
Components for containment enclosures —

Part 2:

Gloves, welded bags, gaiters for remote-handling tongs and for manipulators

Composants pour enceintes de confinement —

Partie 2: Gants, sacs à souder, manches de protection pour pinces à distance et télémanipulateurs



Contents

Page

Introduction

1	Scope	1
2	Normative references	1
3	Definitions	2
4	Designation.....	3
5	Gloves	6
6	Welded bags.....	13
7	Remote-handling tong gaiters for support rings	20
8	Gaiters for manipulators	30

Annexes

A	Description of different glove- or bag-changing methods.....	46
B	Criteria for the choice of material of manufacture.....	54

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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 11933-2 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 interchangeable units*
- *Part 2: Gloves, welded bags, gaiters for remote-handling tongs and manipulators*
- *Part 3: Transfer systems such as plain doors, double doors for leaktight transfer, airlock chambers, leaktight connections for waste drums*

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

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Introduction

A great number of leaktight mechanical components for containment enclosures are presently offered on the market. These components:

- may have different geometric dimensions;
- may require holes of different diameters for attachment on the containment enclosure wall;
- may be attached to this wall by different methods;
- may use different mounting systems for their associated leaktight elements, such as gloves, welded bags, bungs, transfer systems, etc.

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

As a consequence, the aim of this part of ISO 11933 is to present general principles of design and use, and to fully describe the different existing systems in order to:

- avoid new parallel systems based on identical principles and differing only in details or geometric dimensions;
- make possible interchangeability between existing equipment;
- demonstrate consistency among the various parts of the same system such as the basic elements (described in ISO 11933-1), the elements associated with leaktightness (described in ISO 11933-2), or the transfer systems (described in ISO 11933-3).

Components for containment enclosures —

Part 2:

Gloves, welded bags, gaiters for remote-handling tongs and for manipulators

1 Scope

This part of ISO 11933 specifies requirements for the selection, construction and use of the following leaktight components fitted on glove/bag ports and/or ejectable support rings used in containment enclosures and dealt with in ISO 11933-1:

- gloves,
- welded bags,
- gaiters for remote-handling tongs,
- manipulator gaiters.

Tong and manipulator gaiters are respectively the protection sleeves for remote-handling tongs and mechanical master-slave manipulators.

Equipment which differs from those listed in this part of ISO 11933 can be used, but their design criteria should respect those given in this document.

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 10648-1:1996, *Containment enclosures — Part 1: Design principles*.

ISO 10648-2:1994, *Containment enclosures — Part 2: Classification according to leak 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 11933-3:—1), *Components for containment enclosures — Part 3: Transfer systems such as plain doors, double doors for leaktight transfer, airlock chambers, leaktight connections for waste drums.*

ISO 1043-1:—1), *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics.*

EN 421, *Protective gloves against ionizing radiation and radioactive contamination.*

3 Definitions

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

3.1 glove (for glove boxes or containment enclosures): Glove of impermeable flexible material with a long cuff designed to obtain a leaktight fitting around or on the sides of a glove port or on any other component and providing at the same time satisfactory mechanical behaviour.

3.2 welded bag: Flexible component used to introduce pieces or materials into a glove box or into the containment enclosure or to remove them from the containment enclosure.

They are generally made of impermeable, flexible and weldable material, ending in a lip seal, a bead or thermally welded hem containing an O-ring.

3.3 tong or manipulator gaiter: Specially profiled flexible sleeve designed to protect the mechanical parts of remote-handling tongs or the arms of mechanical master-slave manipulators against contamination.

3.4 interchangeable elements: Parts of equipment for containment enclosures which may be exchanged one for another or replaced:

- either manually, by mounting, dismounting or substitution operations (for example screwed enclosure rings which may be replaced by screwed glove ports of the same diameter);
- or by remote-controlled operation and/or using an automatic or manual ejecting device (for example, support rings equipped with gloves, welded bags, tong or manipulator gaiters, bungs or rigid pugs, etc.).

These elements are designed so that their replacement one by another:

- does not reduce the containment enclosure tightness;
- and does not need any modification, by replacement or piercing, of the containment enclosure wall.

3.5 ejectable elements: Elements of containment enclosures which may be exchanged by remote-controlled operation, generally using an appropriate mechanical device, in which the new element takes the place of the old one by pushing it into the containment enclosure by a simple translatory motion.

This equipment is intended for enclosure rings such as: support rings equipped with gloves, welded bags, tong or manipulator gaiters, circular windows, rigid plugs, etc.

They are designed in such a way as to ensure that the leaktightness between the attached element on the enclosure wall (enclosure ring) and the mobile part (ejectable element) is never broken during the exchange operation.

These operations are fully described in this part of ISO 11933.

1) To be published.

4 Designation

The designation of a given component of a containment enclosure shall include the complete name of the component, reference to this part of ISO 11933 and a 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 11933-3. This may be followed by one or several alphanumeric marks characterizing the mounting procedure and/or the material of construction (see also tables 2 through 8).

Table 1 — Series allocation

Components for containment enclosures		Series	Subclause
Gloves	{for glove ports	1300-1309	5/5.2
	{for support rings	1310-1319	5/5.3
Welded bags	{for bag ports	1320-1329	6/6.3
	{for support rings	1330-1339	6/6.4
Tong gaiters	{for type 1 support rings	1340-1349	7/7.1
	{for type 2 support rings	1350-1359	7/7.2
	{for type 3 support rings	1360-1369	7/7.3
Manipulators gaiters	1)	8	

1) Because of the numerous variations in length, type, etc., it is not possible to standardize the designation of manipulator gaiters.

The last digit of the reference number corresponds to the last digit of the glove/bag port or support ring onto which the leaktight component is intended to be mounted. Therefore the reference numbers of the two elements (component and glove/bag port or support ring) have the same correspondence to the internal nominal diameter of the glove/bag port or support ring, in accordance with the designation of these associated components (see definition in ISO 11933-1).

The alphanumeric codes are in accordance with the International Designation System (see ISO 1046).

4.1.1 Gloves

The first group of letters of the alphanumeric code indicates the material(s) of manufacture of the gloves, in accordance with standardized designations of plastics materials.

The designations for the most common glove materials are:

NR	for natural rubber
CR	for polychloroprene
CSM	for chlorosulfonated polyethylene solution
IIR	for (chloro- or bromo)-butyl (butyl)
FPM	for copolymer of vinylidene fluoride and hexafluoropropylene
PU	for polyurethane
PVC	for polyvinyl chloride
EPDM	for ethylene propylene EPM
NBR	for nitrile rubber
EVA	for polyethylene-vinyl acetate

PE	for polyethylene
PP	for polypropylene
XX	for other materials

In this part of ISO 11933, the most commonly used materials will be designated by their standardized abbreviations as indicated above: PVC, PU, EVA, PE, etc.

Some materials may be combined with lead; in this case the designation includes the coding letter of the base material, followed by the letter **b** in bold typeface.

EXAMPLE

CR**b** (lead-loaded polychloroprene)

When gloves are manufactured with several layers (double-layer or triple-layer gloves) the designation includes coding letters corresponding of the association, separated by a “/”.

EXAMPLES

CR/CSM:	polychloroprene coated with chlorosulfonated polyethylene
CR/IIR/CR:	polychloroprene/butyl/polychloroprene
CR/FPM:	polychloroprene coated with fluorinated elastomer
CSM/CR b /FPM:	lead-loaded polychloroprene coated on one side with chlorosulfonated polyethylene and on the other side with fluorinated elastomer

The following indicators refer to:

- the size of the glove (7, 8, 9 or 10),
- the length of the glove, expressed in millimetres (750, 800, etc.),
- the diameter of the bead, expressed in millimetres, preceded by the mark Ø.

NOTE — The association of the different materials (layers) depends on the techniques of manufacturing and/or on the working conditions.

4.1.2 Welded bags

The first group of letters of the alphanumeric code indicates the material of bag manufacture according to 4.1.1 and to standardized designations of plastics materials.

The designations below are for commonly used materials of manufacture:

PVC	for polyvinyl chloride
PU	for polyurethane
EVA	for ethyl vinyl acetate

The following indicators refer to:

- the length of the bag, expressed in millimetres (900, 1 200 or 1 500),
- the type of seal ending the bag:
 - d for a bead,
 - l for a lip seal,
 - r for an O-ring seal,
- the diameter (or width) of the seal, expressed in millimetres, preceded by the mark Ø.

4.1.3 Gaiters for remote-handling tongs

The first group of letter(s) of the alphanumeric code indicates the material of gaiter manufacture, according to 4.1.1 and to standardized designations of plastics materials.

For tong gaiters, designations for the usual materials of manufacture are:

PVC	for polyvinyl chloride
NR	for natural rubber
CR	for polychloroprene
CR/CSM	for polychloroprene coated with chlorosulfonated polyethylene
PU	for polyurethane

The following indicators refer to

- the length of the gaiter, expressed in millimetres (500, 750, 900, 1 000, 1 100, 1 200, etc.),
- the type of seal ending the gaiter:
 - d for a bead,
 - l for a lip seal,
 - r for an O-ring seal,
- the diameter (or width) of the seal, expressed in millimetres and preceded by the mark \emptyset .

4.1.4 Gaiters for manipulators

Because of numerous variations in length, etc. it is not possible to standardize the designation of manipulator gaiters.

4.2 Designation examples

A butyl glove for a support ring of type 1 with a nominal diameter of 150 mm ²⁾, a length of 750 mm, size 8 and bead diameter of 8 mm is designated as follows (see table 3):

ISO glove 1311 IIR 8 750 \emptyset 8

A PVC welded bag for a support ring of type 1 with a nominal diameter of 150 mm ²⁾, a length of 900 mm, with a lip seal of a width of 6 mm is designated as follows (see table 5):

ISO welded bag 1331 PVC 900 l \emptyset 6

A polyurethane tong gaiter, with a length of 1 000 mm, for a support ring of type 1 with a nominal diameter of 150 mm ²⁾ and a O-ring seal of a width of 6 mm is designated as follows (see table 7):

ISO tong gaiter 1341 PU 1 000 r \emptyset 6

2) The nominal diameter indicated here corresponds to the diameter of the leaktight component, and not to the diameter of the support ring or of the glove/bag port on which this leaktight component is mounted. For this latter information, see the corresponding tables.

5 Gloves

5.1 General

5.1.1 Categories of gloves classified according to mounting on enclosure wall

Two types of gloves are considered in this document:

- a) gloves for glove ports,
- b) gloves for ejectable support rings.

5.1.2 Categories of gloves classified according to their material of manufacture and design

The criteria for the choice of the manufacture material are given in annex B.

There are four categories of gloves as follows.

- a) Single-layer gloves
 - gloves made of natural rubber,
 - gloves made of polychloroprene rubber,
 - gloves made of chlorosulfonated polyethylene,
 - gloves made of butyl rubber,
 - gloves made of PVC,
 - gloves made of EPDM,
 - gloves made of fluorinated elastomer,
 - gloves made of polyurethane,
 - gloves made of nitrile rubber,
 - gloves of other material.
- b) Double-layer gloves
 - gloves made of polychloroprene coated with chlorosulfonated polyethylene,
 - gloves made of polychloroprene coated with fluorinated elastomer,
 - gloves made of polyurethane coated with polychloroprene,
 - gloves of other combinations of material.
- c) Triple (or more) layer gloves
 - gloves made of polychloroprene/bromobutyl/polychloroprene,
 - gloves made of polychloroprene/polyurethane/polychloroprene,
 - gloves of other combinations of material.
- d) Lead-loaded gloves

Lead-loaded gloves are used when protection against ionizing radiation is required. They are manufactured with three layers; only the middle layer is loaded with lead, depending on the needed resistance to ionizing radiation.

The outer layers are made of the material selected to meet the other requirements (mechanical resistance, chemical resistance, thickness, etc.).

EXAMPLE: gloves made of polychloroprene/lead-loaded polychloroprene/chlorosulfonated polyethylene.

5.2 Gloves for glove ports

5.2.1 Assembly of gloves on glove ports and glove-changing methods

Depending on the design of the different types of glove port, several methods exist to assemble gloves to glove ports and to change gloves.

NOTE — In most of the cases described hereafter, the mechanical assembly of gloves on glove ports is achieved by auxiliary devices such as adhesive tape or internal/external clamping rings. These auxiliary devices improve the mechanical assembly of gloves on glove ports during use, and prevent the spread of contamination during exchange of gloves.

In no case do these auxiliary devices participate directly in the leak tightness of the containment enclosure; this function is provided only by the bead of the glove.

5.2.1.1 Method a: Glove port with two external grooves and glove assembly without clamping and/or O-ring

The glove is set in the first groove of the glove port (as seen from the operator's standpoint) and mechanically fastened with adhesive tape (see figure 1).

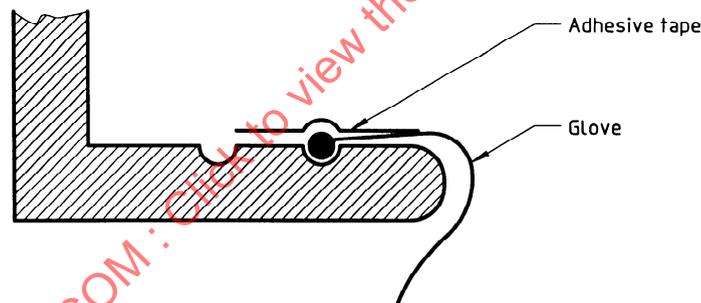


Figure 1 — Normal method of glove attachment to glove ports with two external grooves

The advantages of this method are as follows:

- a) The space between the two grooves can never be contaminated in normal use.
- b) The glove is not held with a clamping ring or a snap ring and therefore the mechanical stress on the glove sleeve is minimized.

The glove-changing procedure for this method is described in clause A.1 of annex A.

5.2.1.2 Method b: Glove port with two external grooves and glove assembly with an auxiliary inner clamping ring

This method of fastening the gloves to the glove port is nearly identical to method a, except that the glove is held inside the glove port by a clamping ring (see figure 2).

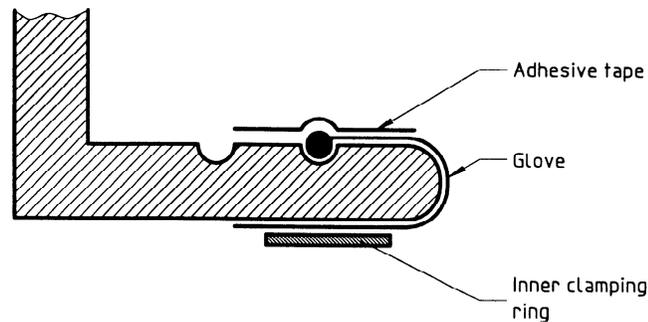


Figure 2 — First alternative method of glove attachment to glove ports having two external grooves

The advantages of this method are as follows.

- a) The space between the two grooves can never be contaminated in normal use.
- b) The glove is always held, in normal use, by the use of two independent mechanical securing devices (adhesive type, clamping ring).

The glove-changing procedure for this method is described in clause A.2 of annex A.

5.2.1.3 Method c: Glove port with two external grooves and glove assembly with an auxiliary outer clamping ring and an O-ring

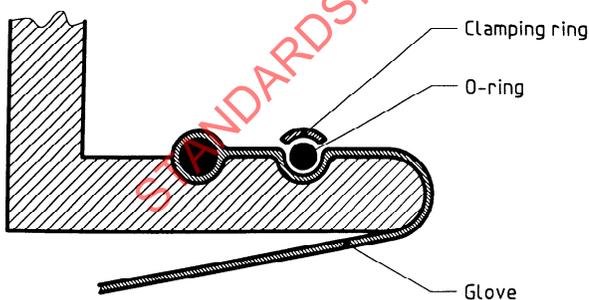
This method is nearly identical to methods a and b, except that (see figure 3):

- the bead of the glove is mounted on the second groove of the glove port (seen from the operator's standpoint),
- the glove is held by an external O-ring and a clamping ring fastened over the first groove.

The advantages of this method are as follows.

- a) The space between the two grooves can never be contaminated in normal use.
- b) The glove is always held, in normal use, by the use of two independent securing devices (O-ring, clamping ring).

The glove-changing procedure for this method is described in clause A.3 of annex A.



Clamping ring

Figure 3 — Second alternative method of glove attachment on glove ports having two external grooves

5.2.1.4 Method d: Glove port having three external grooves and glove attachment on glove ports with two auxiliary external O-rings

The glove is clamped on the port using all three grooves (see figure 4) with the bead placed in the third groove and with two additional O-rings, placed over the other grooves.

When placing the glove sleeve into the glove port, care must be taken to avoid removing the two O-rings simultaneously.

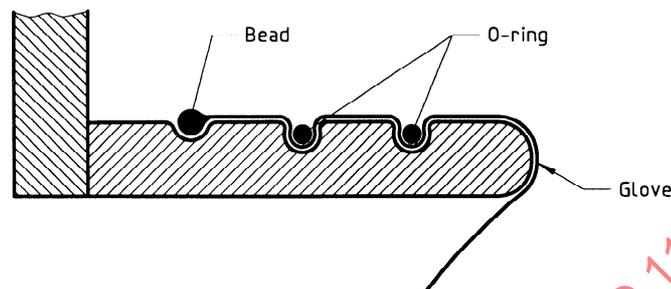


Figure 4 — Method of glove attachment on glove ports having three external grooves

The advantages of this method are as follows.

- In normal use, the glove is held by the use of two independent securing devices.
- The spread of contamination is limited by the use of two separate O-rings.

The glove-changing procedure for this method is described in clause A.4 of annex A.

5.2.1.5 Method e: Glove port having one external and two internal grooves and glove attachment on glove ports with two auxiliary internal O-rings

This case is very similar to the previous, except that two additional grooves are situated on the inside of the glove port instead of the outside (see figure 5).

The glove and the changing procedure used for this method are similar to those in the method with the use of two additional O-rings.

The thickness and the flexibility of the glove must be in accordance with the size of the O-ring and the dimensions of the grooves.

When placing the glove sleeve into the glove port, care must be taken to avoid removing the two O-rings simultaneously.

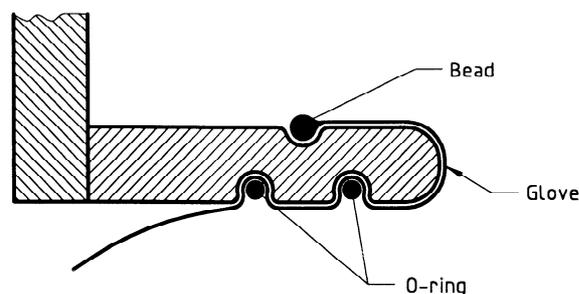


Figure 5 — Method of glove attachment on ports having one external groove and two internal grooves

The advantages of this method are as follows.

- a) In normal use, the glove is always held by two independent securing devices (O-rings).
- b) The spread of contamination is limited by the use two internal O-rings.

The glove-changing procedure for this method is described in clause A.5 of annex A.

5.2.2 Dimensions (see figure 6)

The usual thickness for a single-layer glove is $(0,5 \pm 0,1)$ mm. The standardized bead diameter is 6 mm. Other diameters are also available.

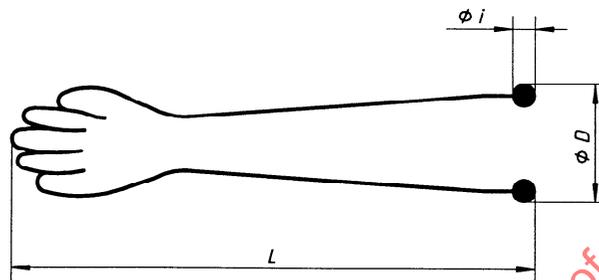


Figure 6 — Glove for glove ports

Standard dimensions of ISO gloves for glove ports are given in table 2.

Table 2 — Standard dimensions of gloves for glove ports

Dimensions in millimetres

References	Glove dimensions			Associated glove ports	
	Nominal diameter ¹⁾ <i>D</i>	Length ²⁾ <i>L</i>	Diameter of bead <i>i</i>	Type	Useful diameter of glove port <i>U</i>
1300 m t L Ø i ³⁾	160	750	6	1000	156
1301 m t L Ø i ^{3) 4)}	194	750	6	1001/1002/1003	180/186/200
1304 m t L Ø i ^{5) 4)}	250 ⁶⁾	750	6	1004/1005	249/254

- 1) Nominal dimension, varying according to the material of the glove.
- 2) Depending on type, other lengths ranging from 500 mm to 800 mm may be supplied on request.
- 3) This glove could also have reference 1302 or 1303, according to the rule given in clause 4.
- 4) According to the rule given in clause 4, m, t, L and i are alphanumeric indexes corresponding respectively to:
 - the material(s) of manufacture (m = NR, CR, CSM, IIR, FPM, PU, EPDM, NBR, CR/CSM, CR/IIR/CR, CR/FPM, ..., SCM/CRb/FPM, CR/CRb/CSM, etc.),
 - the size of the glove (t = 7, 8, 9 or 10),
 - the length of the glove (L = 750 mm for a standard glove),
 - the diameter of the bead (i = 6 mm for a standard glove).
- 5) This glove could also have reference 1305, according to the rule given in clause 4.
- 6) Special glove for glove ports of large diameter.

NOTE — Gloves manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. The use of such items is acceptable, providing that they are used in accordance with this part of ISO 11933.

5.3 Gloves for support rings

5.3.1 General

These types of gloves are used on containment enclosures generally located behind a shielding wall and equipped with enclosure rings of type 1 or 2. They are fitted on ejectable support rings of the same type (type 1 or 2) (see figure 7). These gloves are interchangeable with other leaktight components (welded bags, bungs, tong gaiters and manipulator gaiters).

They are replaced using an ejection device. Ejectable support rings are dealt with in ISO 11933-1.

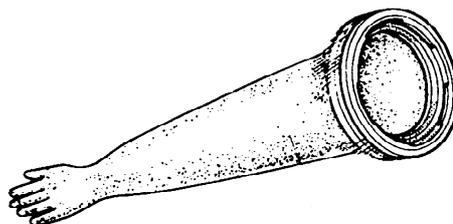


Figure 7 — Glove fitted on an ejectable ring (general view)

5.3.2 Material and design

The gloves are made of elastomer and terminate with a bead of diameter 6 mm to 8 mm (see figures 8 and 9 and table 3).

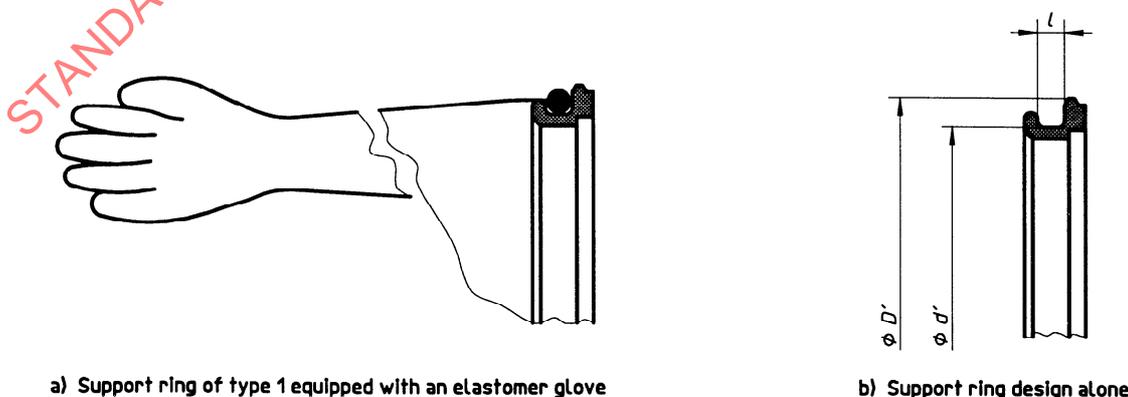
The diameter of the bead is designed in accordance with the width of the groove of the support ring on which it intended to be mounted (8 mm for a support ring of type 1 and 6 mm for a support ring of type 2, see ISO 11933-1).

5.3.3 Fitting of gloves on the support ring

The diameter of the bead and the shape of the groove on the ejectable support ring shall be designed to provide the required leaktightness when mounted under any operating condition.

This leaktightness is obtained by the bead of the glove when mounted on support ring of type 1 (see figure 8) and with the bead of the glove associated with a flat seal when mounted on a support ring of type 2 (see figure 9).

Gloves equipped with these two kinds of seal are supplied already fitted on the respective support rings. The proper fit of the glove to its support ring shall be checked by an approved method before acceptance.



a) Support ring of type 1 equipped with an elastomer glove

b) Support ring design alone

Figure 8 — Elastomeric glove fitted on an ejectable support ring of type 1

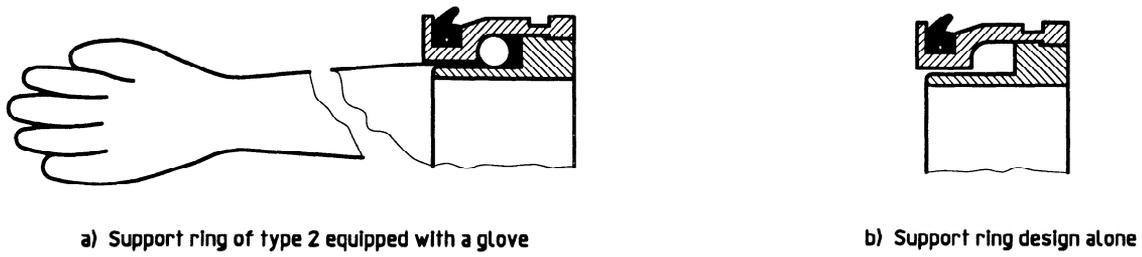


Figure 9 — Elastomeric glove fitted on an ejectable support ring of type 2

5.3.4 Dimensions

Standard dimensions ISO gloves for ejectable support rings are given in table 3.

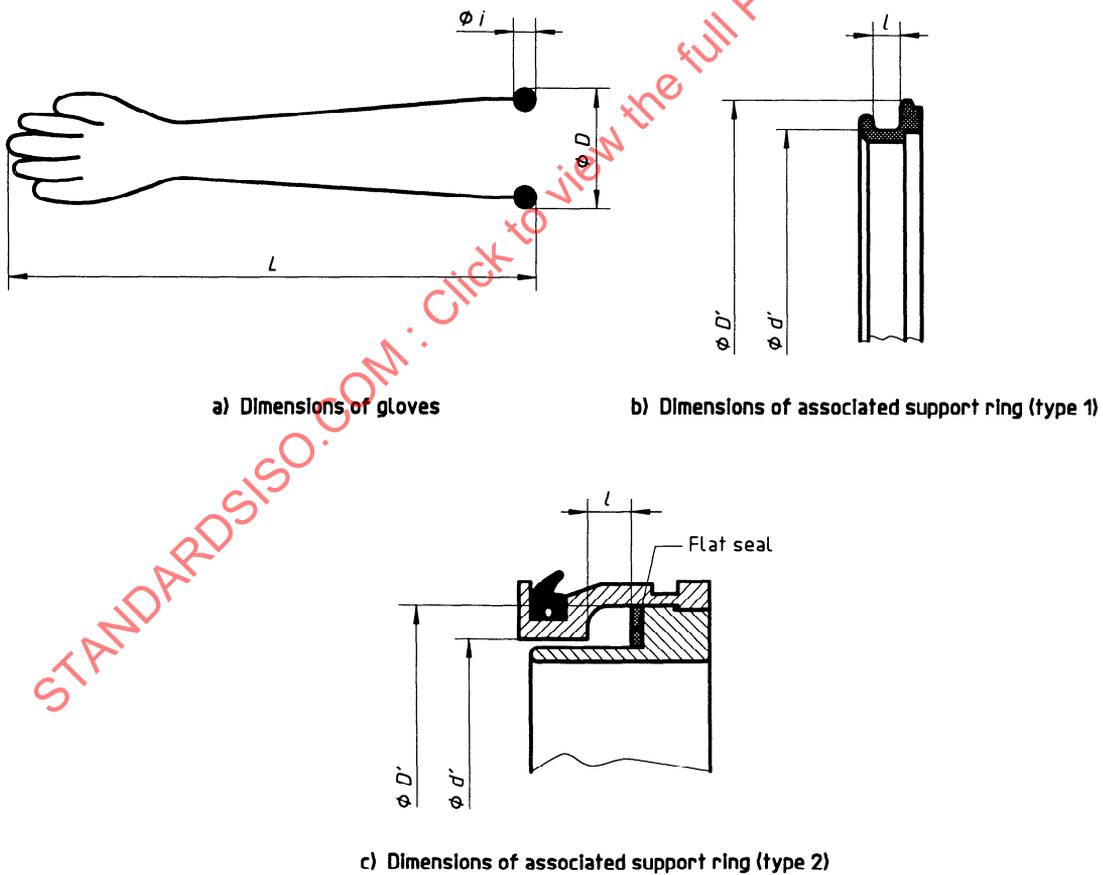


Figure 10 — Dimensions of gloves fitted on ejectable support rings

Table 3 — Standard dimensions of gloves for ejectable support rings

Dimensions in millimetres

References	Dimensions of the glove			Associated support rings				
	Nominal diameter ¹⁾	Length	Diameter of bead ²⁾	Diameter		Width ²⁾	References ³⁾	Type ⁴⁾
	<i>D</i>	<i>L</i>	<i>i</i>	<i>d'</i>	<i>D'</i>	<i>l</i>		
1310 m t L Ø 8 ⁵⁾	130	750 ⁶⁾	8	135,5	154	8	1130	1
1311 m t L Ø 8 ⁵⁾	150	750 ⁶⁾	8	160,5	179	8	1131	1
1313 m t L Ø 6 ⁵⁾	178	750 ⁶⁾	6	180	190	6	1153	2
1314 m t L Ø 8 ⁵⁾	200 ⁷⁾	750 ⁶⁾	8	210,5	229	8	1134	1

1) Dimensions, given for guidance, depend on the groove material.

2) Diameter of the bead of the glove depends on the width of the associated support ring (8 mm for type 1 and 6 mm for type 2).

3) These models of support ring are usually intended to accommodate gloves. Other models can be manufactured to accommodate special gloves if required.

4) Types of associated support ring are defined in ISO 11933-1.

5) According to the rule given in clause 4; m, t and L are alphanumeric indexes corresponding respectively to:

- the materia(s) of manufacture (m = NR, CR, CSM, FPM, PU, EPDM, NBR, CR/CSM, CR/IIR/CR, CR/FPM, ..., SCM/CRb/FPM, CR/CRb/CSM, ...),
- the size of the glove (t = 7, 8, 9 or 10),
- the length of the glove (L = 750 mm for a standard glove).

6) Depending on the model, other lengths between 500 mm and 800 mm may be supplied on request.

7) Gloves for special purposes.

NOTE — Gloves manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. The use of such items is acceptable, providing that they are used in accordance with the provisions of this part of ISO 11933.

6 Welded bags

6.1 General

There are two categories of welded bag:

- welded bags for bag ports,
- welded bags for ejectable support rings.

6.2 Material and design

Welded bags are usually made of translucent PVC, PU or EVA.

6.3 Chloride or other halogen-containing material

Users who intend to dispose of used welded bags by incineration should review the applicable waste disposal, air- and water-pollution standards before specifying material containing chlorides or other halogens.

6.4 Welded bags for bag ports

6.4.1 Use of welded bags

Welded bags are used to move an object into or out of a containment enclosure. The transfer principle is illustrated in figure 11).

6.4.1.1 Introducing an object into a containment enclosure

Take the bag partially out of the enclosure, so that the object is contained in a pocket (1).

Weld the bag as near as possible to the fold (bag/pocket) (2).

Reintroduce the object contained in the pocket with the rest of the bag into the enclosure (3).

Inside the enclosure, release the object from the pocket by cutting the pocket as near as possible to the weld (4).

NOTE — After each operation, it is recommended to place adhesive tape on the weld in order to retain any contamination.

6.4.1.2 Removing an object from a containment enclosure

Form the bag into a pocket and place the object to be removed into the pocket (1).

Take the assembly out of the enclosure, being careful not to detach the bag from the port (2). Do not unduly stress the sides of the bag when removing the object.

Weld the bag by means of a wide weld or overlapping double or triple weld (3).

Separate the bag from the pocket by cutting in the middle of the weld(s) (4).

After each transfer, check for contamination near the weld.

The operator shall verify that the temperature of the welding unit is properly adjusted, so that the material of the bag to be welded does not melt or burn, breaking the containment boundary of the bag.

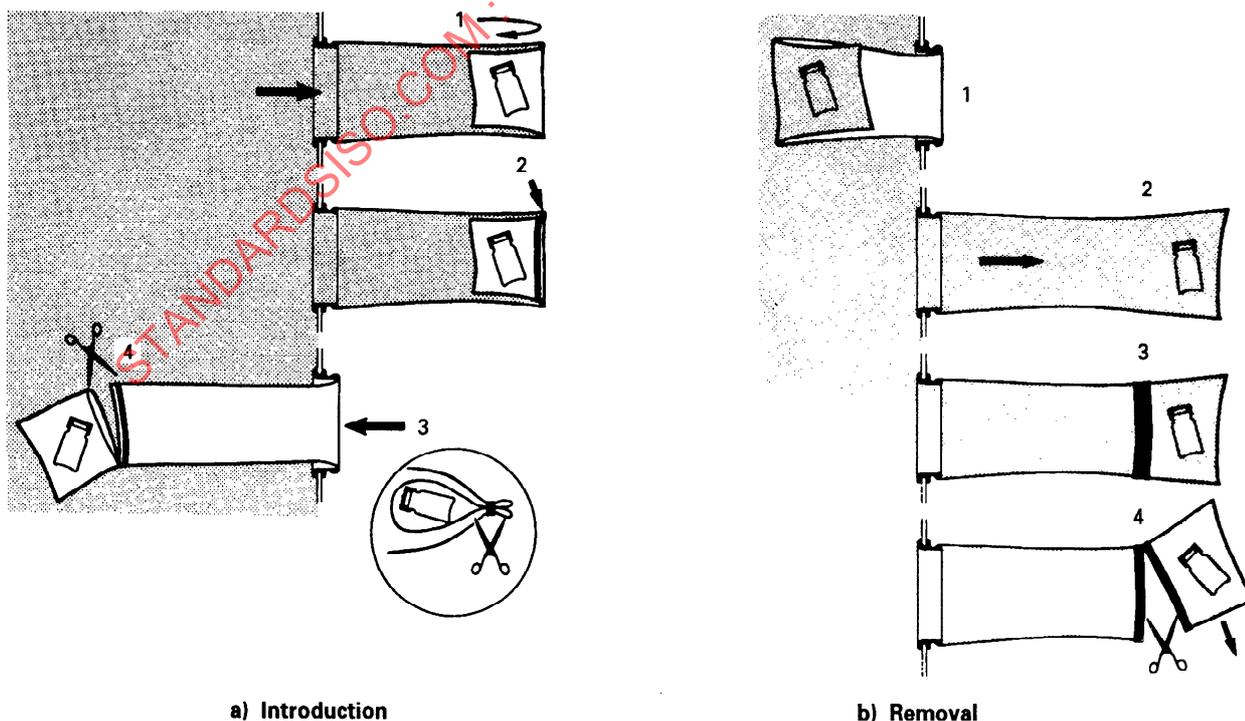


Figure 11 — Transfer principles

NOTES

- 1 After each removal operation, it is recommended to place adhesive tape on the weld in order to fix any contamination.
- 2 When there is high risk of contamination (powder, liquid), operational safety can be improved by previously fixing a save bag onto the enclosure wall under the bag port.
- 3 When introducing or removing heavy materials, a shelf should be used to avoid any wrench risk (see figure 12).

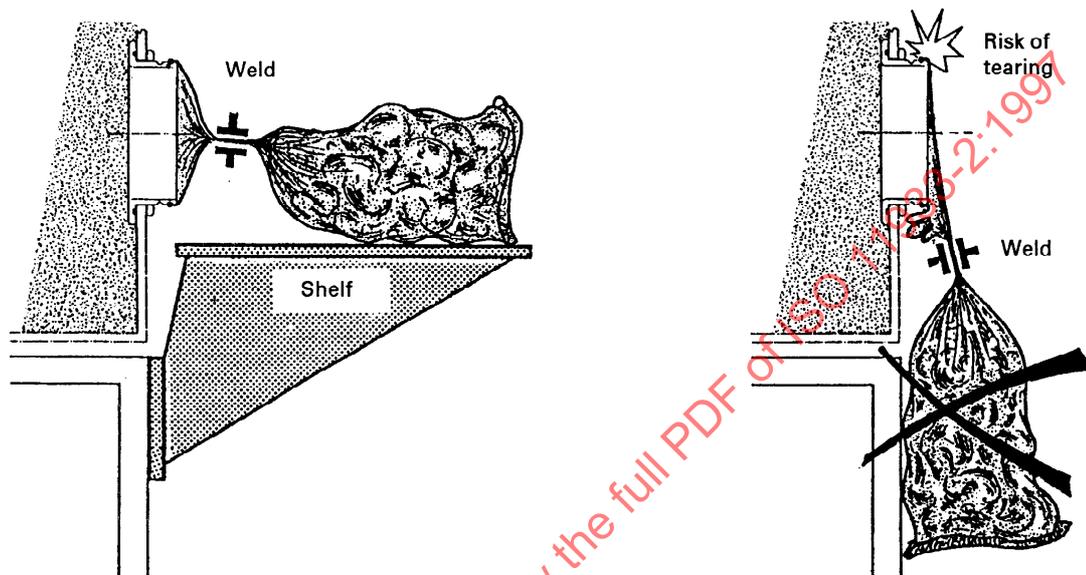


Figure 12 — Precautions to take during transfer

6.4.2 Attachment of bag to bag port, and bag changing

Welded bags are mounted on bag ports in the same way as gloves on glove ports (see 5.2.1), and bag-changing techniques depend on the design of the bag port (number of grooves, external or internal grooves, use of adhesive tape or clamping systems, etc.).

For a glove-port/bag-port with the same design, the bag-changing procedure is similar to that for glove changing (see clauses A.1 to A.5 in annex A).

6.4.3 Dimensions

The bag consists of a sleeve with a thickness of 0,15 mm to 0,30 mm ³⁾ and ending in a flanged seal comprised of an integrated O-ring around which the bag end is wound and then welded (see figure 13). The O-ring is made of elastomeric or plastic material of dimensions:

3 mm to 5 mm when the bag diameter is < 350 mm

5 mm to 7 mm when the bag diameter is \geq 350 mm

Standard dimensions of ISO welded bags for bag ports are given in table 4.

³⁾ This thickness depends on the material of construction and on the type of application.

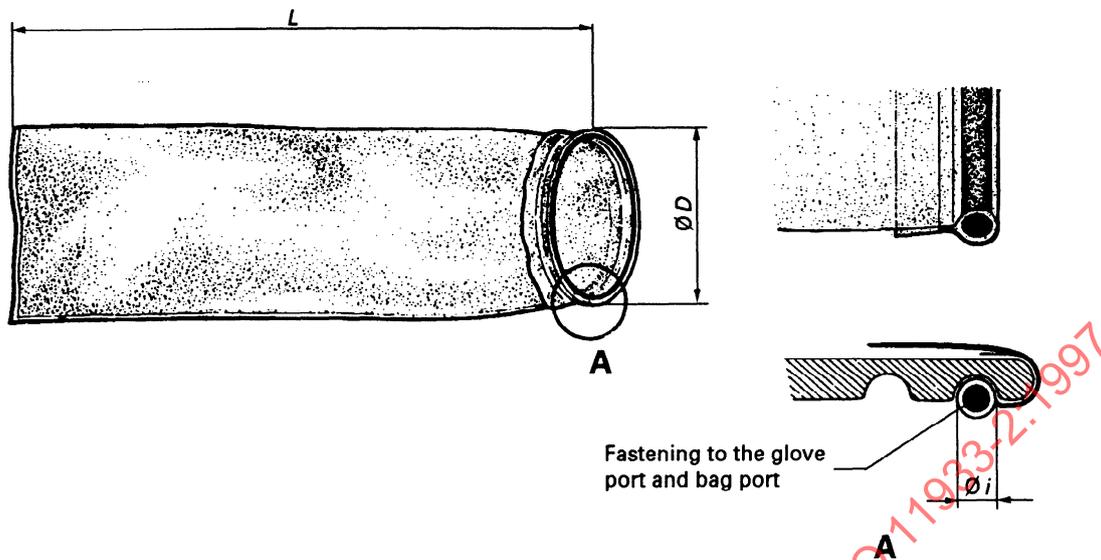


Figure 13 — Welded bag for bag ports

Table 4 — Standard dimensions of welded bags for bag ports

Dimensions in millimetres

References	Bag dimensions			Associated bag ports	
	Nominal diameter ¹⁾ <i>D</i>	Length <i>L</i>	Diameter of the seal <i>i</i>	References	Useful diameter <i>U</i>
1320 m L r Ø i ²⁾	150	900 and 1 200	3 to 5	1000	156
1321 m L r Ø i ^{2) 3)}	180	900 and 1 200	3 to 5	1001/1002	180/186
1323 m L r Ø i ²⁾	200	900 and 1 200	3 to 5	1003	200
1324 m L r Ø i ^{2) 4)}	250	900, 1 200, 1 500	3 to 5	1004/1005	249/254
1326 m L r Ø i ^{2) 5)}	350	900 and 1 200	5 to 7	1006/1007	330/340
1328 m L r Ø i ²⁾	400	1 200 and 1 500	5 to 7	1008	400

1) The effective diameter of the bag is 8 % to 10 % less than the nominal diameter of the bag port.
 2) According to the code given in clause 4, m, L and i are alphanumeric indexes corresponding respectively to:
 — the material(s) of manufacture (m = PVC, PU, EVA, etc.),
 — the length of the bag (L = 900, 1 200 or 1 500 mm),
 — the diameter of the seal (i = 3, 4, 5, 6 or 7 mm).
 3) This bag may also have reference 1322, according to the rule given in clause 4.
 4) This bag may also have reference 1325 according to the rule given in clause 4.
 5) This bag may also have reference 1327 according to the rule given in clause 4.

NOTE — Welded bags manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. The use of such items is acceptable, providing that they are used in accordance with this part of ISO 11933.

6.5 Welded bags for ejectable support rings

6.5.1 General

These types of welded bag are used on containment enclosures generally located behind a shielding wall and equipped with enclosure rings of type 1 or 2. They are fitted on ejectable support rings of same type (type 1 or 2; see figure 14). The bags are interchangeable with other leaktight components (gloves, bungs, tong gaiters and manipulators gaiters).

They are replaced by using an ejection device. Ejectable support rings are dealt with in ISO 11933-1.

There are two types of bag:

- bags ending in a lip seal (bags for type 1 support rings: see figure 15),
- bags ending in a bead (bags for type 2 support rings: see figure 16).

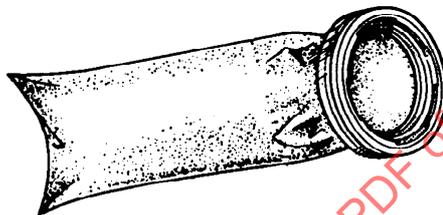


Figure 14 — Welded bags fitted on an ejectable support ring (general view)

6.5.2 Material and design

Welded bags are generally made of translucent PVC. These kinds of PVC bag are terminated in a lip seal and mounted on support rings of type 1. The width of the lip seal is typically 6 mm. It is designed in accordance with the width of the groove of the support ring on which it is mounted (see figure 15). The width of the groove is also 6 mm (see ISO 11933-1).

Bags of other material (PE, EVA, PU, etc.) ending either in a lip seal of the same shape as previously, or in a bead of the same material as the welded bag, are also available. Both (lip seal or bead) are welded on the end of the bag. When a bead is used, the welded bag is mounted on a support ring of type 2, and the diameter of bead is typically 6 mm. The bead is designed to conform to the shape of the groove of the support ring on which it is mounted (see figure 16). In the other case (lip seal), only support rings of type 1 should be used.

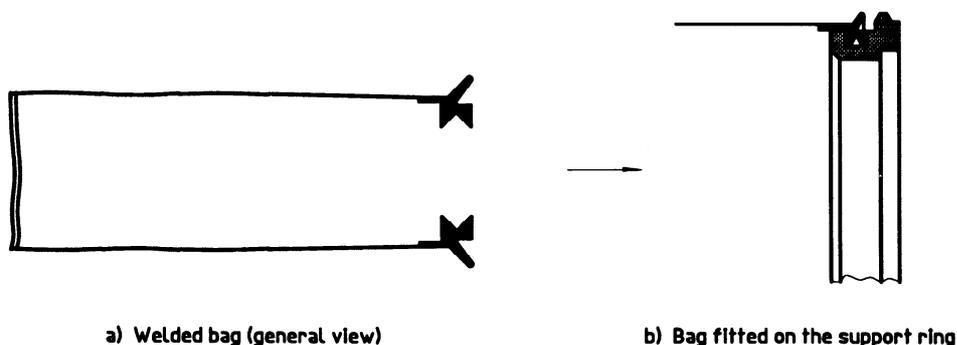


Figure 15 — Welded bag ending in a lip seal for fitting on a support ring of type 1

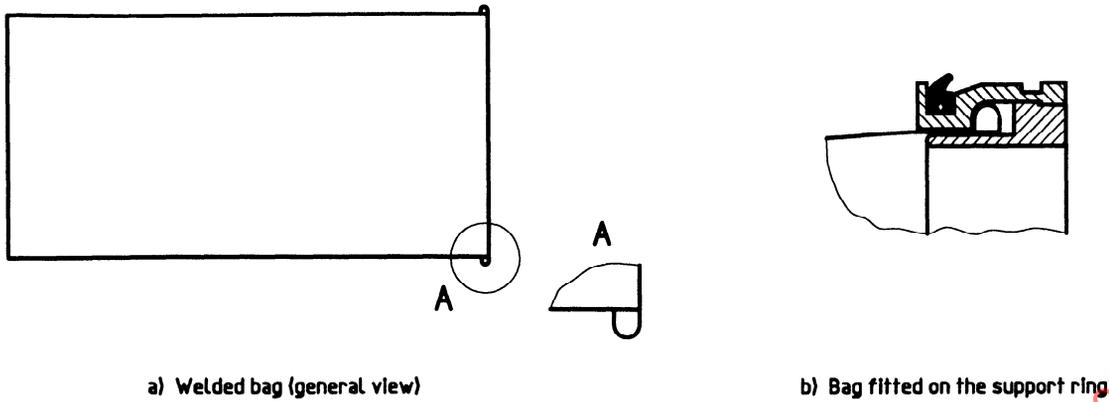


Figure 16 — Welded bag ending in a bead for fitting on a type 2 support ring

6.5.3 Mounting of bags on the support ring

Follow the procedure described in ISO 11933-1 for fitting welded bags on support rings.

The diameter of bead or width of lip seal shall be designed to fit the shape of the groove of the ejectable support ring on which it is intended to be mounted. This fit shall provide, under any operating conditions, the required leaktightness.

The leaktightness is obtained solely by means of the profile of the lip seal ending the bag when mounted on support ring of type 1 (see figure 15), and by means of the bead of the bag and an associated flat seal when mounted on a support ring of type 2 (see figure 16).

Welded bags equipped with these two kinds of seal (lip seal and bead) are supplied already fitted on support rings. The proper fit of the bag on its support ring shall be checked by an approved method before acceptance.

6.5.4 Dimensions

Standard dimensions of ISO bags for ejectable support rings are given in table 5.

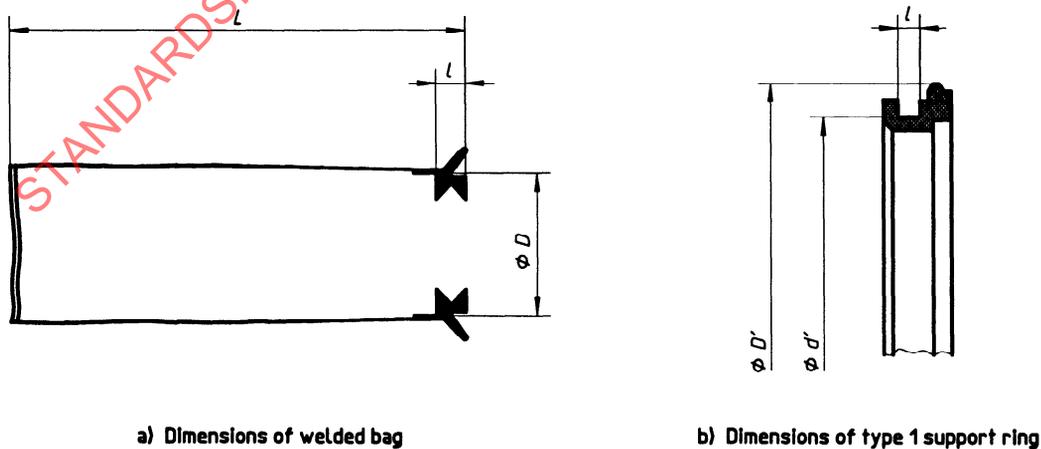
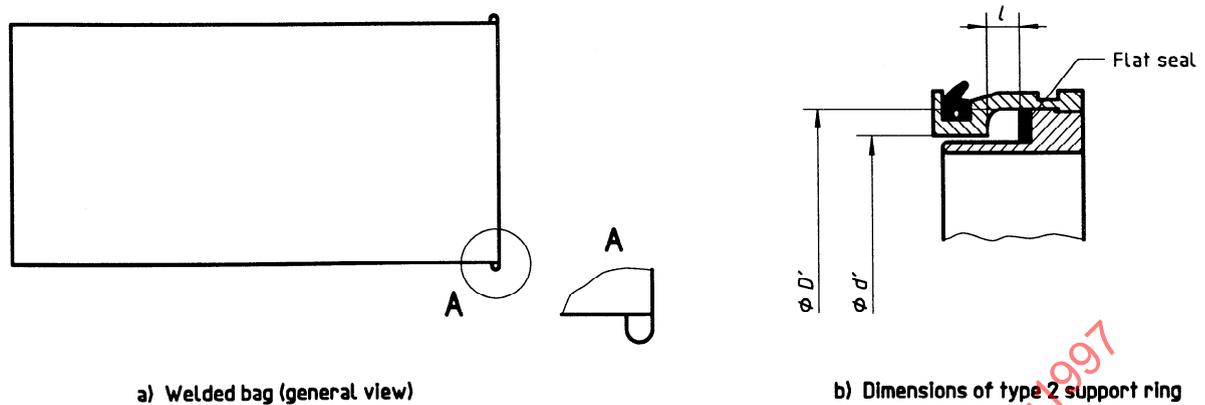


Figure 17 — Dimensions of welded bags fitted on a type 1 support ring



a) Welded bag (general view)

b) Dimensions of type 2 support ring

Figure 18 — Dimensions of welded bags fitted on a type 2 support ring

Table 5 — Standard dimensions of welded bags for ejectable support rings of type 1 or 2

Dimensions in millimetres

References	Dimensions of the bag			Associated support rings				
	Nominal diameter ¹⁾	Length	Width of seal	Diameter		Width of groove	References	Type ²⁾
	<i>D</i>	<i>L</i>	<i>i</i>	<i>d'</i>	<i>D'</i>	<i>l</i>		
1330 m L I Ø 6 ³⁾	130	900 or 1 200	6	135,5	154	6	1130	1
1331 m L I Ø 6 ³⁾	150	900 or 1 200	6	160,5	179	6	1131 ⁴⁾	1
1333 m L d Ø 6 ³⁾	178	1 000/2 000 or 3 000	6	180	190	6	1153	2
1334 m L I Ø 6 ³⁾	200	900 or 1 200	6	210,5	229	6	1134	1
1335 m L I Ø 6 ³⁾	220	900 or 1 200	6	226,5	244	6	1135 ⁴⁾	1
1336 m L I Ø 6 ³⁾	250	900 or 1 200	6	261,5	269	6	1136 ⁴⁾	1
1337 m L I Ø 6 ³⁾	250	900 or 1 200	6	258,5	276	6	1137	1
1338 m L I Ø 6 ³⁾	300	900 or 1 200	6	311,5	329	6	1138	1
1339 m L I Ø 6 ³⁾	350	900 or 1 200	6	386,5	404	6	1139	1

1) The effective diameter of the bag is 5 % to 10 % smaller than the nominal diameter of the support ring groove.

2) Types of associated support ring are defined in ISO 11933-1.

3) According to the code given in clause 4, m and L are alphanumeric indexes corresponding respectively to:

- the material(s) of manufacture (m = PVC, PU, EVA, ...),
- the length of the bag (L = 900 mm or 1 200 mm).

4) These support rings are usually intended for manipulator gaiters. Exceptionally they can accommodate welded bags.

NOTE — Welded bags manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. The use of such items is acceptable, providing that they are used in accordance with the provisions of this part of ISO 11933.

7 Remote-handling tong gaiters for support rings

7.1 Remote-handling tong gaiters for type 1 support rings

7.1.1 General

These gaiters are used for the protection of remote-handling tongs and are fitted with their support rings on enclosure rings of the same type (type 1), mounted on containment enclosures generally located behind a shielding wall, and in which the high level of contamination does not allow manipulation with gloves (see figure 19). They are fitted on ejectable support rings of the same type (type 1). The remote-handling tong gaiters are interchangeable with other leaktight components (gloves, welded bags, rigid plugs, etc.).

They are replaced using an ejection device. Ejectable support rings are dealt with in ISO 11933-1.

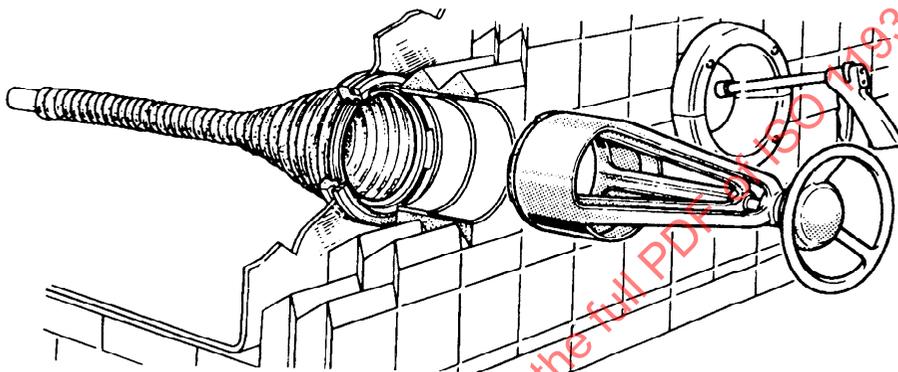


Figure 19 — Remote-handling tong gaiter for type 1 ejectable support rings

7.1.2 Material and design

There are four types of remote-handling tong gaiters (see figure 20):

- PVC gaiters:** This kind of gaiter terminates in a flat seal at the grip end. For mounting it is recommended to push the leaktight connection of the tong into the gaiter through the larger opening. Immersion in hot water (about 60 °C) makes fitting of seals easier. At the support ring end, this gaiter terminates in a lip seal [see figure 21 b)].
- Latex gaiters:** This kind of gaiter terminates in a cylindrical sleeve having a smaller diameter than the connection (or alpha adapter) at the grip end. At the support ring end, this gaiter terminates with a bead [see figure 21 c)].

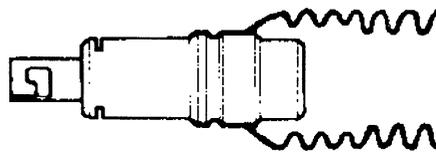


Figure 20 — Details of fastening at the tong end of the gaiter

- Polychloroprene gaiters:** This kind of gaiter can be coated or not, inside and/or outside with chlorosulfonated polyethylene. At the support ring end it is supplied with a bead and is mounted like the latex gaiter.
- Polyurethane gaiters:** This kind of gaiter can be coated or not with chlorosulfonated polyethylene. It terminates either in a lip seal or in a bead.

The choice of the suitable material results from a selection among the following requirements:

- mechanical resistance,
- chemical resistance,
- permeability to gases,
- resistance to ionizing radiation,
- ease of decontamination,
- ease of use,
- waste disposal, etc.

7.1.3 Mounting of gaiters on the support rings

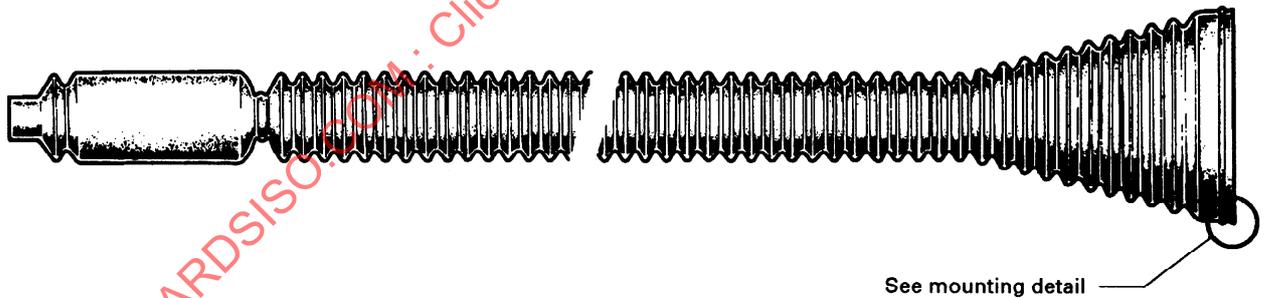
7.1.3.1 Lip seal

This seal requires a progressive application of force in order to be stretched and fitted into the groove of the support ring. Immersion in hot water (about 60 °C) makes fitting easier.

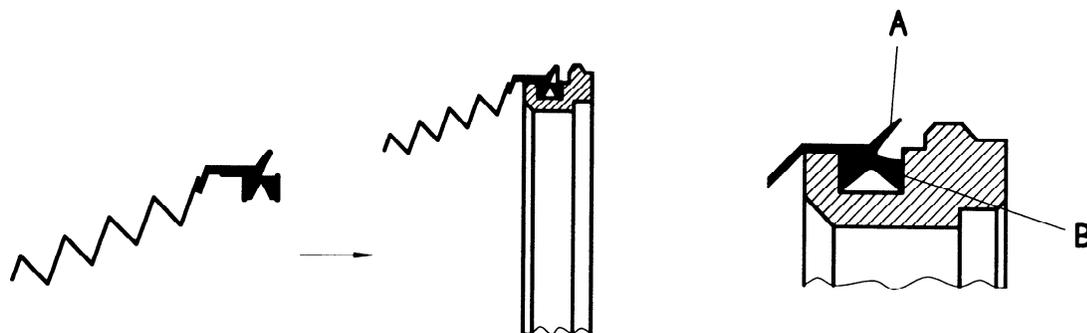
Once the seal has been fitted, check that the outer lip (A) projects uniformly and that lips (B) are correctly located in the groove.

7.1.3.2 Bead

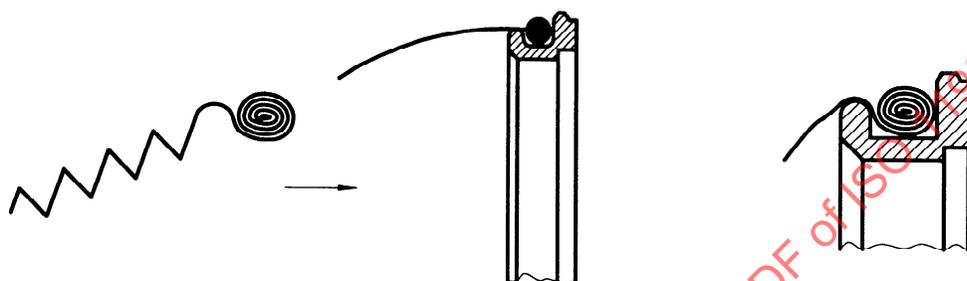
Gaiters equipped with such seals are supplied already fitted to the support ring.



a) General view



b) Detail with lip seal and support ring equipped with a gaiter including a lip seal



c) Detail with a bead and support ring equipped with a gaiter including a bead

NOTE — The grooves on support rings accommodating gaiters with a bead are larger than those for gaiters with lip seals (8 mm instead of 6 mm).

Figure 21 — Mounting of remote-handling tong gaiters on type 1 support rings

7.1.4 Mounting of remote-handling tongs on enclosure walls

Two cases can be considered:

- Tongs mounted on containment enclosure walls placed behind shielding. In this situation the tong is generally fitted on a shielded sphere unit mounted within the shielding wall (see figure 22).
- Tongs mounted on unshielded containment enclosure walls. In this situation the tong is fitted on a special plastic sphere unit, directly mounted on the containment enclosure ring (see figure 23), instead of the usual securing ring.

The procedure for changing tong gaiters is dependent on the method of tong mounting on the enclosure walls.

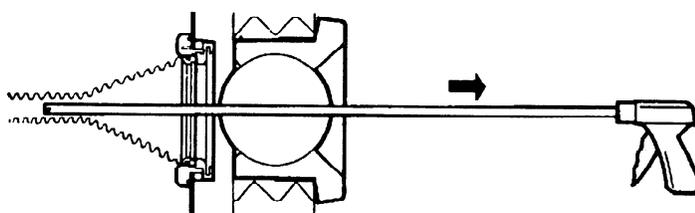


Figure 22 — Mounting of remote-handling tongs on containment enclosure walls behind shielding

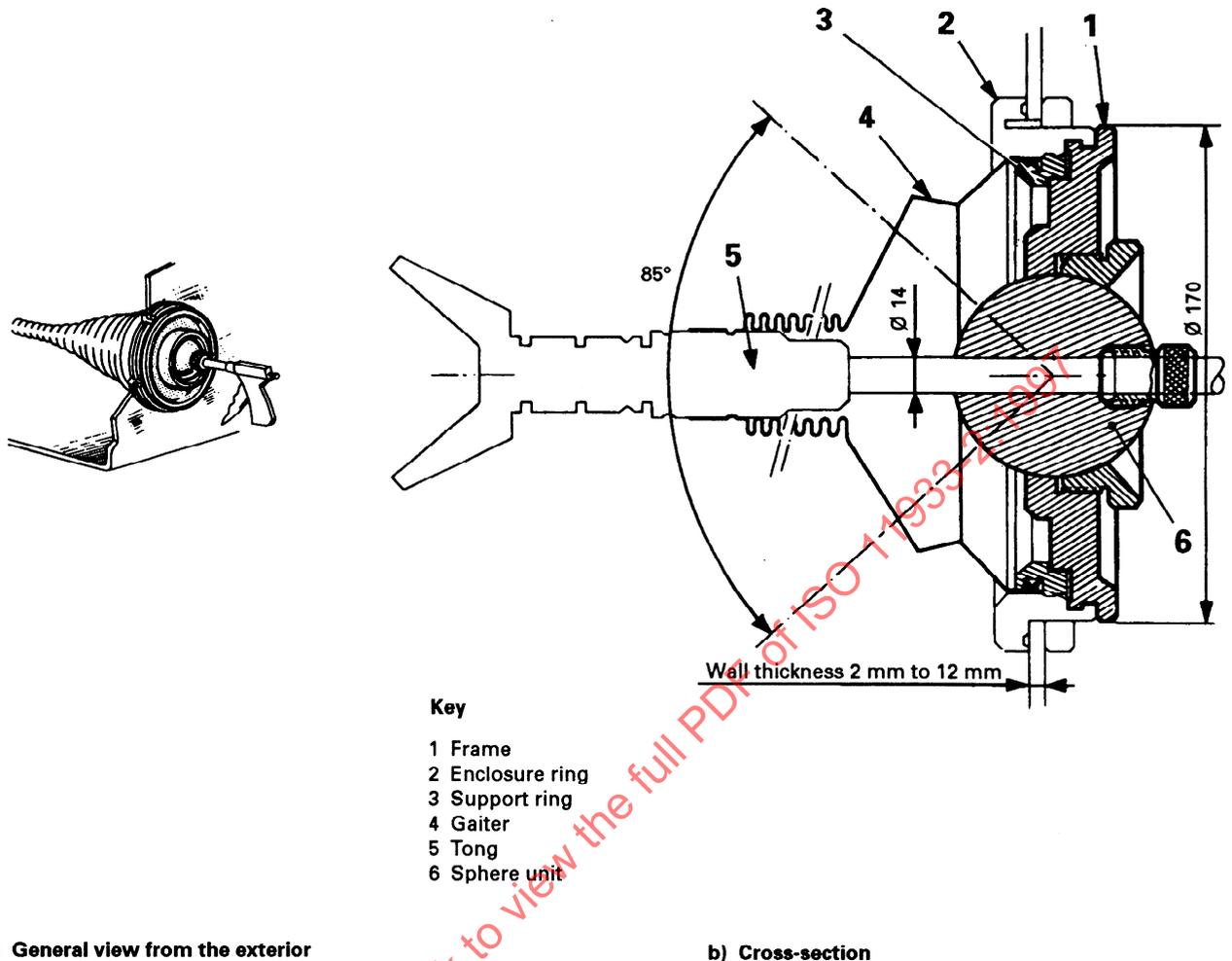


Figure 23 — Mounting of remote-handling tongs directly on containment enclosure walls

7.1.5 Gaiter changing

In accordance with 7.1.4, gaiter changing is carried out as follows (see figure 24).

- a) Unlock the leaktight connection and the tong head by using a disconnection device and remove the tong shaft [figure 24 a)].
- b) Disengage and remove the sphere unit [figure 24 b)]. In the case of a containment enclosure wall placed behind shielding, an auxiliary handling device is needed due to the weight of the sphere unit. In the case of an unshielded containment enclosure wall, this operation is done manually.
- c) Remove the securing ring on enclosure ring (if fitted).
- d) Lock the ejection device, equipped with a new leaktight gaiter fitted on its support ring, on the enclosure ring [figure 24 c)].
- e) Place the new gaiter into working position by pushing the old gaiter into the enclosure (this operation is obtained by screwing the ejection device onto the enclosure ring) [figure 24 d)].
- f) Unlock the ejection device.
- g) Place the securing ring back on the enclosure ring (if fitted).
- h) Replace the sphere unit on the enclosure wall or on the shielding wall.
- i) Insert the tong shaft and fit the leaktight connection on the tong head using a disconnection device.

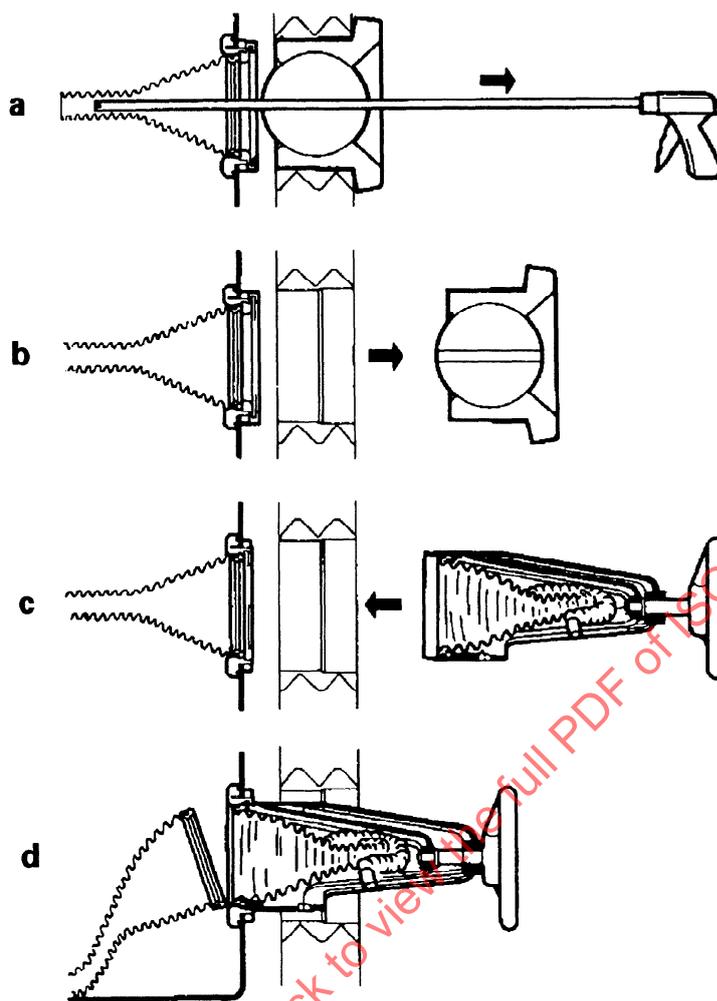


Figure 24 — Gaiter changing with type 1 support ring

7.1.6 Dimensions

Standard dimensions of ISO remote-handling tong gaiters mounted on type 1 support rings are given in table 6.

7.2 Remote-handling tong gaiters for type 2 support rings

7.2.1 General

These gaiters are used for the protection of remote-handling tongs and are fitted with their support rings on enclosure rings of the same type (type 2), mounted on containment enclosures in which the high level of contamination does not allow manipulation with gloves. They are interchangeable with other leaktight components like gloves, circular windows, welded bags, plugs. The remote-handling tongs are fitted on a spherical plastic unit, mounted on the exterior of the enclosure ring (see figure 26).

7.2.2 Material and design

Remote-handling tong gaiters are made of latex, polychloroprene, polyurethane or polyvinyl chloride. At the tong end they are fitted with a gastight adapter, on which the tong shaft can be connected from inside the gaiter and the squeezing tong from outside the gaiter, in the containment enclosure. The adapter ensures the leaktightness of the gaiter end and the transfer of motion between the squeezing tong and the tong shaft. On the opposite end, the tong gaiters are fixed on a support ring.

Table 6 — Standard dimensions of remote-handling tong gaiters for type 1 support rings

Dimensions in millimetres

References	Dimensions of the gaiter			Associated support rings			
	Nominal diameter ¹⁾ <i>D</i>	Length <i>L</i>	Diameter or width of seal <i>i</i>	Useful diameter <i>d</i>	Nominal diameter <i>d'</i>	Width of groove <i>e</i>	References
1340 m <i>Ld</i> Ø 8 ²⁾	130	500 to 1 200	8	136	135,5	8	1130
1340 m <i>LI</i> Ø 6 ²⁾	130	500 to 1 200	6	136	135,5	6	1130
1341 m <i>Ld</i> Ø 8 ²⁾	150	500 to 1 200	8	155	160,5	8	1131
1341 m <i>LI</i> Ø 6 ²⁾	150	500 to 1 200	6	155	160,5	6	1131
1344 m <i>Ld</i> Ø 8 ²⁾	200	500 to 1 200	8	205	210,5	8	1134
1344 m <i>LI</i> Ø 6 ²⁾	200	500 to 1 200	6	205	210,5	6	1134
1347 m <i>LI</i> Ø 6 ²⁾	290	500 to 1 200	6	300	311,5	6	1137

1) The given diameter corresponds approximately to the external diameter of the support ring groove.
2) According to the rule given in clause 4, m and L are alphanumeric indexes corresponding respectively to:
— the material(s) of manufacture (m = NR, PVC, CR, PU),
— the length of the gaiter (L = 500, 750, 900, 1 000, 1 100 or 1 200 mm).

NOTES

1 Remote-handling tong gaiters manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. The use of such items is acceptable, providing that they are used in accordance with the provisions of this part of ISO 11933.

2 Because of the many variations in type, leaktightnesses, etc., of tong connections at the lower end, it is not possible to standardize the technique of fastening of the tong gaiter at the tong end.

7.2.3 Mounting of the remote-handling tong gaiter on the enclosure ring

The larger opening of the gaiter is ended with an O-ring or a bead of 6 mm of diameter, which is fitted on the support ring shown in figure 27. Details of mounting are also given in ISO 11933-1.

The gaiter, fitted to an ejectable support ring, is retained in the enclosure ring by the compression of the O-ring by the ejecting support ring in the groove and the mechanical locking of the sphere unit.

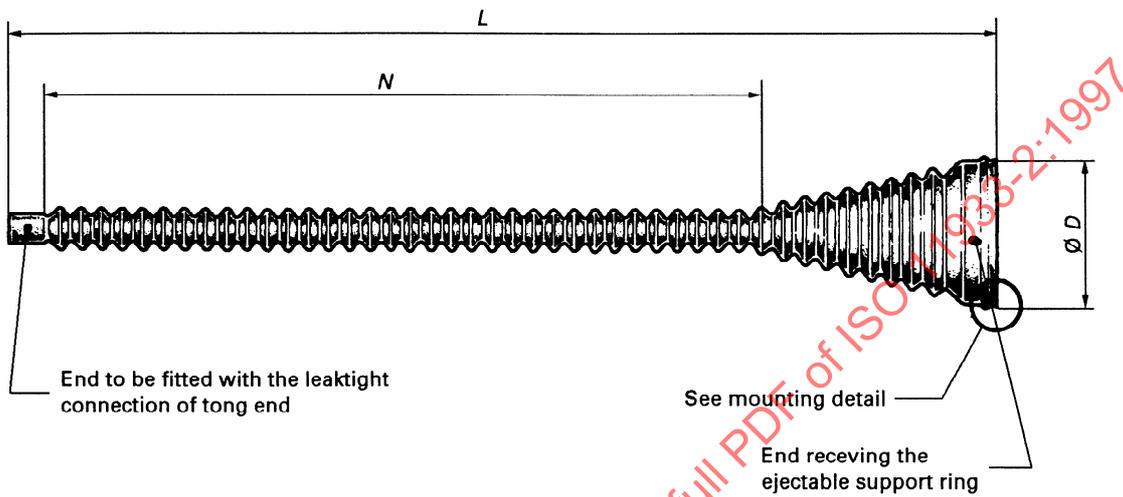
7.2.4 Gaiter changing

Changing of gaiters is carried out as indicated in 7.1.5 for the case of unshielded containment enclosures.

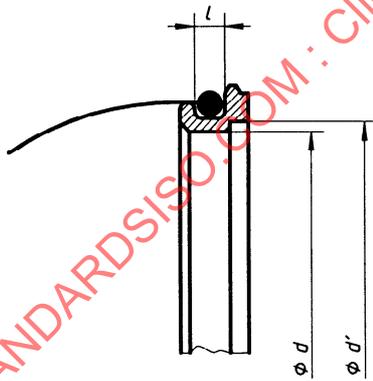
7.2.5 Dimensions

The length and bellow diameters of the gaiters depends on the type and dimensions of the tong.

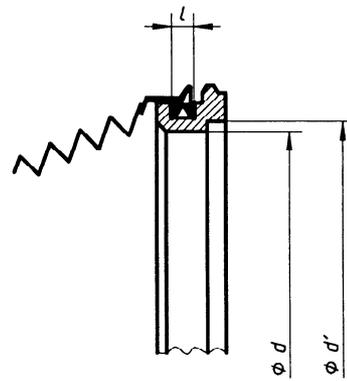
Other standard dimensions for ISO tong gaiters mounted on type 2 ejecting support rings are given in table 7.



a) Dimensions of the remote-handling tong gaiter



b) Remote-handling tong gaiter ended by a bead, fitted on support ring



c) Remote-handling tong gaiter ended by a lip seal, fitted on support ring

Figure 25 — Dimensions of remote-handling tong gaiters for type 1 support rings

Table 7 — Standard dimensions of remote-handling tong gaiters for type 2 support rings

Dimensions in millimetres

References	Dimensions of the gaiter			Associated support rings			References
	Nominal diameter ¹⁾ <i>D</i>	Length <i>L</i>	Diameter of seal <i>i</i>	Useful diameter <i>d</i>	Nominal diameter <i>d'</i>	External diameter <i>D'</i>	
1353 m L t Ø 6 ²⁾	180	500 to 1 200	6	175	178	200	1153

1) The given diameter corresponds approximately to the external diameter of the support ring groove.
2) According to the code given in clause 4, m, and t are alphanumeric indexes corresponding respectively to:

- the material(s) of manufacture (m = PVC, NR, CR, PU, etc.),
- the length of the gaiter ($L = 500, 700, 900, 1\ 000, 1\ 100$ or $1\ 200$ mm),
- the type of seal ending the gaiter ($t = r$ for an O-ring seal and $t = d$ for a bead).

NOTES

- 1 Remote-handling tong gaiters manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. the use of such items is acceptable, providing that they are used in accordance with the provisions of this part of ISO 11933.
- 2 Because of the many variations in types, leak tightnesses, etc., of tong connections at the lower end, it is not possible to standardize the technique of fastening of the tong gaiter at the tong end.

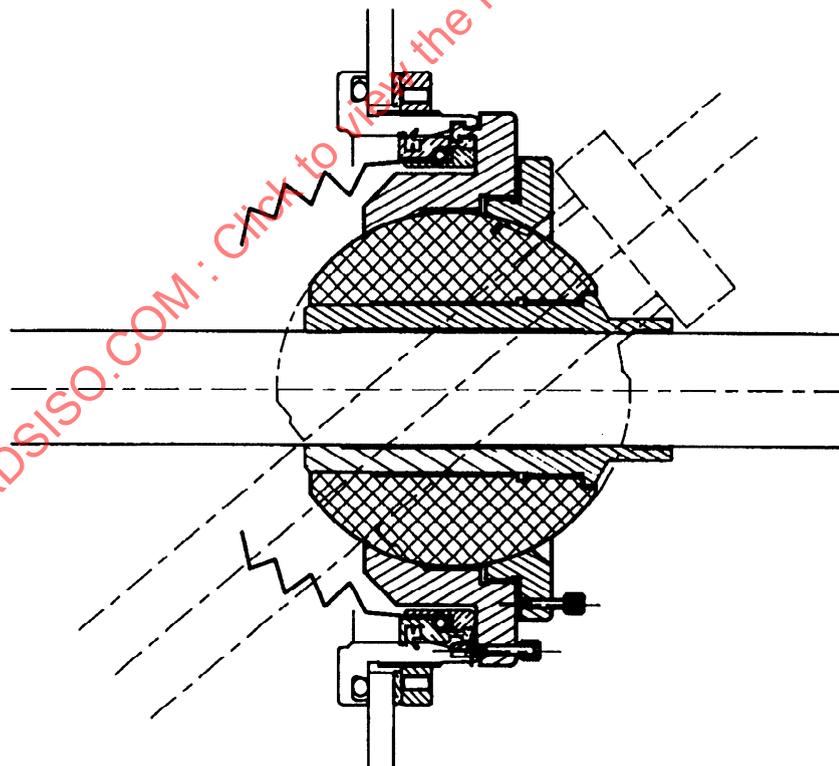


Figure 26 — Remote-handling tong gaiters for type 2 — Detail of fitting of the tong

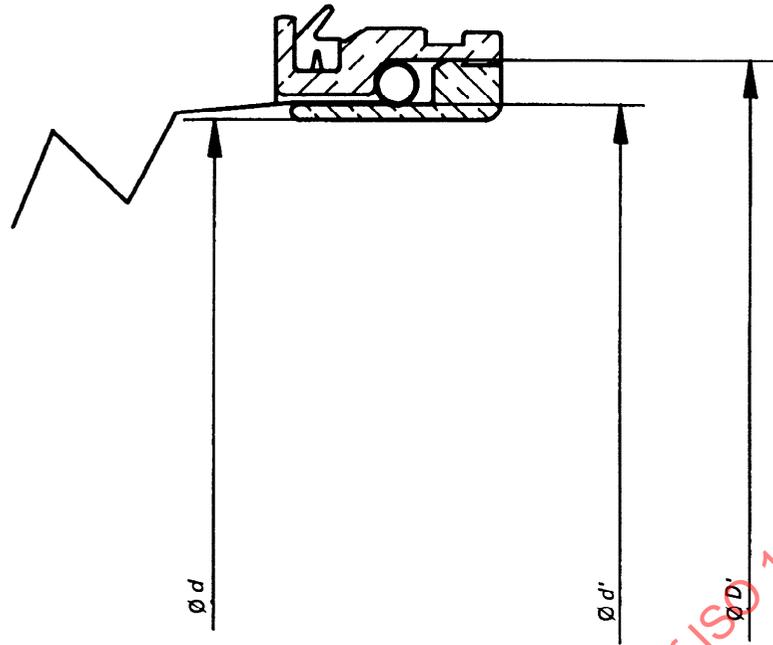


Figure 27 — Dimensions and detail of fitting remote-handling tong gaiters of type 2 on type 2 ejection support rings

7.3 Remote-handling tong gaiters for type 3 support rings

7.3.1 General

These gaiters are used for the protection of remote-handling tongs and are fitted with their support rings in glove/bag ports on containment enclosures generally located behind shielding walls, especially those constructed with lead shielding units. They are interchangeable with other leaktight components such as gloves, circular windows, welded bags, double-door transfer systems or bungs.

7.3.2 Material and design

The remote-handling tong gaiters are usually made of plastics, in particular polyurethane or polychloroprene. They terminate at the tong end in a gastight adapter made of stainless steel, on which the tong shaft can be connected from inside the gaiter and the tong from outside the gaiter, in the containment enclosure. The adapter allows transmission of the motion for opening and closing the tong jaws tightly. At the opposite end, the tong gaiters are fixed on a support ring.

7.3.3 Mounting of support ring on the glove/bag ports

Support rings for remote-handling tong gaiters are equipped on the outer periphery with a seal made of PVC (see figure 28) which remains under tension in order to ensure the leaktightness of the mounting on the glove/bag port. The design of the enclosure ring, the support ring and the seal shall prevent any displacement of the gaiter under normal working conditions as in any other circumstances (rapid movement, strong vibration, underpressure, etc.).

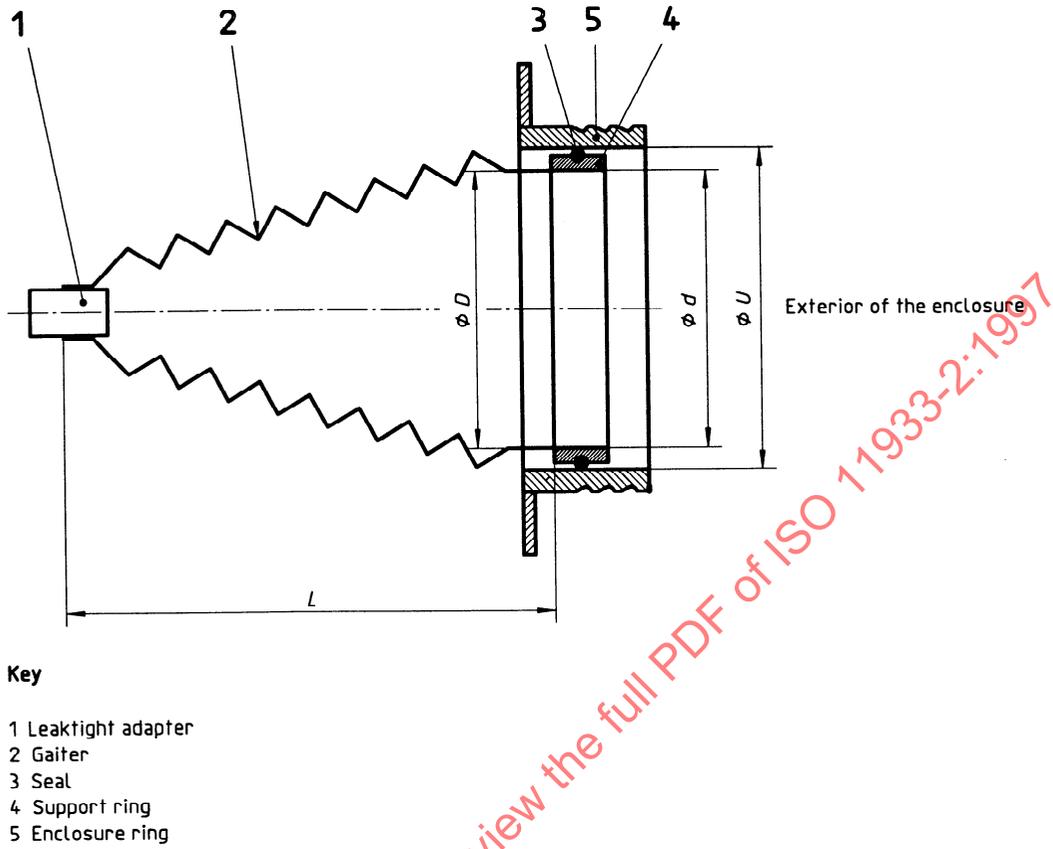
7.3.4 Gaiter changing

Replacement of gaiters is performed following the method described in 7.1.5: the used gaiter is pushed out of the glove/bag port into the containment enclosure and the new gaiter is pushed into the working position using an ejection device without breaking the leaktightness.

7.3.5 Dimensions

Remote-handling tong gaiters exist with a stiff shaft and articulated tongs. For articulated remote-handling tongs, special design is required for the gaiter.

The standard dimensions of ISO remote-handling tong gaiters with stiff shafts for type 3 support rings are given in table 8.



- Key**
- 1 Leaktight adapter
 - 2 Gaiter
 - 3 Seal
 - 4 Support ring
 - 5 Enclosure ring

Figure 28 — Remote-handling tong gaiters for type 3 support rings

Tableau 8 — Standard dimensions of remote-handling tong gaiters for type 3 support rings

Dimensions in millimetres

References	Dimensions of the gaiter		Associated support rings	
	Nominal diameter ¹⁾ <i>D</i>	Length <i>L</i>	Nominal diameter <i>d</i>	References
1361 m <i>L</i> ²⁾	160	700 to 1 200	160	1161
1365 m <i>L</i> ²⁾	234	625 to 1 125	234	1165
1367 m <i>L</i> ²⁾	320	540 to 1 085	320	1167

- 1) The given diameter corresponds approximately to the external diameter of the ring.
 2) According to the rules given in clause 4, m and L are alphanumeric indexes corresponding respectively to:
 — the material(s) of manufacture (m = PVC, NR, CR, PU, etc.),
 — the length of the gaiter (L = 625 mm to 1 200 mm).

NOTES

- 1 Remote-handling tong gaiters manufactured in accordance with national codes and standards may have thicknesses, lengths, diameters and other aspects different from those presented in this part of ISO 11933. The use of such items is acceptable, providing that they are used in accordance with the general provisions of this part of ISO 11933.
 2 Because of the many variations in types, leaktightnesses, etc. of tong connections at the lower end, it is not possible to standardize the method of fastening of the tong gaiter at the tong end.

8 Gaiters for manipulators

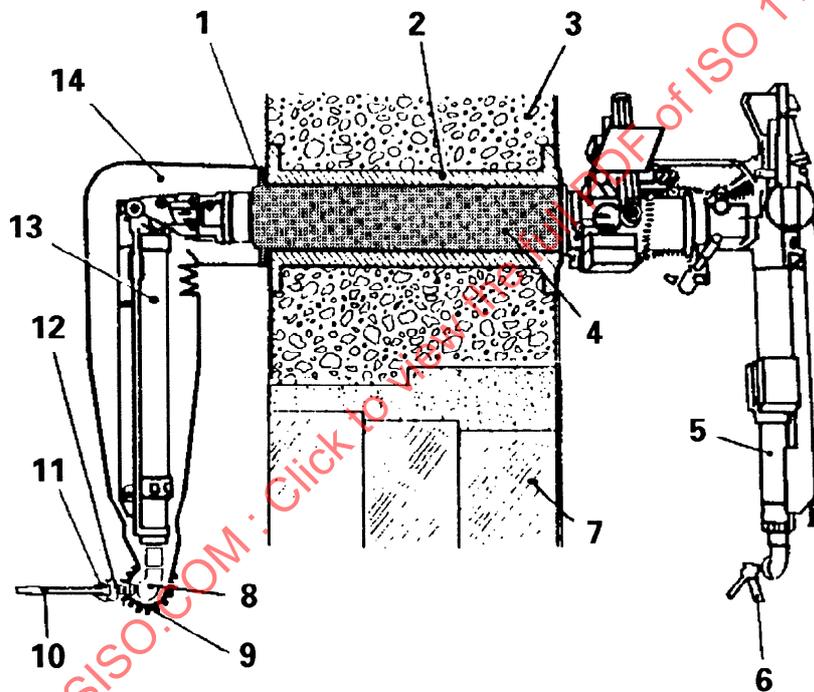
The following requirements concern only gaiters for **mechanical master-slave** manipulators.

Gaiters for other categories are outside of the scope of this part of ISO 11933, due to the great diversity of models covered.

8.1 General

Gaiters are flexible sleeves covering the slave arm. They are intended to afford suitable leaktightness when mounted on the through-wall tube or on an enclosure ring of the hot cell, and to protect the slave arm against contamination (see figure 29).

Gaiters shall be designed for the manipulator category, the interchangeable principle for maintenance, the environmental conditions (radiation exposure, mechanical damage, etc.) and the tightness requirements.



Key:

- | | |
|---------------------|-------------------|
| 1 Enclosure ring | 8 Wrist joint |
| 2 Through-wall tube | 9 Leaktight piece |
| 3 Enclosure wall | 10 Tool |
| 4 Connection tube | 11 Tong fingers |
| 5 Master arm | 12 Tong |
| 6 Handle | 13 Slave arm |
| 7 Window | 14 Gaiter |

Figure 29 — General view of a manipulator with gaiter

There are two categories of manipulator gaiters:

- a) **leaktight gaiters;**
- b) **protection gaiters.**

These two categories are used in the following way:

- a) **a leaktight gaiter ensures** the leaktightness of the hot cell or the containment enclosure in the case of a non-leaktight manipulator;
- b) **a protection gaiter ensures**, only in case of a leaktight manipulator, the protection of the slave-arm against radioactive contamination and physical or chemical pollutants present inside the hot cell; **it does not participate in the leaktightness of the hot cell or of the containment enclosure.**

A manipulator is equipped with only one category of gaiter, which depends upon operating conditions.

NOTE — A leaktight manipulator generally includes three removable parts:

- a master arm,
- a manipulator through-tube,
- a slave arm.

The leaktightness of the hot cell or the containment enclosure is achieved between the through-wall tube and the manipulator through-tube.

Installation and replacement of the gaiters is accomplished as follows:

- a) **for the leaktight gaiters**, from the exterior of the enclosure and after removal of the manipulator;
- b) **for the protection gaiters**, as the same time as the whole slave arm, using an auxiliary lifting device which is maintained inside the hot cell.

8.2 Profile

The profile of a gaiter is established by the manipulator category it is intended to protect.

Gaiters for manipulators with telescope arms shall have a long bellow to permit vertical motion of the lower end of the manipulator [see figure 30 a) and b)]. The upper end can be plain [see figure 30 a)] or can have [see figure 30 b)] a bellow. Gaiters for manipulators with three pivots are plain [see figure 30 c)].

NOTES

- 1 A convoluted sleeve with single convoluted reduction in the forearm [see figure 30 a)] does not produce undesirable resistance during vertical motion but acts like a spring under torsional force.
- 2 A convoluted sleeve with double convoluted reduction in the forearm [see figure 30 b)] does not produce an undesirable effect during vertical motion and does not act as spring under torsional force.
- 3 A plain sleeve as shown in figure 30 c) can interfere with vision and produce undesirable retraction during vertical motion.

8.3 Design

8.3.1 Design of upper end of gaiter

The upper end of a gaiter should be designed as a function of:

- the procedure for changing or replacing the manipulator,
- the method of attachment to the hot cell wall.

There are four different methods of mounting manipulator gaiters.

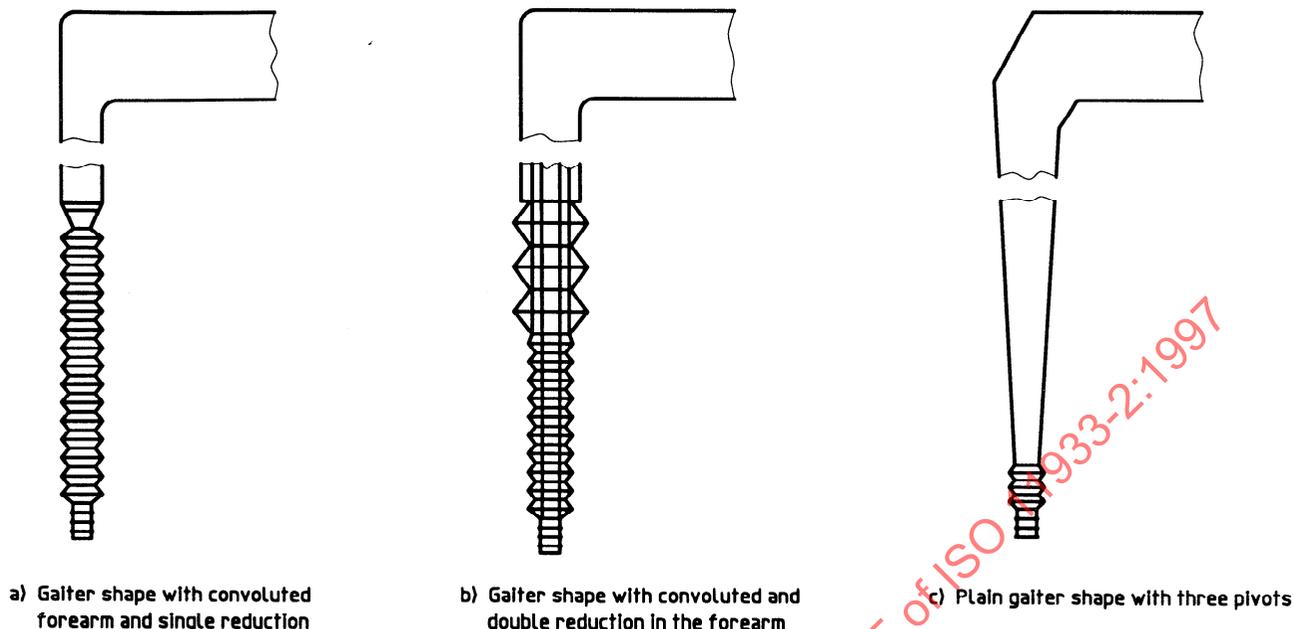


Figure 30 — Gaiter shapes

8.3.1.1 Method 1

Gaiters are mounted on an ejectable support ring fastened to the containment enclosure wall located behind a shielding wall (see figure 31).

This mounting can be accomplished in two ways:

- gaiter fixed on a type 1 support ring, mounted on an enclosure ring of same type [see figure 31 b)];
- gaiter fixed on a type 3 support ring, mounted on a glove port of the same type [see figure 31 c)].

A variation of this system can be considered in the following method, where the gaiter is mounted on the inner liner of a leaktight concrete hot cell (see figure 32).

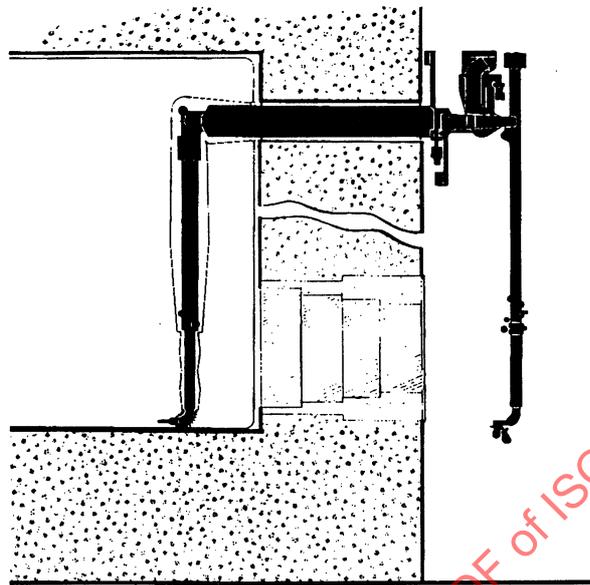
Depending on the type of support ring used, the gaiter is:

- either fixed directly on a type 3 support ring, which is attached to a type 3 glove port thus ending the inner liner,
- or mounted on a type 1 support ring, fixed on an enclosure ring of the same type, which is screwed on a flange located at the end of the liner.

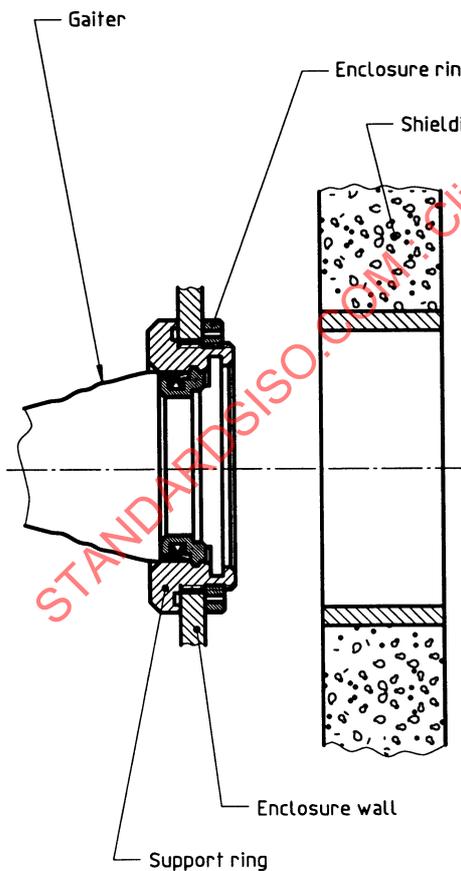
8.3.1.2 Method 2

Gaiters are mounted on a support ring fixed at the inner end of the through-wall tube (on the side opposite the operator).

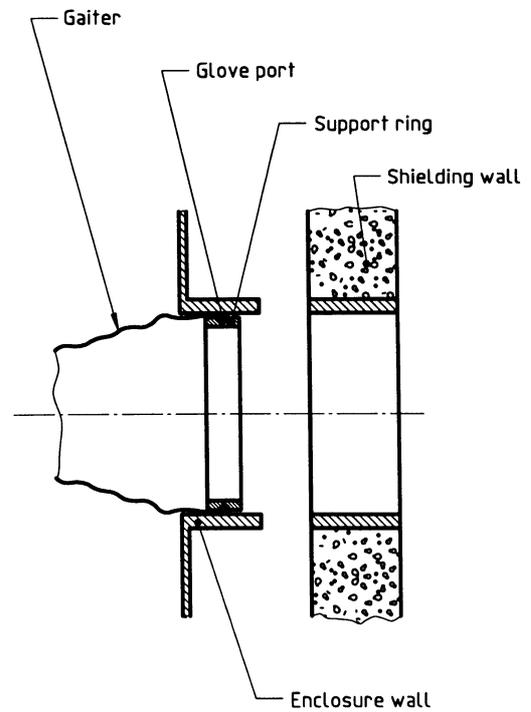
In this case the support ring is mounted either directly on the through-wall tube [when a type 3 support ring is used, see figure 33 a)], or indirectly through a containment enclosure ring [when a type 1 support ring is used, see figure 33 b)].



a) General view

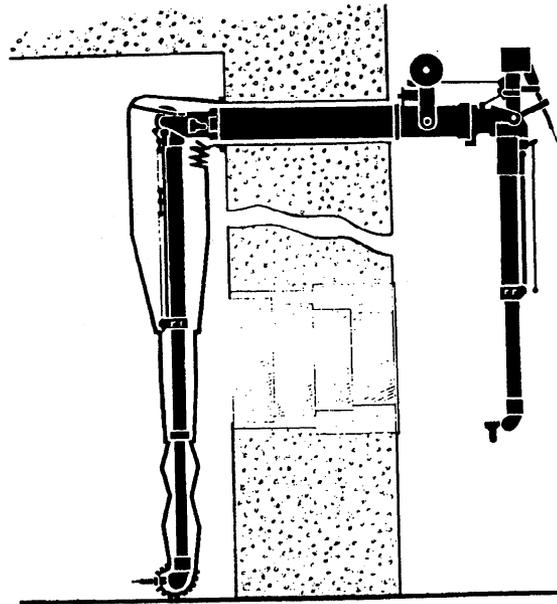


b) Gaiter fixed on a type 1 support ring, mounted on an enclosure ring of the same type

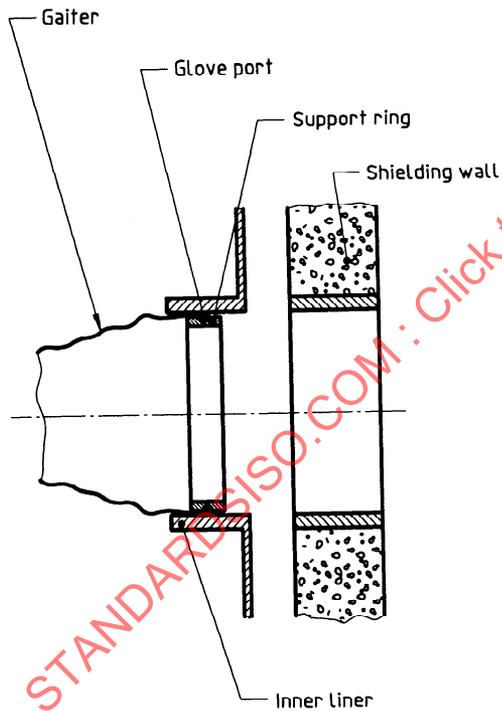


c) Gaiter fixed on a type 3 support ring, mounted on an enclosure ring of the same type

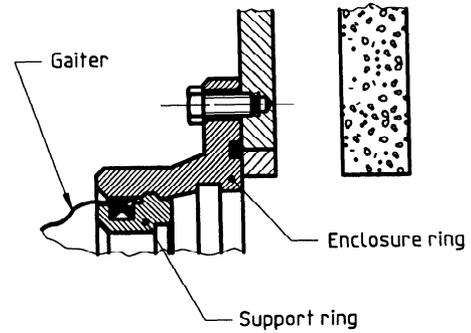
Figure 31 — Gaiter fastened on enclosure wall



a) General view



b) Gaiter mounted on a type 3 support ring



c) Gaiter mounted on a type 1 support ring, fixed on an enclosure ring of the same type

Figure 32 — Gaiter fixed on the inner liner of a leaktight concrete hot cell

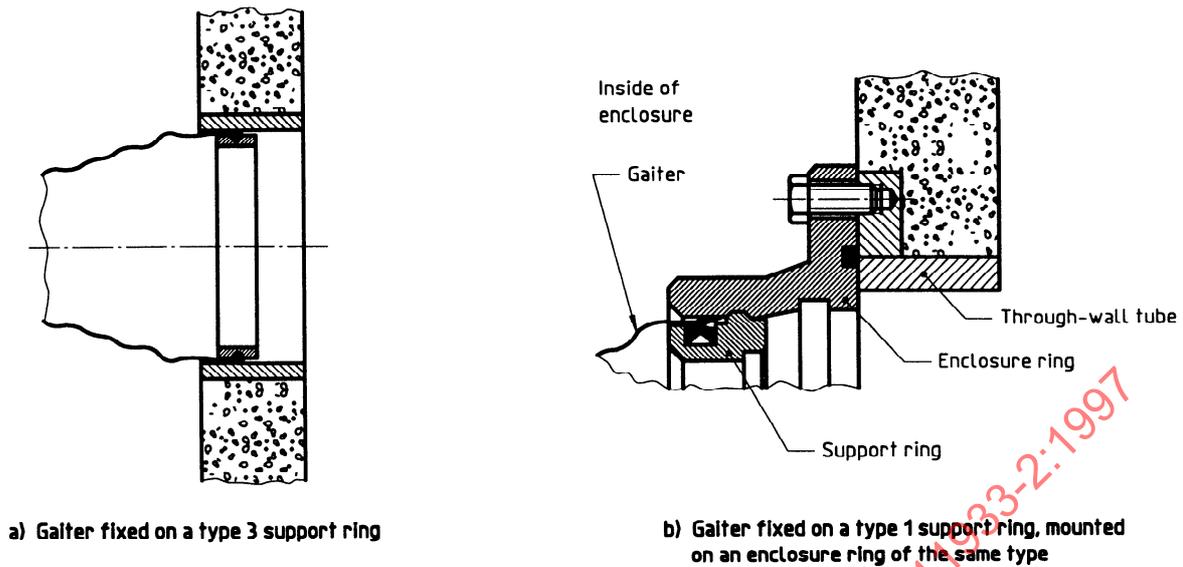


Figure 33 — Gaiter fixed on through-wall tube

8.3.1.3 Method 3

Gaiters are mounted directly on a flange of a glove/bag port fixed on the shielding wall at the operator side (see figure 34).

In the three previous examples (methods 1 to 3), the gaiter maintains the leaktightness of the containment enclosure when the manipulator is removed from the wall (see figure 35).

8.3.1.4 Method 4

Gaiters are mounted on a ring to be fastened on the slave arm behind the shoulder pivot (see figure 36). The slave arm is exchangeable remotely.

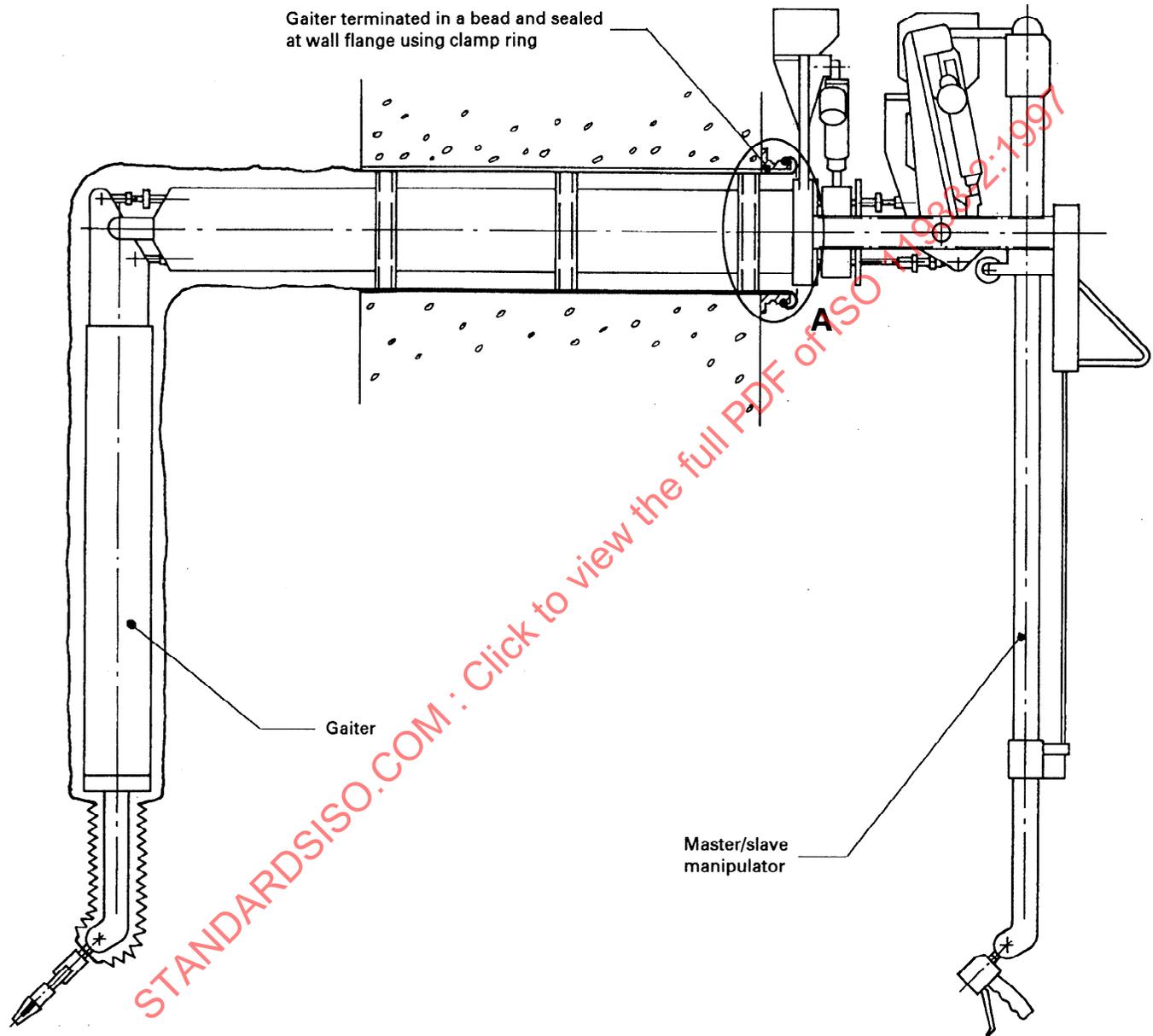
In this case, the gaiter is not essential to the leaktightness of the cell, but does provide for protection of the slave arm against radioactive contamination, corrosive chemicals, etc.

The slave arm, with its gaiter, is exchanged using a lifting device which is kept inside the hot cell.

8.3.2 Design of lower end of gaiter

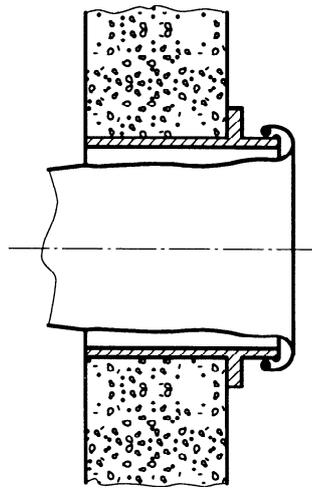
The nature of the work to be done and the constraints imposed by the manipulator model shall be considered in the design of the lower end of the gaiter. Parameters considered shall include the following.

8.3.2.1 Lateral and rotational motion required for the gaiter to accomplish the work to be done.



a) General view

Figure 34 — Mounting of gaiter on glove/bag port fixed on shielding wall at operator side



b) Detail A of mounting

Figure 34 — Mounting of gaiter on glove/bag port fixed on shielding wall at operator side (end)

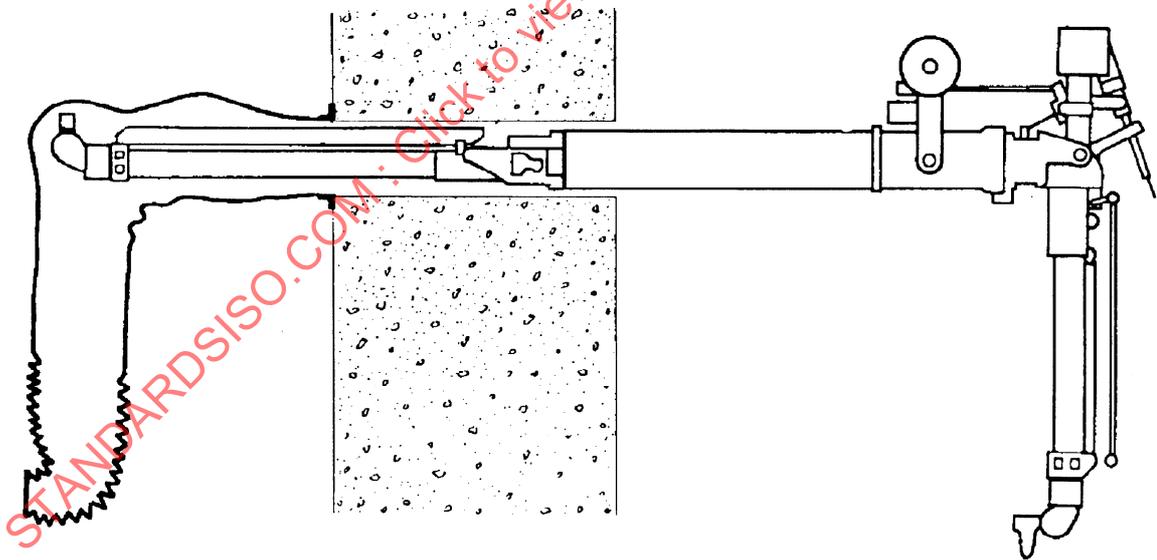


Figure 35 — Exchange of manipulator by extraction from the front

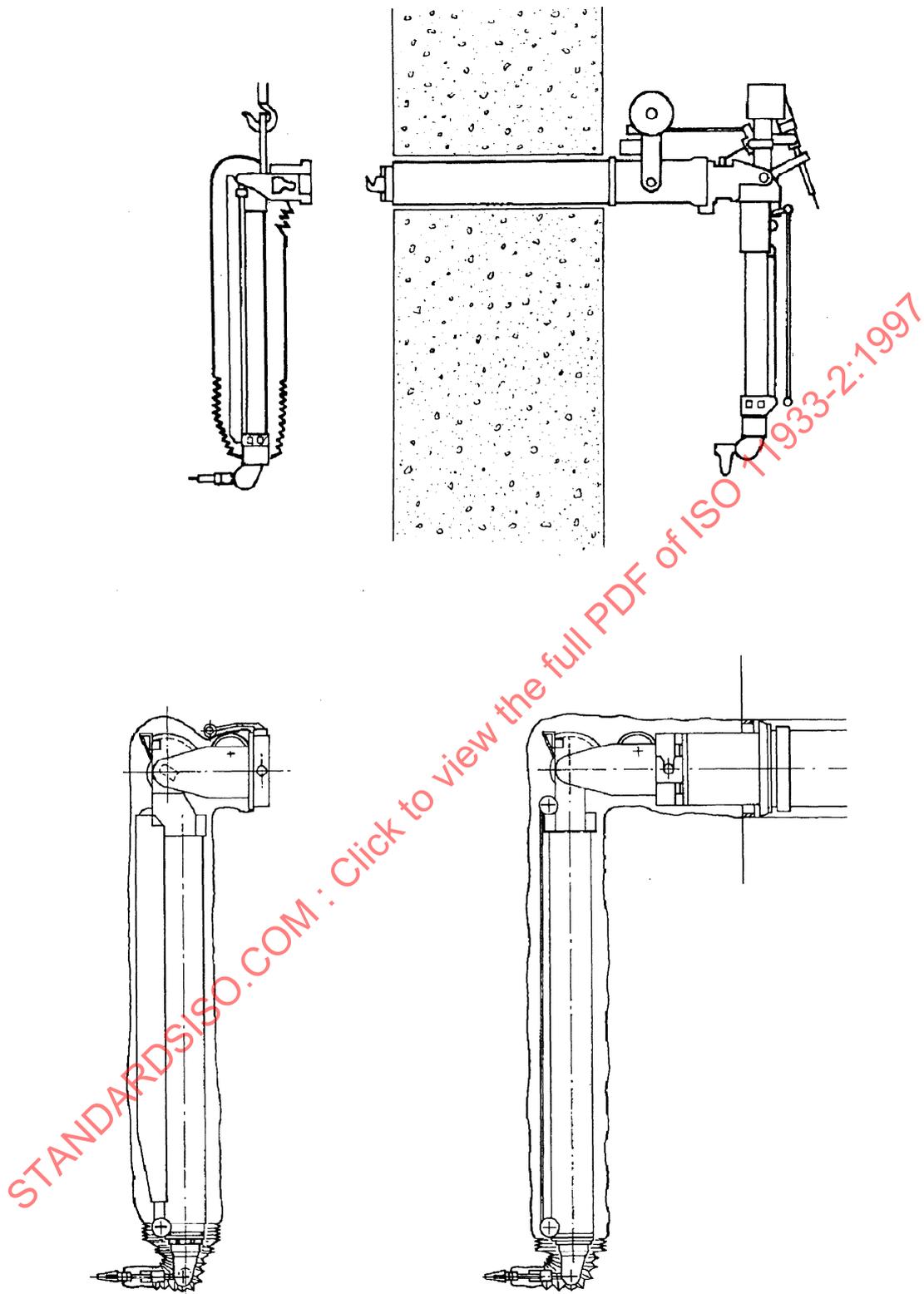


Figure 36 — Gaiter fixed directly on a ring, which is situated behind the shoulder pivot of a removable slave arm

8.3.2.2 Force placed upon the gaiter during work, with respect to lifting and rotational movement and the mechanical protection of the sleeves.

Examples shown as figure 37 b) and c) are suitable for application of a direct force.

The example shown in figure 37 a) should be used with caution. The sleeve may be damaged by connecting the device to the control arm.

8.3.2.3 Leaktightness required to avoid to spread of radioactive contamination. The example shown in figure 37 should be used instead that in figure 38 if containment of contamination is important.

8.3.2.4 Temperature of the objects to be handled. The sleeve may be destroyed or damaged when handling materials at elevated temperatures. Regarding this hazard:

- the example of figure 38 is the best,
- the example of figure 37 b) is less safe,
- the examples of figures 37 a) and 37 c) should not be used.

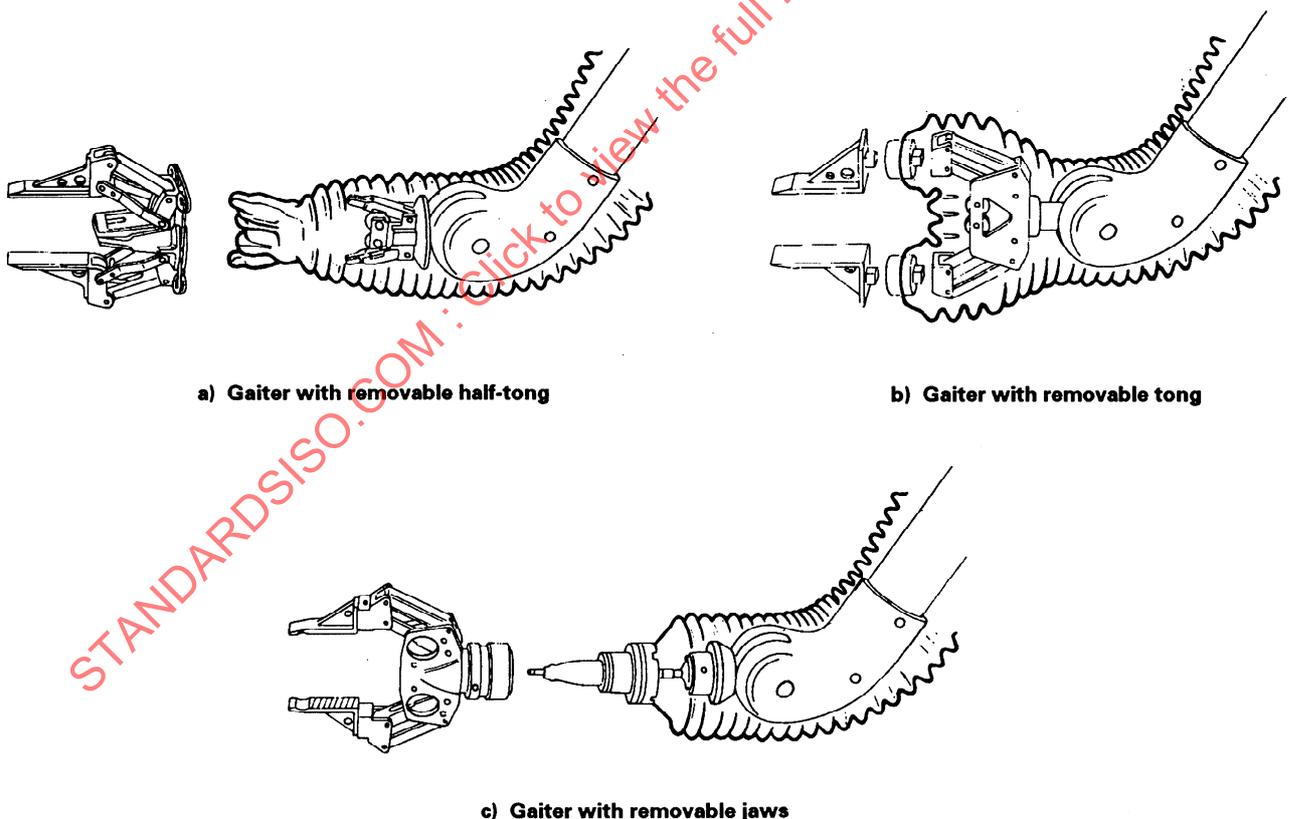


Figure 37 — Gaiter ensuring leaktightness

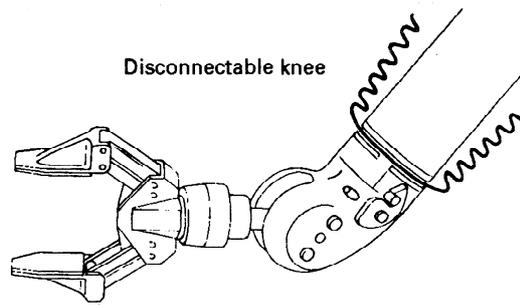


Figure 38 — Gaiter ensuring protection of manipulator, with removable tong at the wrist

8.4 Special case of double gaiters

Double gaiters should be used when a high purity internal atmosphere containment enclosure is required (neutral gases containing only trace impurities of H_2O , H_2 , N_2) (see figure 39).

These double gaiters are fitted on two support rings, situated one behind the other, and mounted on a specially profiled enclosure ring (enclosure ring with two or three grooves). The use of this kind of equipment allows a purge of the intermediate atmosphere. Purging of the space between the two gaiters is made with the same gas as that of the containment enclosure.

The control of negative pressure in the space between the two gaiters permits the detection of any leak inside the gaiter and replacement of the leaking gaiter. The double-gaiter system offers good protection against contamination of the slave arm.

8.5 Dimensions

The dimensions of the gaiters shall match the diameter and length of the slave arm, taking in account the manipulator type and model. For extended-reach manipulators, the length of the double telescope shall be considered.

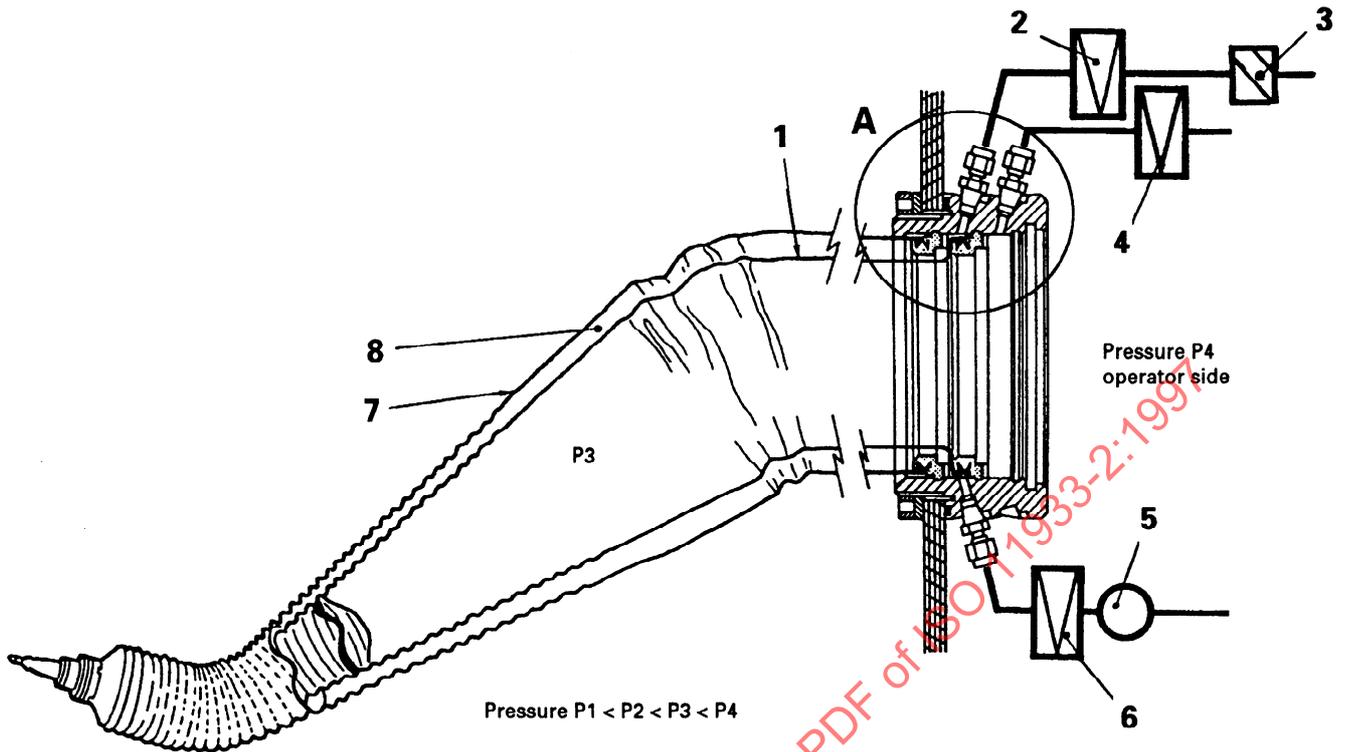
The dimensions of gaiters shall be chosen so that the manipulator movements are not restricted. The outer dimensions should be increased as little as possible, in order to retain the best viewing capability.

As manipulator gaiters are normally made to cover a great variety of existing manipulators, there are no standard dimensions.

8.6 Materials

Gaiters are generally manufactured from the following materials:

- PVC,
- polyurethane,
- chlorosulfonated polyethylene,
- polychloroprene,
- natural rubber (latex),
- polyamide and polyurethane (polyurethane cloth coated inside and/or outside with polyamide),
- polyurethane coated outside with chlorosulfonated polyethylene.



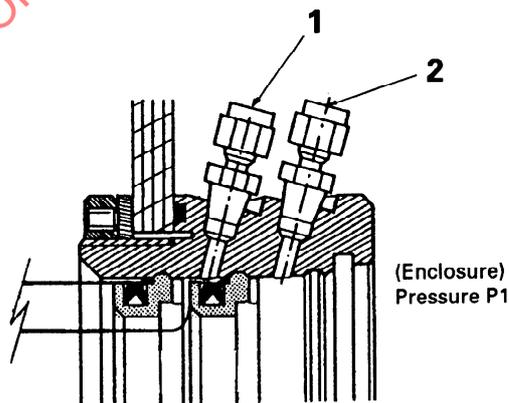
Pressure $P1 < P2 < P3 < P4$

Pressure $P4$
operator side

Key

- 1 Internal sleeve
- 2 HEPA filter
- 3 Balloon regulated to $P2$
- 4 Intermediary purge with controlled atmosphere at pressure $P3$
- 5 Manometer
- 6 HEPA filter
- 7 External sleeve
- 8 Inter-sleeve pressure $P2$

a) General view



Key

- 1 Circuit of neutral gases
- 2 Intermediary purge

b) Detail A

Figure 39 — Design of a double gaiter with intermediary purge

In practice, PVC and polyurethane are most commonly used.

Gaiters can be manufactured by welding of sheet, by injection or dipping.

Gaiters for telescopic slave arms shall be welded in a manner which ensures easy movement.

8.7 Changing of manipulator gaiters (see figure 40)

Due to the great number of shapes of manipulator arms and to the different kinds of gaiters and leaktightness seals, it is not possible to propose detailed methods for exchanging all types of gaiter.

However, for the most frequently used (methods 1 and 2 in 8.3), the gaiter-changing procedure can be summarized as follow:

- the exchange begins by removing the fingers from the jaws or the grip in the containment enclosure; the end of the gaiter is also separated from the manipulator arm;
- then, from outside of the enclosure, the manipulator arm is removed, keeping the enclosure leaktight [see figure 40 a)];
- the gaiter is then exchanged without breaking the leaktightness of the connection using the method appropriate to the kind of seal; for gaiters defined previously (methods 1 to 3), the ejection device is designed to fit with the support rings and through-wall tube characteristics (see figure 40 b)];
- finally, the manipulator arm is replaced and the forward end of the arm is connected to the new gaiter; the jaws or the grip are then installed in position.

NOTE — A specific ejection device is necessary to change a double-gaiter system.

Changing a gaiter of the latter category (method 4, figure 28) is not possible in an active cell; an assistance cell must be used after removing the whole slave arm.

8.8 Attachment of gaiters to type 1 support rings

The attachment of manipulator gaiters is the same as that for gloves.

Type 1 support rings accommodating manipulator gaiters are 1130, 1131, 1134, 1135, 1136 and 1139.

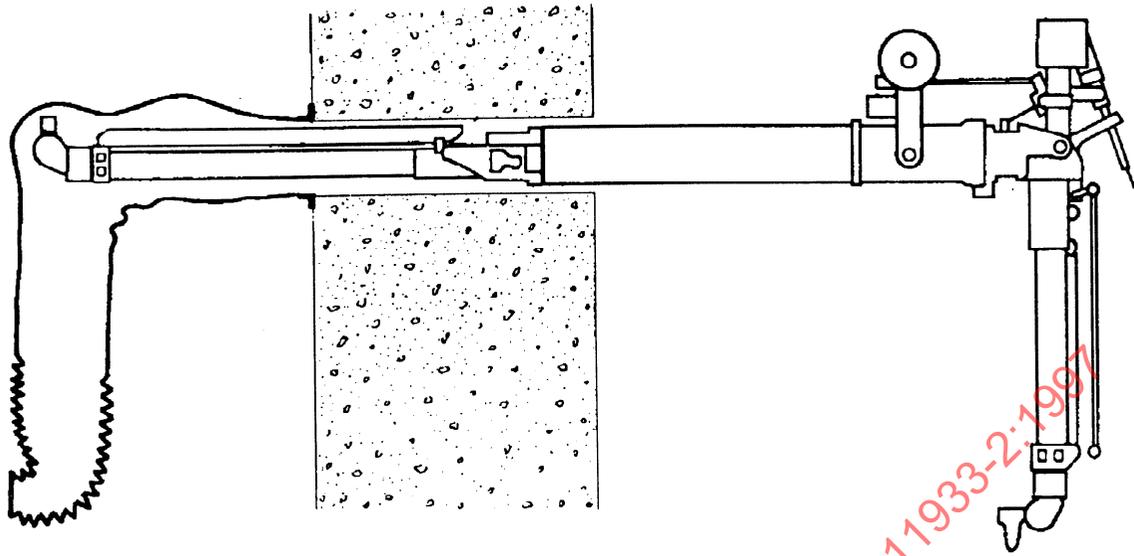
The sleeves terminate in a lip seal on the support ring side (see figure 41). The manipulator gaiters mounted on their support ring are replaced using an ejection device.

Attachment and removal procedures for manipulator gaiters are the same as for tong gaiters (see 7.1.3), gloves or welded bags fitted on support rings (see 5.3. and 6.4).

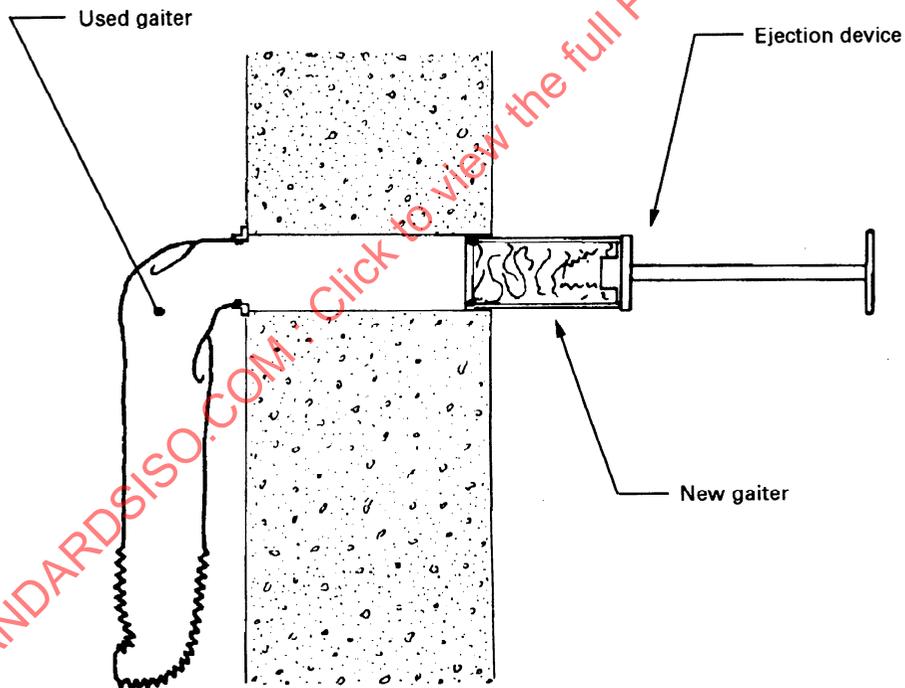
8.9 Assembly of gaiters on type 3 support rings

The gaiter is pressed against the through-wall tube by a support ring made of spring steel, which can be compressed or relaxed by a key from the operator's side. Between the gaiter and the support ring there is an auxiliary seal made of natural rubber.

The change procedure for these gaiters is described in figure 42.



a) Removal of slave-arm from the outside



b) Exchange of gaiter using an ejection device

Figure 40 — Usual method of exchanging of a leaktight manipulator gaiter

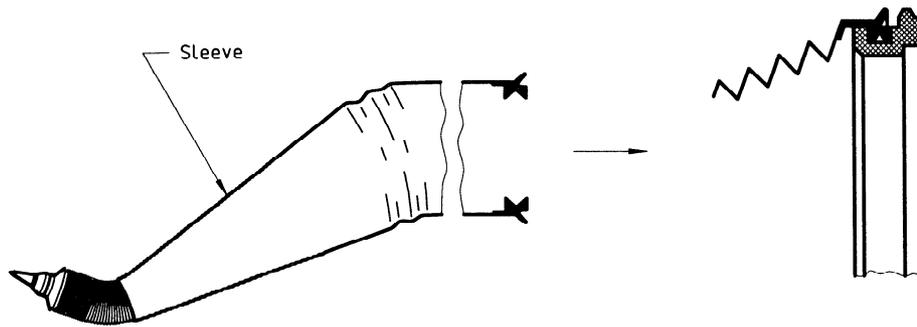


Figure 41 — Detail of lip seal and support ring for a manipulator gaiter

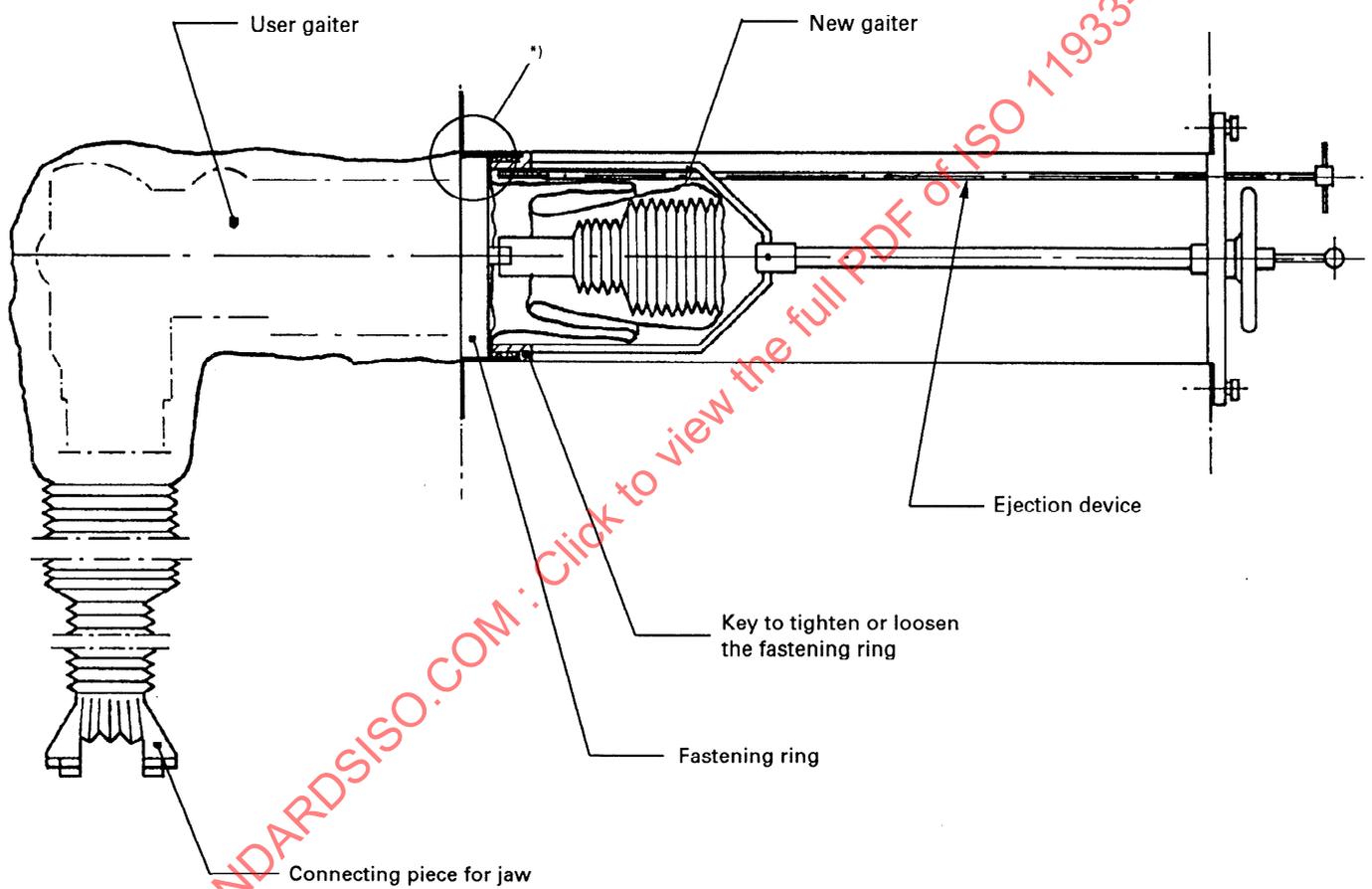
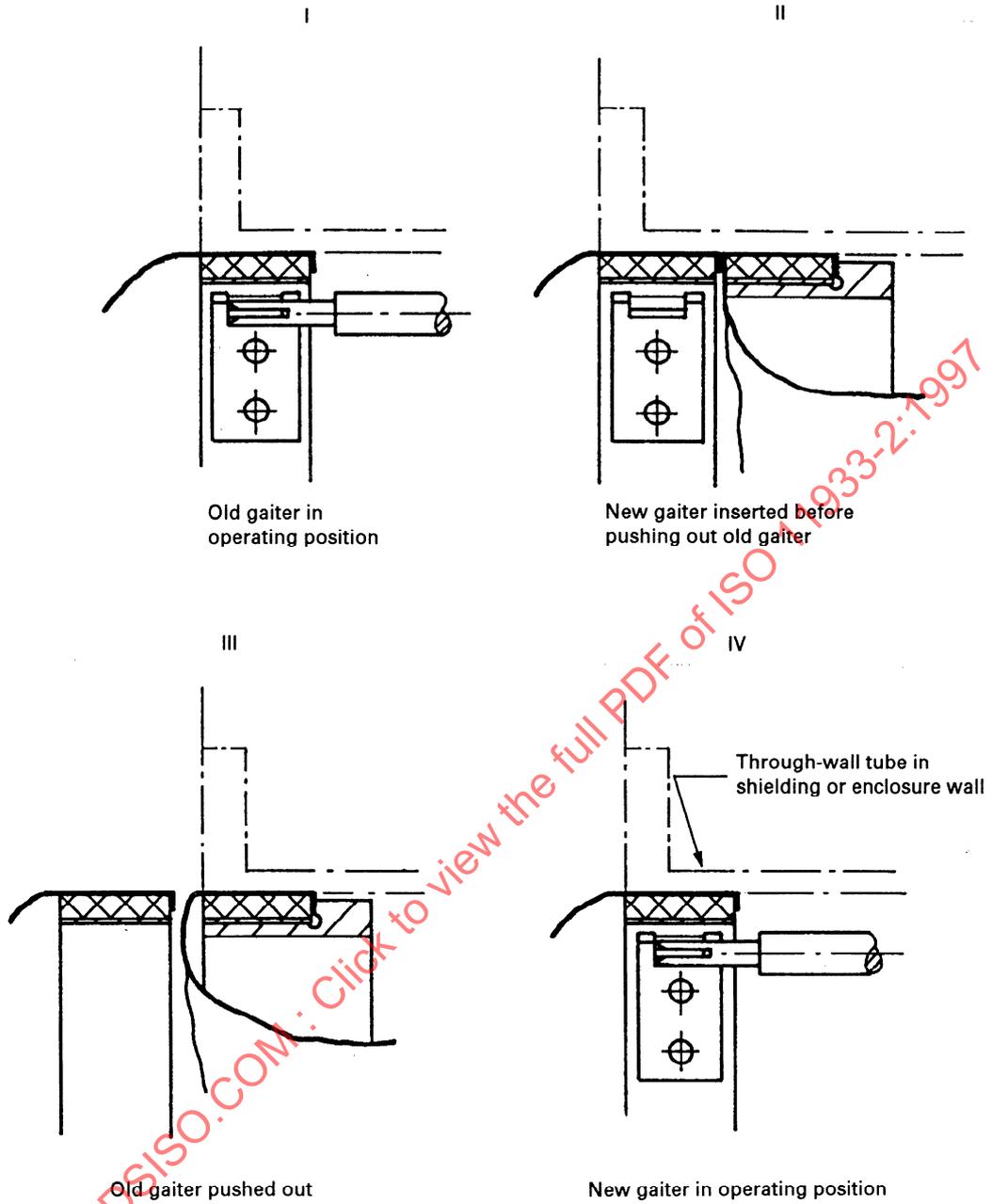


Figure 42 — Changing a manipulator gaiter mounted on a type 3 support ring



*) Detail of steps for gaiter exchange procedure.

Figure 42 — Changing a manipulator gaiter mounted on a type 3 support ring (end)

Annex A (informative)

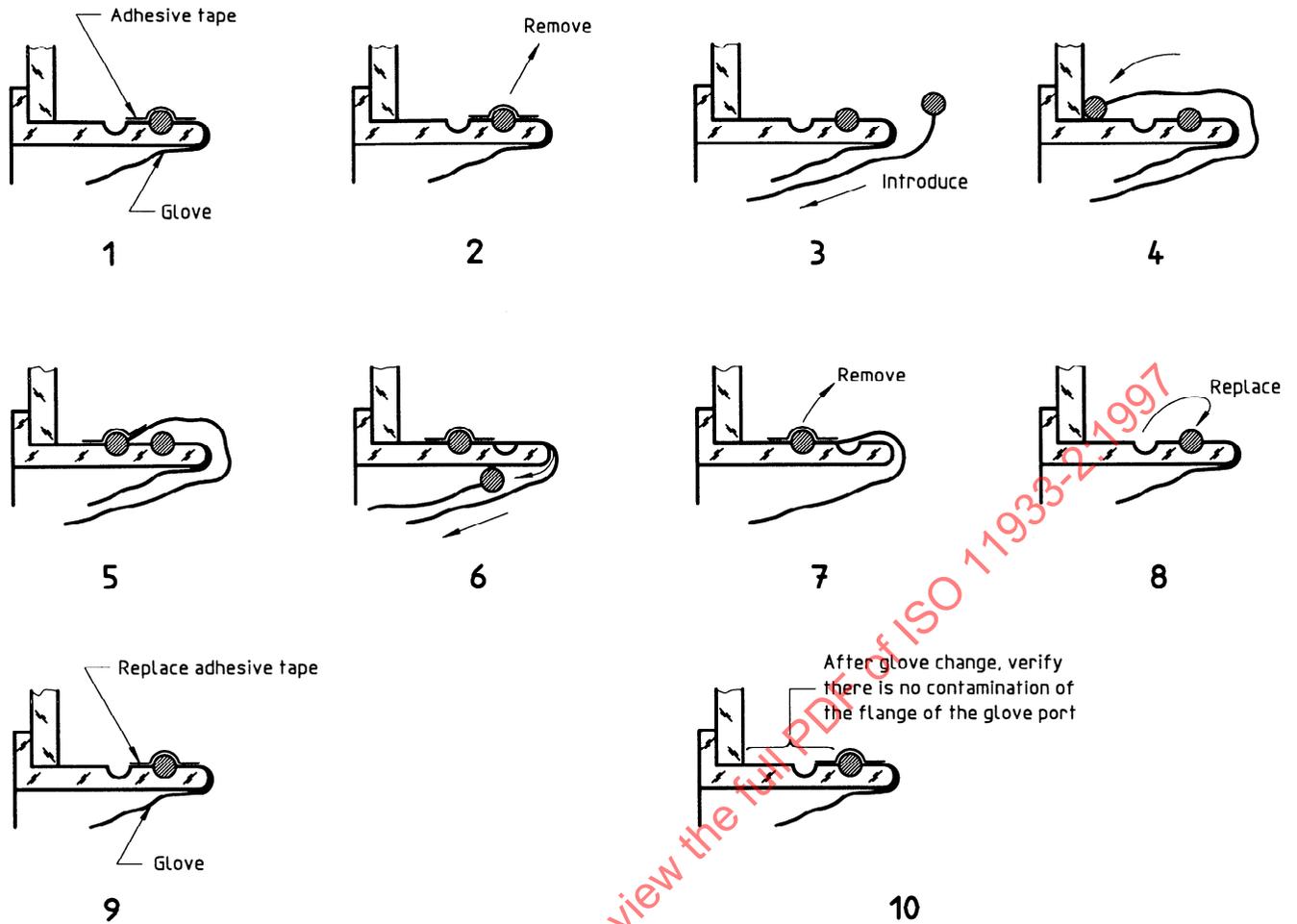
Description of different glove- or bag-changing methods

This annex describes the different procedures for the exchange of gloves or bags.

A.1 Glove-changing procedure for a glove port having two external grooves: method a)

Glove-changing is carried out using the following operations (see figure A.1):

- 1 Verify that the pressure level in the containment enclosure is suitable.
- 2 Remove the adhesive tape.
- 3-4-5 Put the bead of the new glove (previously drawn out) in the second groove over the glove to be replaced (beware of hand orientation, thumb up and of the right positioning of the bead), then temporarily fix it with an adhesive tape.
- 6 Through the new glove, remove the old one and push it inside the enclosure.
- 7-8-9 Remove the auxiliary adhesive tape. Bring back the bead of the new glove into the first groove, check then decontaminate the exposed surface if necessary and fix the bead with an adhesive tape.
- 10 The new glove is put in place under the action of reduced pressure.
- 11 Verify the pressure level inside the containment enclosure.
- 12 After glove-changing verify there is no contamination on the flange of the glove port.



NOTES

- 1 When there is a high contamination risk (powder, liquid, etc., operational safety can be improved by previously fixing a safety bag onto the enclosure wall under the port.
- 2 To maintain dynamic containment safety, a glove or bag shall not be changed with the bung in position.
- 3 The glove-changing procedure requires special care because the operator runs the risk of breaking the leaktightness of the containment enclosure if the bead of the glove escapes from the groove.

Figure A.1 — Glove-changing procedure for method a)