8 Leaktight container
9 Plastic sleeve
10 Bolt
11 Glove/bag port
12 Rotating knob

Figure 19 — Mounting of the double door transfer system

7.3.4 Material

The transfer port, the two doors and the container are generally made of stainless steel.

7.3.5 Dimensions (see figure 20)

The standard dimensions of ISO double door transfer systems of type 2 are given in table 11.

Table 11 — Dimensions of type 2 double door transfer systems

Dimensions in millimetres

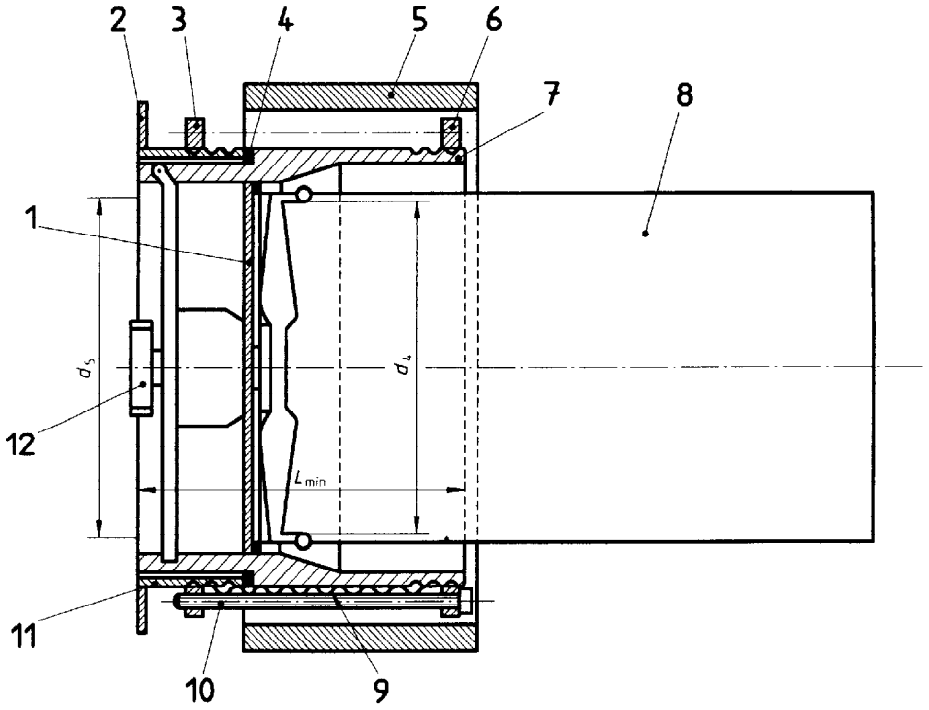
Double door transfer system				Associated glove/bag port
References[1]	d_4 [2]	d_5 [3]	L_{min} [3]	References[4]
1621 x y	140	179	125	1001 W 3 X
1625 x y	207	253	120	1005 W 3 X
1627 x y	290	339	120	1007 W 3 X

1) According to the rules given in clause 4; x and y are alphabetical indexes corresponding respectively to:
— the material of construction (x = X or E),
— the mode of manipulation of the double door transfer system (y = t or m).

2) d_4 is the smallest inner diameter.

3) See figure 20.

4) Other cases can also be referenced respectively: 1001 B 3 M, 1005 B 3 M, 1107 B 3 M.



Key

1 Double door
2 Containment enclosure wall
3 Locking ring on the glove/bag port
4 Seal
5 Lead shielding wall
6 Locking ring on the insert port
7 Transfer port
8 Leaktight container
9 Plastic sleeve
10 Bolt
11 Glove/bag port
12 Rotating knob

Figure 20 — Dimensions of type 2 double door transfer system

8 Leaktight connections for waste drums

The principle of the double door transfer system has also been applied to the larger diameters of leaktight connections for radioactive waste drums. These connections can also be used with leaktight enclosures inside lead shielded cells or with enclosures inside concrete shielded cells, leaktight concrete shielded cells and glove boxes.

8.1 General

The whole device [see figure 21 a)] comprises:

— a leaktight transfer drum **1**;

— a transfer carriage under the waste drum **2**;

— a lifting device to raise the drum to the enclosure door **3**;

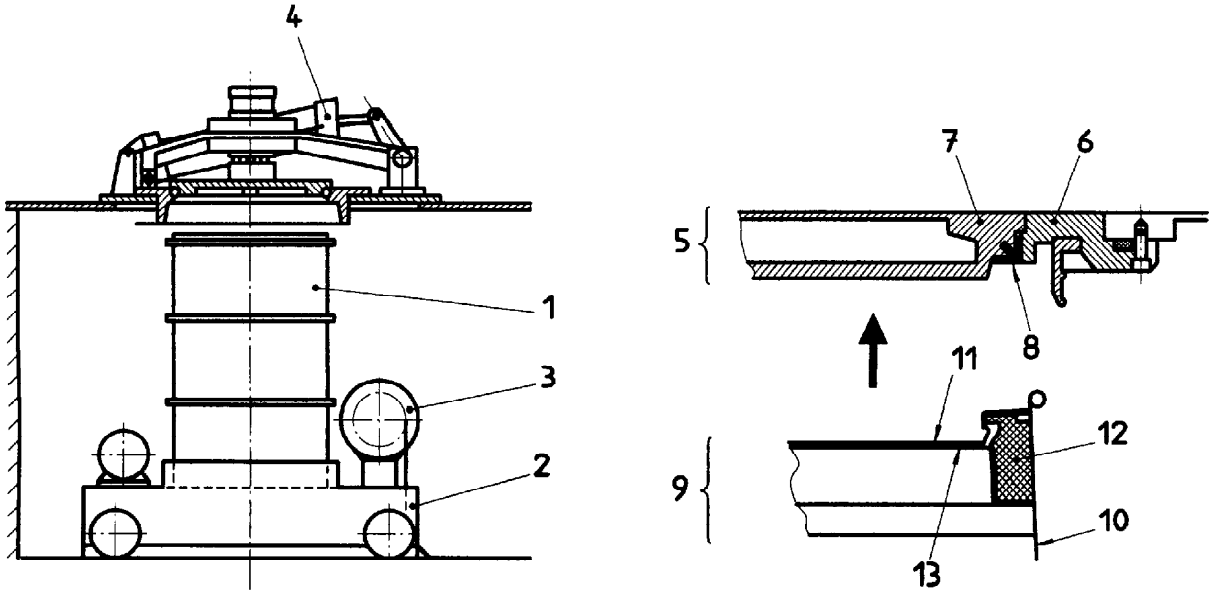
— an enclosure door against which the container door comes into contact **4**;

— a shielded device to hoop or to crimp the drum before storage (not shown in the drawing).

The double door system, illustrated in figure 21 b), consists of:

— a fixed part **5** on the enclosure, including an enclosure flange **6** and a leaktight enclosure door **7** equipped with a profiled elastomer seal **8**,

— a mobile part **9**, including a drum **10** equipped with a drum lid called "drum door" **11** and a profiled elastomer seal **12**, held in place by a locking ring **13**.



a) General view **b) Detail of double door system**

Figure 21 — Leaktight connection system for waste drums

The top part of the drum and the elastomer profiled seal form the sub-assembly part and is called the "drum flange". The connected assembly "fixed part" and "mobile part" is called the "leaktight connection for waste drums".

Due to their size and weight, double doors are operated by compressed-air actuators, with a motor for unlocking the drum door and coupling both doors, and a cylinder for opening and closing the double door. Versions with electric motors are also available.

Two types of leaktight connections for waste drums exist, which differ in

— the sealing system,

— the mechanical operating system,

— the dimensions used.

Such waste drums can also be used for transferring objects with larger dimensions than those accommodated by double door transfer systems described in clause 7.

8.2 Principle of use

The transfer procedure is shown in figure 22. There is an alternative method for shielded transfer.

The different operations are:

a) transport of the waste drum into the transfer area and positioning under the fixed enclosure door;

b) lifting and coupling the waste drum to the fixed door and locking together (drum door with enclosure door), constituting the double door;

c) unlocking the double door;

d) removing the double door and loading the drum.

The evacuation of the drum is achieved by using reverse operations. In special cases, the drum can be approached under the fastening system in order to adjust the additional lid.

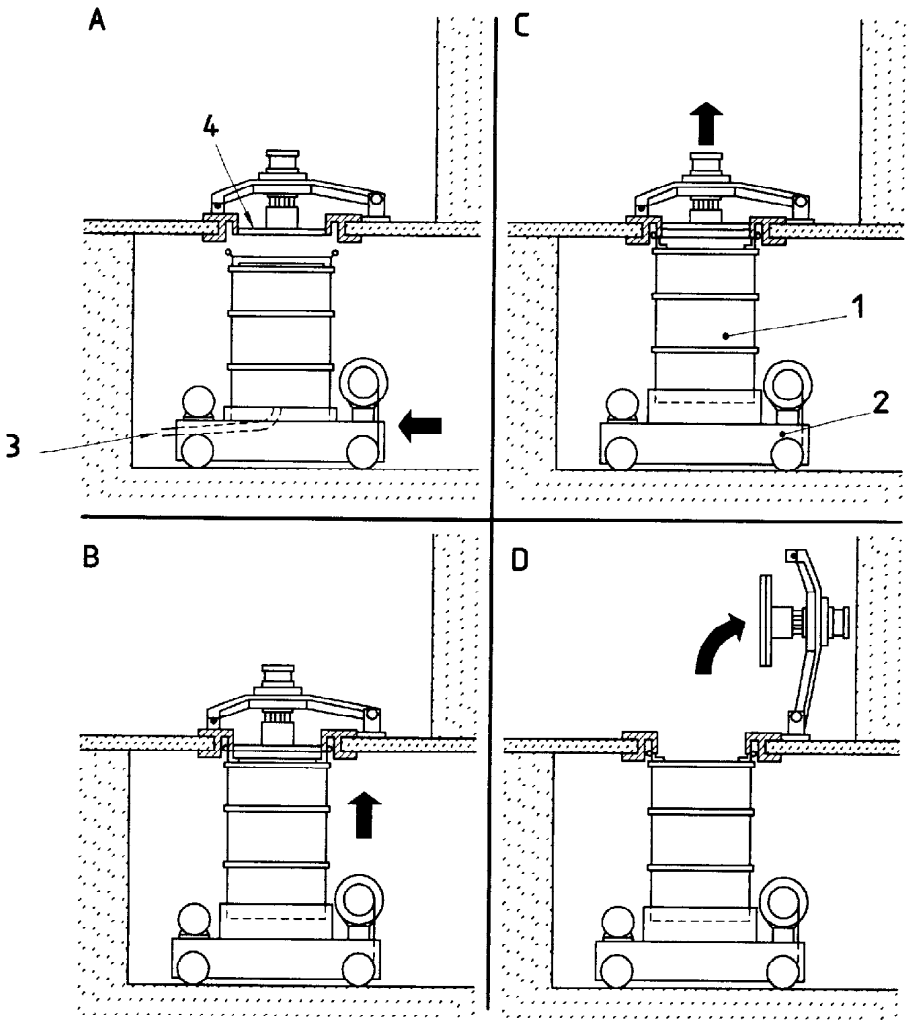


Figure 22 — Operating principle of leaktight connection systems for waste drums

8.3 Type 1 leaktight connections for waste drums

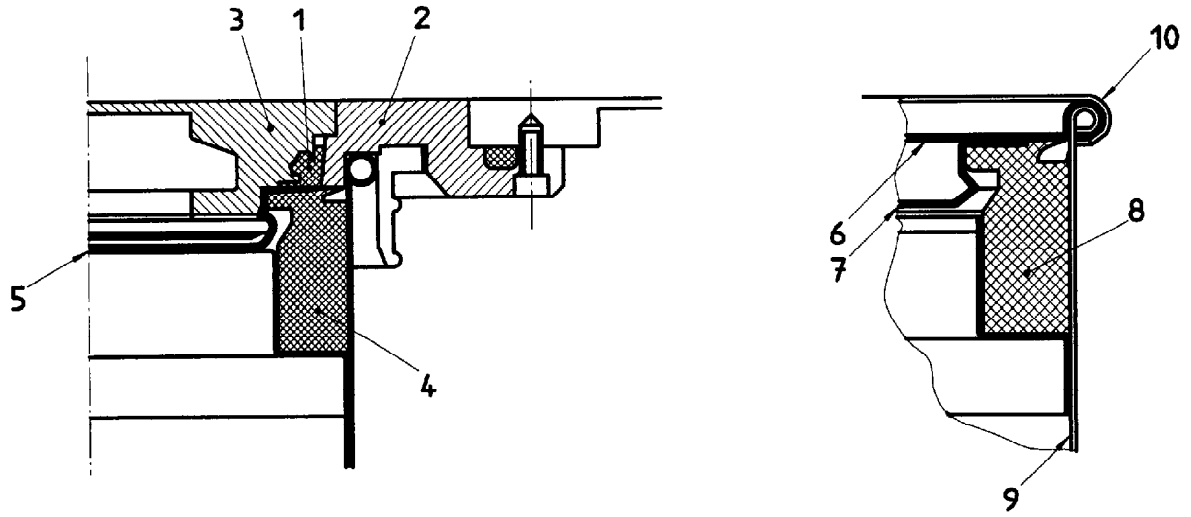
8.3.1 General

The enclosure flange is tightened on the enclosure wall by means of a screw system and O-ring seal.

It includes a ring with a slope (driven by two pressure cylinders) which ensures the locking of the enclosure door on the flange. Details of the fastening are given in figure 23 a).

The enclosure door is equipped with a lip seal, and the drum includes a special profiled seal.

According to the drum destination, the drum may receive an additional lid, providing mechanical stability, after the fixed and mobile parts have been disconnected. This second lid may be fastened or hooped [see figure 23 b)].



Key

1 Enclosure door
2 Flange on containment enclosure
3 Lip seal on enclosure
4 Special profiled seal on drum
5 Drum door
6 Additional lid
7 Drum door
8 Seal
9 Drum
10 Details of fastening

a) Detail of locking **b) Detail of additional fastening lid**

Figure 23 — Type 1 leaktight connection for waste drums

8.3.2 Operation

The leaktight transfer between the enclosure and the drum is achieved by locking the drum door to the enclosure door by means of a pressure cylinder actuating a rotating control which drives eight fingers for locking. Leaktightness is provided by the compression of the profiled lip seal of the enclosure door against the profiled seal of the drum.

The opening of the double door is achieved by actuating two parallel pneumatic jacks.

8.3.3 Material

Enclosure flanges and doors are made of stainless steel. Drum flanges and doors are made of carbon steel or stainless steel. Bolts and nuts are made of carbon steel and may be galvanized with zinc.

The drum profiled seal is made of ethylene/propylene. The enclosure seal is made of PVC or ethylene/propylene.

The inside of the drums may be coated with glass-fibre reinforced plastic and the outside (of carbon steel) may be painted if requested.

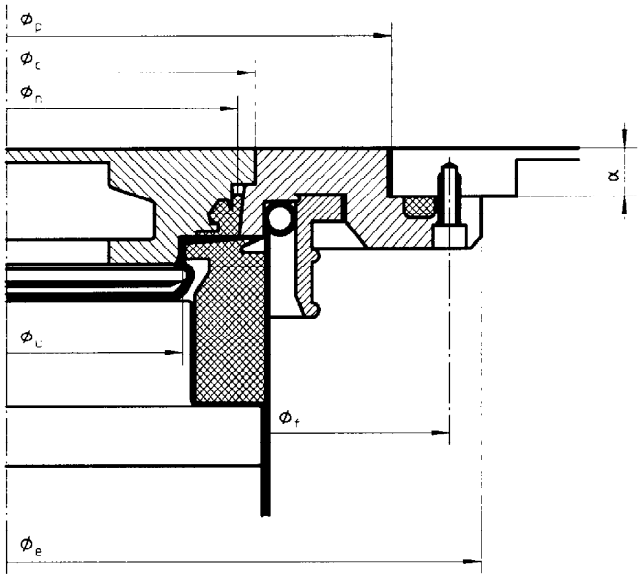
8.3.4 Dimensions (see figure 24)

The standard dimensions of ISO leaktight connections for waste drum systems of type 1 are given in table 12.

Table 12 — Dimensions of type 1 leaktight connections for waste drums

References[1]	Useful diameter $\varnothing_u$	Drum door diameter $\varnothing_c$	Nominal diameter of containment enclosure door $\varnothing_n$	Diameter of hole in containment enclosure $\varnothing_p$	Useful volume of drum V	Useful height of drum H
	mm				l	mm
1651 x y	515	609	560	691	200	≈ 900
1653 x y	645	748	695	840	440	≈ 1 200

1) According to the rules given in clause 4; x and y are alphabetical indexes corresponding respectively to:
— the material of construction of the double door transfer system (x = X or O),
— the material of construction of the drum (y = X or O).



Key

$\varnothing_u$: Useful diameter of drum
$\varnothing_n$: Nominal diameter of containment enclosure door
$\varnothing_c$: Drum door diameter
$\varnothing_p$: Diameter of hole in containment enclosure
$\varnothing_f$: Diameter of screwing of enclosure ring
$\varnothing_e$: Largest diameter of the whole system

Figure 24 — Dimensions of type 1 leaktight connection for waste drums

8.4 Type 2 leaktight connections for waste drums

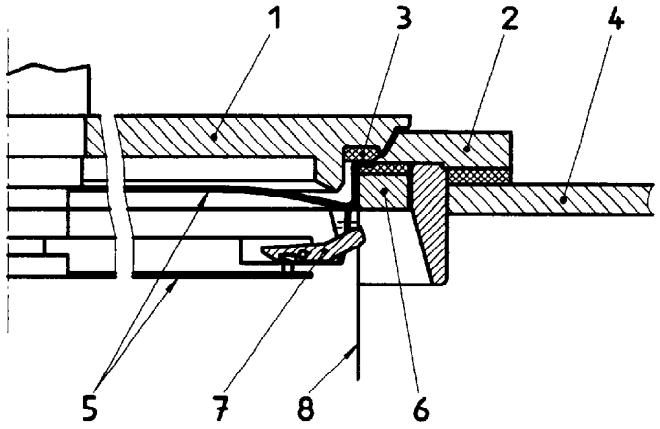
8.4.1 General

In this system, the design of the double door is the same, in principle, as the double door transfer system described in clause 7. The type 2 leaktight connection for waste drums differs from type 1 by the following considerations (see figure 25):

— form of the seals (flat seals instead of lip seals),

— mode of closing,

— dimensions of drums, etc.



Key

1	Enclosure door	5	Drum door
2	Flange on containment enclosure	6	Special profiled seal on drum
3	Flat seal on enclosure door	7	Fastening mechanism for drum door
4	Containment enclosure ceiling	8	Drum

Figure 25 — Type 2 leaktight connection for waste drums

8.4.2 Operation

A small transfer area below the hot cell or the containment enclosure is necessary. The waste drums are transported on a carriage in a standing position and are lifted and locked on the enclosure door by a lifting device.

For transfer, the drum is sealed onto the enclosure port. A bolt, in the centre of the drum door with left and right hand threads, is operated by a rotating drive shaft, so that the drum door is unlocked and tightly coupled to the enclosure door. The drum door is secured against rotation during this operation. The double door is then opened from inside the enclosure using a pressurized air-piston or an electrical motor operating as a threaded rod.

The door handle mechanism can be mounted either on a platform near the enclosure wall or on a shielding wall. In hot cell applications, the transfer area shall be provided with external shielding (e.g. a sliding door).

8.4.3 Material

The enclosure flange and the enclosure door shall be made of stainless steel.

The waste drums and their doors may be made of carbon steel. The inside of the drums may be coated with glass fibre reinforced plastic and the outside may be painted. Bolts and nuts are made of carbon steel and may be galvanized with zinc.

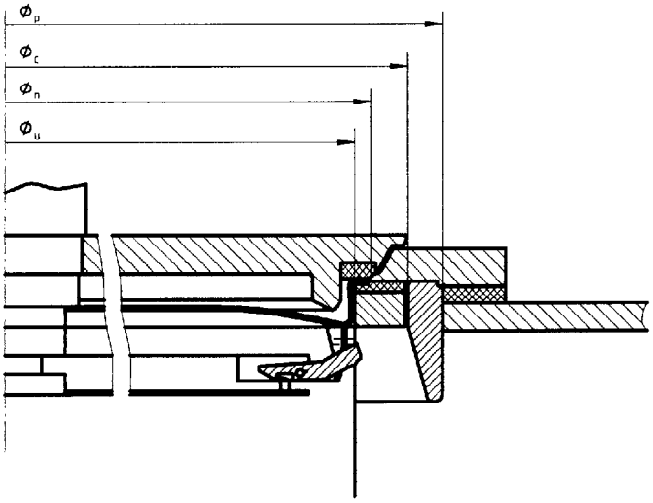
8.4.4 Dimensions (see figure 26)

The standard dimensions of ISO leaktight connections for waste drum systems of type 2 are given in table 13.

Table 13 — Dimensions of type 2 leaktight connections for waste drums

Reference[1)]	Useful diameter $\varnothing_u$	Drum lid diameter $\varnothing_c$	Nominal diameter of enclosure door $\varnothing_n$	Diameter of hole in containment enclosure $\varnothing_p$	Useful volume of drum V	Useful height of drum H
	mm				l	mm
1662 x y	560	624	571,5	674	200	≈ 800
1664 x y	710	774	721,5	824	400	≈ 1 000

1) According to the rules given in clause 4; x and y are alphabetical indexes corresponding respectively to:
— the material of construction of the double door transfer system (x = X or O),
— the material of construction of the drum (y = X or O).



Key

$\varnothing_u$: Useful diameter
$\varnothing_n$: Nominal diameter of enclosure door
$\varnothing_c$: Drum lid diameter
$\varnothing_p$: Diameter of hole in containment enclosure

Figure 26 — Dimensions of type 2 leaktight connection for waste drums

Annex A
(informative)

Examples of plain doors and airlock chambers

A.1 Refrigerator-type doors

A.1.1 Definition

This kind of door consists generally of hinge-mounted lightweight plastic doors.

Leaktightness is ensured by a seal inserted in a trapezoid groove.

A.1.2 Field of application

These doors are generally manually operated and mounted on the outer face of the containment enclosures.

The leaktightness of these doors is in accordance with containment enclosures of class 3 or 4 (see ISO 10648-2).

A.1.3 Description (see figure A.1)

The assembly is manufactured from a plastic sheet, possibly ribbed, and with dimensions appropriate to the objects to be transferred. The door is mounted on ordinary hinges and closed with a spring-loaded latch.

The door comprises an O-ring seal mounted in a groove.

Usual dimensions of these doors are 200 mm × 300 mm.

Other dimensions are available.

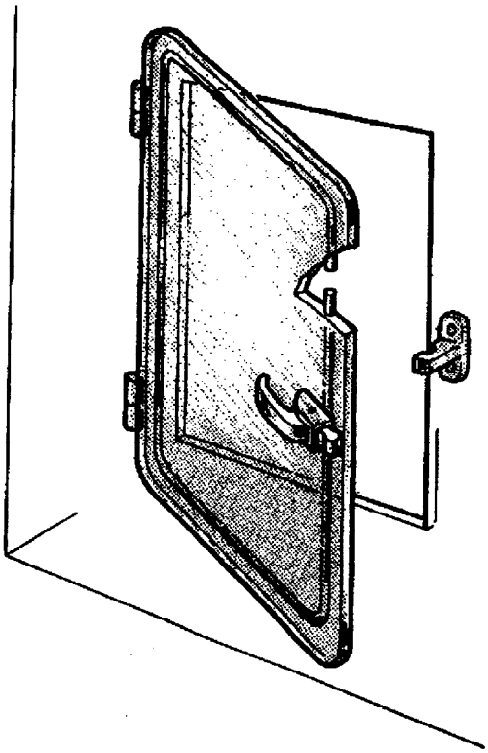


Figure A.1 — General view of refrigerator-type door

A.1.4 Assembly and operating constraints

These doors are easy to assemble. They require clearance, for opening the door.

Recommended use: door clamped shut by negative pressure.

Avoid using near a source of heat.

A.1.5 Safety system

Electromagnetic lock servosystems are suitable.

A.2 Inflatable-seal sliding doors

A.2.1 Definition

This kind of sliding door (see figure A.2) ensures leaktightness by inflation of the seal raised either

— by means of pressurized liquid actuated by a hydraulic pedal or by a hand operated press;

— or by means of a valve-controlled compressed air (maximum pressure 0,7 bar to 1 bar).

A.2.2 Application

These doors can be used either inside or outside the containment enclosure, in a vertical or horizontal position. The leaktightness of these doors is in accordance with containment enclosures of class 2, 3 or 4 (see ISO 10648-2).

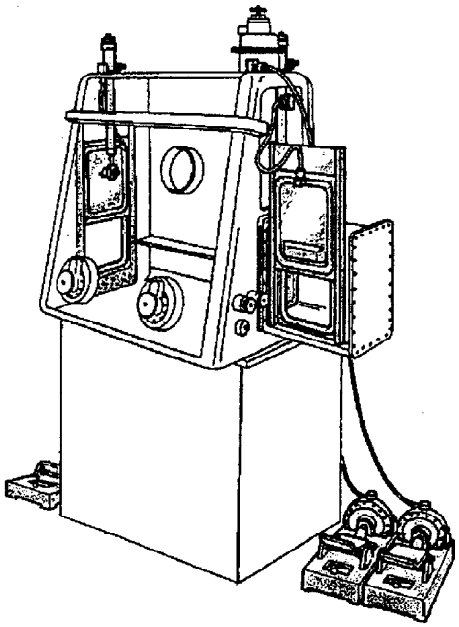


Figure A.2 — General view of inflatable-seal sliding door

A.2.3 Description

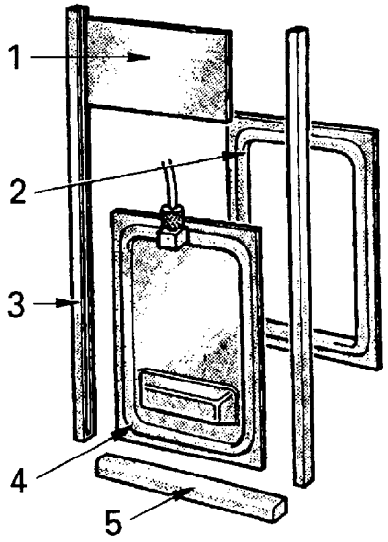
The assembly is made of plastic material and comprises the following (see figure A.3).

— A frame fitted with a drawn sealing flange of the same dimensions but closed by a flexible seal bonded onto the sides. The pressurized liquid or compressed air circulates through this door sealing flange.

— A door.

— Welded slides attached to the frame sides.

— A lower cross-guide receiving the door in the fully-closed position.



Key

1 Slide upper spacer
2 Frame with scaling flange
3 Slides
4 Sliding door
5 Lower cross-member

Figure A.3 — Detail of components of inflation-seal sliding door

A.2.4 Operating principle

The door is moved in its slides (see figure A.4). Opening and closing can be carried out manually or by means of a compressed air or pressurized liquid.

A.2.5 Assembly and operating constraints

The assembly of frame and slides is welded to the inner wall of the containment enclosures, or outside on an airlock chamber.

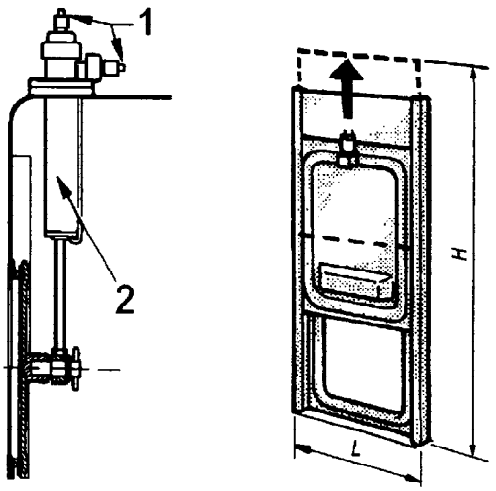
These sliding doors offer a completely free working place, but occupy a large space of the panel. Standard dimensions of these doors are in millimetres:

Opening	L	H
140 x 140	242	395
270 x 190	292	655
330 x 240	342	775
500 x 350	452	1115

A.2.6 Safety system

A pneumatic servo system prevents the door sliding with the seal inflated.

In the case of a manually operated vertical opening door, a system for the prevention of inadvertent or accidental closing of the door shall be provided.



Key

1 Pressurized liquid or compressed air

2 Jack

Figure A.4 — Operating principle of inflatable-seal sliding door

A.3 Sliding doors operated by lifting

A.3.1 Definition

This kind of sliding door ensures leaktightness in the closed position by mechanical compression of an O-ring seal.

A.3.2 Field of application

These doors are used in containment enclosures, in particular for airlock chambers.

They allow quick and easy operation with one hand (used in glove boxes). Remote handling is possible.

The leaktightness of these doors is in accordance with containment enclosures of class 3 or 4, possibly class 2 (see ISO 10648-2).

A.3.3 Description

These doors consist of square or rectangular cross-sections, sliding in two vertical slides balanced by a counterweight (see figure A.5). In certain cases this mechanism can be raised to the ceiling (see figure A.6).

Immobilization and leaktight sealing is obtained by compression of an O-ring seal with a lever-operated cam.

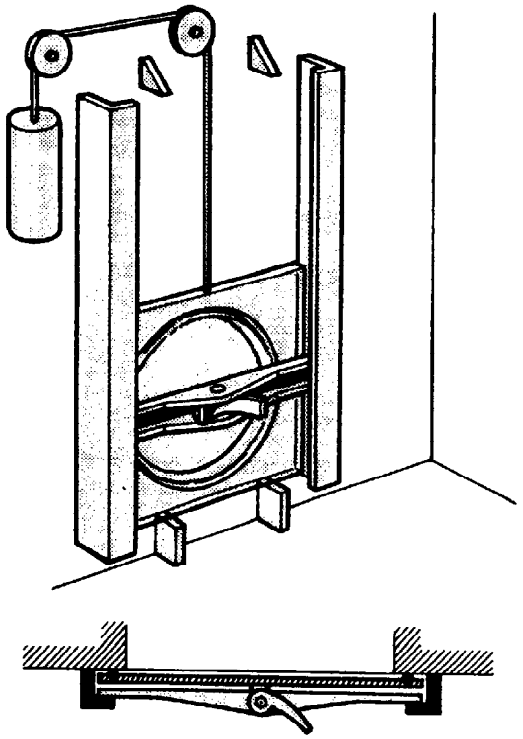


Figure A.5 — General view of sliding door operated by lifting

A.3.4 Assembly and operating constraints

These doors shall be assembled on a rigid monoblock frame.

They offer a completely free working place, but occupy a large space of the panel.

All dimensions are possible.

A.3.5 Material

These doors are made of polymethyl methacrylate or other material on request.

A.3.6 Special application

These doors can be used in a horizontal level; in which case the counterweight is not used.

In the case of an opening with a diameter of more than 250 mm, closing is done by two cams joined by a handle.

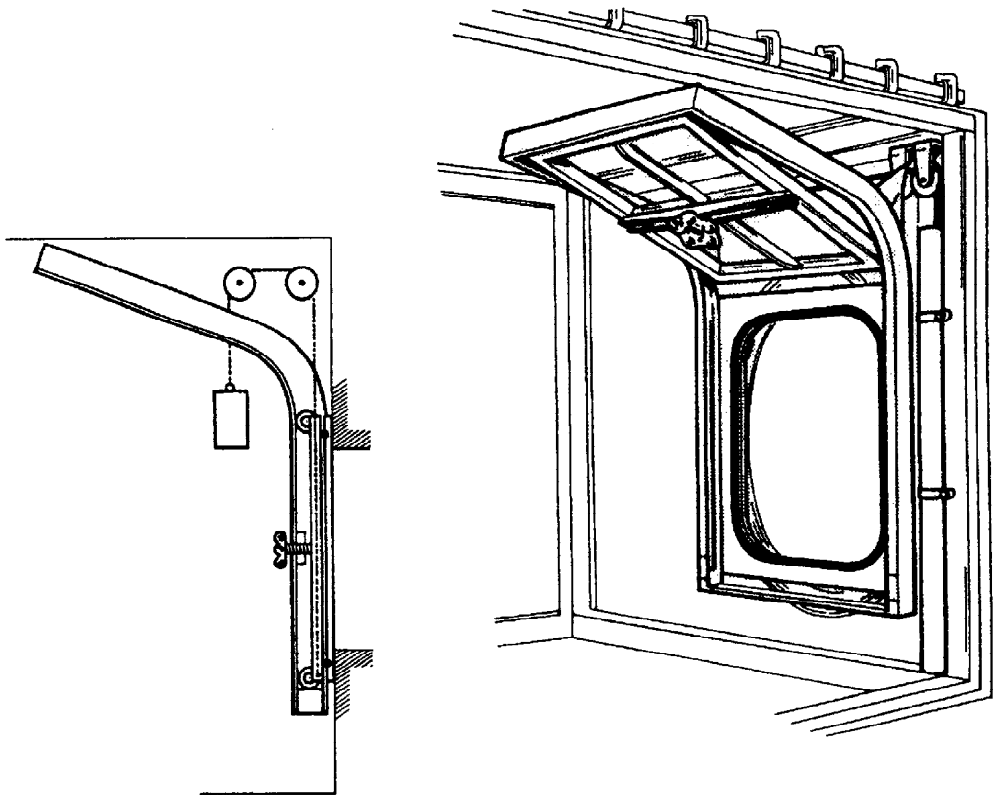


Figure A.6 — Operating principle of sliding door (lifting)

A.4 Rigid or retractable airlock chambers equipped with a double door transfer system

A.4.1 Definition

This device ensures a leaktight connection between two containment enclosures allowing the transfer of objects from one enclosure to another and the separation of the two enclosures, without breaking containment.

This system is an extension of the double door transfer system described in 7.2.

A.4.2 Field of application

The device can be mounted between two glove-boxes or two metal containment enclosures used behind a shielding.

The doors can be opened and closed manually or by means of a pneumatic jack and/or remote manipulation.

The leaktightness of these airlock chambers and of the double door transfer system is in accordance with containment enclosures of class 2, 3 or 4 (see ISO 10648-2).

A.4.3 Description

The device comprises the following (see figure A.7):

— A containment enclosure door (1) which can be handled by remote manipulation.

— A containment enclosure flange (2) including a ring with a slope (driven by a pneumatic jack). This containment enclosure flange can be equipped with a hinge.

— A linking tunnel including a container flange (8) associated with a container door (7) and welded to a bellows (5). This bellows is itself mounted on a rotating seal (4) integrated into the container flange.

This flange includes a ring with a slope (driven manually or by a pneumatic jack) which ensures the locking or unlocking of the doors.

The retractable airlock chamber also comprises additional components such as: a linking tunnel mobile flange (3), a fixed flange (6) and bellows compression screws (9).

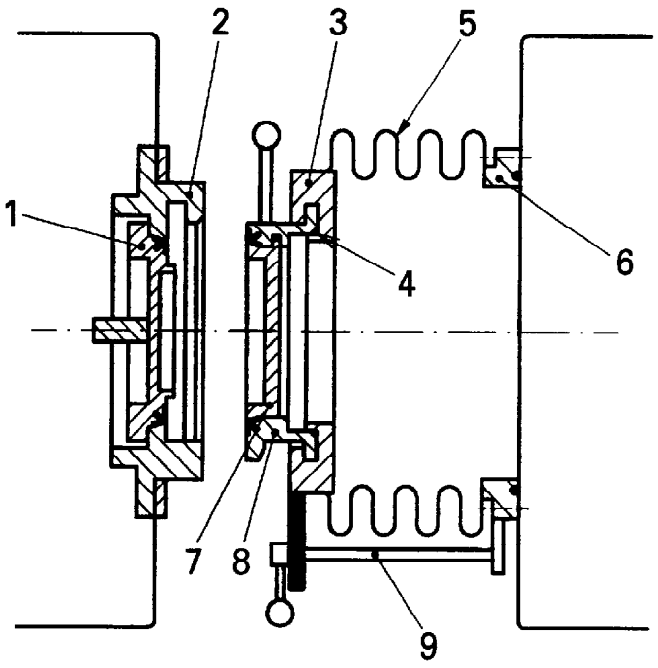


Figure A.7 — Detail of components

A.4.4 Material

The linking tunnel is made of stainless steel.

The container door and the containment enclosure door are made of polyethylene or of stainless steel.

The seals are made of PVC.

A.4.5 Mounting

The underpressure needed for opening the retractable bellows is about 1 200 Pa. The maximum underpressure in use is about 2 000 Pa.

A.4.6 Operating principle

The operations are carried out following the 3 steps below (see figure A.8):

a) Step 1: Connection of the double door

— Approaching the whole assembly: "containment enclosure door (2) and container door (4)".

— Connection of this assembly onto the enclosure flange (1).

b) Step 2: Unlocking the airlock chamber bellows

— Unlocking the airlock chamber bellows by 60° clockwise rotation acting on the container flange (3).

c) Step 3: Disconnection of the tunnel

— Retracting the bellows using the underpressure in the airlock chamber.

NOTE The connection of a retractable tunnel is achieved using the reverse order: 3 - 2 - 1.

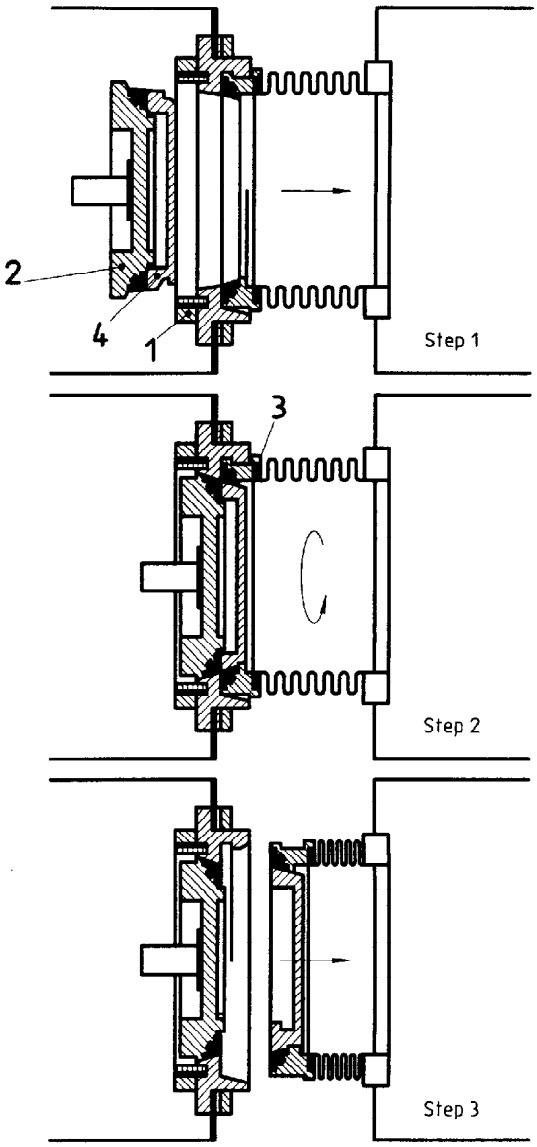


Figure A.8 — Operating principle

A.4.7 Dimensions

Useful diameters of retractable tunnels are 250 mm.

NOTE The basic system described here is a one-side linking tunnel.

A variation of this system can be provided, with a both-sides linking tunnel.

A.5 Circular airlock chambers with bellows

A.5.1 Definition

This device allows the transfer of objects:

— either between the operating room and a containment enclosure,

— or between two containment enclosures,

— or both purposes according to the design,

and ensures the separation of two volumes without breaking the containment.

A.5.2 Field of application

This device can be mounted on a containment enclosure or between two containment enclosures.

The airlock chamber is opened and closed manually using bungs.

The leaktightness of these airlock chambers is in accordance with containment enclosures of class 2 (see ISO 10648-2).

If the enclosure is contaminated, the transfer between the operating room and the containment enclosure can only be made from the operating room into the enclosure and not vice versa.

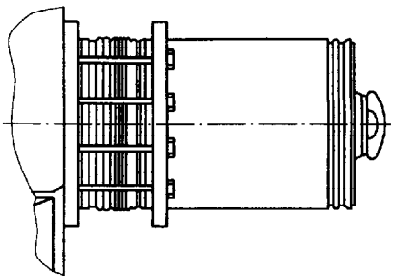
A.5.3 Description

The device comprises (see figure A.9):

— A T-shaped tube with one or two openings related to the operating room, closed by a bung(s), and with two openings, which each have a flange for locking onto a containment enclosure port.

The latter openings are each closed by a bung from the inside of the containment enclosure.

— Two plastic bellows mounted between the airlock chamber and the containment enclosure ports.



T-shaped airlock chamber for transfer between operating room and containment enclosure

Figure A.9 — General view

A.5.4 Assembly

The airlock chamber is fastened onto a glove/bag port of the enclosure by long bolts connecting the flange and the glove/bag port (see figure A.10).

The plastic bellows, mounted between the airlock chamber and the glove/bag ports, allow the disconnection of the airlock chamber and the containment enclosures according to the welded bag transfer method, if the enclosures are contaminated.

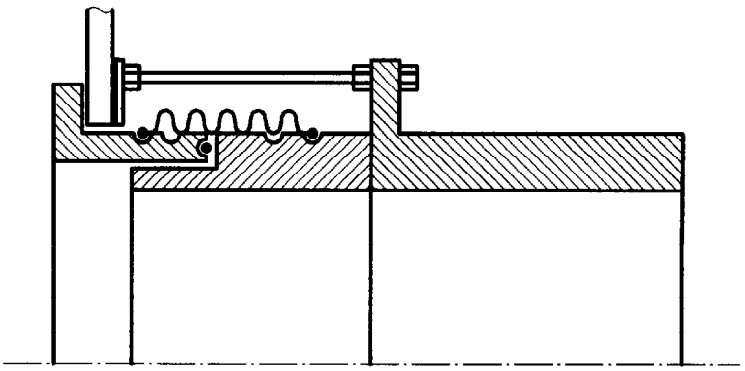


Figure A.10 — Detail of mounting

A.5.5 Material

The device is either made of PVC, PMMA or stainless steel.

The seals are made of PVC.

Annex B
(informative)

Bibliography

[1] ISO 11933-4:—[4], *Components for containment enclosures — Part 4: Ventilation and air cleaning systems such as filters, traps, pressure regulators, safety and control devices.*

[2] ISO 11933-5:—[4], *Component for containment enclosures — Part 5: Penetration for electrical and fluid circuits.*

4) To be published.

ICS 13.280; 71.040.10

Descriptors: nuclear energy, radioactive materials, radiation protection, environmental protection, operator protection, containment enclosures, components, specifications, characteristics, dimensions, designation, interchangeability.

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