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Remote handling devices for radioactive materials —

Part 5: Remote handling tongs

Dispositifs de manipulation à distance pour matériaux radioactifs — Partie 5: Pinces de manipulation à distance

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17874-5 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

ISO 17874 consists of the following parts, under the general title *Remote handling devices for radioactive materials*:

— *Part 1: General requirements*

— *Part 2: Mechanical master-slave manipulators*

— *Part 4: Power manipulators*

— *Part 5: Remote handling tongs*

The following part is under preparation:

— *Part 3: Electrical master-slave manipulators*

Introduction

This part of ISO 17874 concerns multi-purpose remote handling tongs for nuclear applications.

These remote handling tongs replace some functions of human hands and arms in inaccessible areas (generally, behind shielding or containment walls). In general, remote handling tongs provide limited functionality compared to master-slave manipulators, such as those described in ISO 17874-2.

Remote handling tongs are typically used in hot cells for the following applications: fuel element examination, radio-isotope manipulation, reprocessing and waste treatment, radio-chemical analysis.

Vertically mounted remote handling tongs are typically applied in pools for work on radioactive sources and irradiated fuel elements.

End-effectors other than tongs, e.g. special-purpose tools, can be mounted on similar actuators, but these are not included within the normative part of this part of ISO 17874.

This part of ISO 17874 addresses only manually-actuated remote handling tongs and does not address any powered versions.

Remote handling devices for radioactive materials —

Part 5:
Remote handling tongs

1 Scope

The purpose of this part of ISO 17874 is to provide guidance for the selection, installation and use of manually-operated remote handling tongs within nuclear installations.

This part of ISO 17874 covers only the specific engineering aspects of manually-operated remote handling tongs and their interfaces with the nuclear facilities in which these devices are to be installed.

Specifically, it does not address design options concerning aspects such as the process and general maintenance arrangements that lead to the selection of any particular type of remote handling device.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7212 *Enclosures for protection against ionizing radiation (Lead shielding units for 50 mm and 100 mm thick walls)*

ISO 9404-1, *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 11933-1, *Components for containment enclosures — Part 1: Glove/bag ports, bungs for glove/bag ports, enclosure rings and interchangeable units*

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

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

ISO 17874-1, *Remote handling devices for radioactive materials — Part 1: General requirements*

ISO 17874-2, *Remote handling devices for radioactive materials — Part 2: Mechanical master-slave manipulators*

3 Terms and definitions

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

3.1
axis
direction of a Cartesian coordinate system defined from the operator standing point, considered as the origin of this system

NOTE The following axes are considered:

— X axis, from right to left along the shielding wall;

— Y axis, forward into the shielded cell;

— Z axis, up towards the ceiling of the shielded cell.

3.2
containment enclosure
enclosure designed to prevent leakage of products contained in the internal environment under consideration into the external environment, or the penetration of substances of the external environment into the internal environment, or both simultaneously

NOTE This is a generic term to designate all kinds of enclosures, including glove boxes, or cells of different geometries used for handling or to store radioactive materials, with handling devices.

3.3
shielded containment enclosure
hot cell
containment enclosed by a shielding wall intended to provide complementary shielding against penetrating radiation

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

3.4
disconnection
mechanical operation allowing the separation of two assembled elements, such as the disconnection of the tongs from the leak-tight coupling

3.5
disconnection device
mechanical device located inside a hot cell and used to connect or disconnect the end-effectors of a remote handling device, e.g. tongs, jaws, special tool, etc.

NOTE Such a device can also be used to store these elements.

3.6
enclosure ring
plastic or metallic ring mounted on containment enclosure or glove box walls, using threaded components or by welding or bonding

NOTE The ring is used to allow fitting of interchangeable leak-tight units mounted on a support ring (e.g. gloves, rigid plugs, gaiters for remote handling tongs, etc.).

3.7
ejection device
device used to release an interchangeable element, e.g. a gaiter or a seal, and to replace it with another element without compromising the integrity of the containment

3.8
handle
component gripped by the operator, fixed to the end of the rod and enabling control of the movement of the remote-handling device

3.9
jaws (of tongs)
components fixed to the actuator assembly of the tongs which enable the handling of an object

NOTE The jaws can be disconnectable.

3.10
joint
assembly of several moveable components allowing at least one rotational motion about one axis

3.11
operating volume
space in which the operation of tongs is possible, considering all the positions reached by any end-effector

3.12
tongs
gripping device fixed at the active end of the rod and consisting of an actuator assembly and jaws

NOTE The actuator assembly is also referred to as the tongs unit.

3.13
sphere unit
component inserted in the shielding or containment wall used to support a spherical or cylindrical moving part and forming the pivot for the remote handling tongs

NOTE Swivel joints, or systems using pins but having the same properties of two parts swivelling at right angles to one another (as in universal joints or gimbals), can also be referred to as sphere units.

3.14
gaiter
booting US
specially profiled flexible sleeve designed to protect the mechanical parts of the remote handling tongs from contamination or to provide the continuity of the leak-tightness of the hot cell

3.15
gaiter assembly
gaiter equipped at one side with a leak-tight coupling and at the other side with a support ring or an expandable ring

3.16
rod
rigid tube which connects the handle and the tongs and contains the transmission elements for the gripping motions

NOTE The length of the rod defines the working range of the tongs.

3.17
leak-tight coupling
intermediate device mounted between the tongs unit and the rod, ensuring the continuity of the leak-tightness of the gaiter and the transmission of the gripping motion in a leak-tight way

3.18
motion
term defining the possibility to execute a movement, which may be linear or rotation about a defined axis

3.19
orientation motion
rotational motions around certain axes of the tongs.

NOTE According to the axes considered, three following motions are distinguished: tilt (α), twist (β) and swivel or azimuth motion (γ).

3.20
positioning motion
motion effecting a linear displacement of the tongs (or end-effector)

NOTE According to the axes considered, three different motions are distinguished: x, y and z.

4 General features and classification

4.1 General

Remote handling tongs consist of an end-effector and a handle connected together by means of a tubular rod containing elements providing the mechanical linkage between the handle and the end-effector. They are either installed in a shielding or containment wall, or mounted on a carrying system or held by an operator.

Remote handling tongs permit the direct transfer of the operator's movements from the handle to the end-effector (in accordance with ISO 17874-1). Through this direct mechanical linkage, the operator is able to feel the forces applied to the end-effector and any reaction forces transferred back. This is termed "bilateral force reflection".

When installed on a shielding or containment wall, remote handling tongs may be fitted with a gaiter assembly which ensures leak tightness and protection against contamination.

Depending on the intended use, the tongs unit mounted at the end of the rod may have to be interchangeable in order to allow the use of different end-effectors or to replace the gaiter assembly.

4.2 Classification and mode of use

4.2.1 Horizontal remote handling tongs

These are remote handling tongs where the central axis of the rod is essentially horizontal. The load capacity is modest (see 5.2).

Horizontal remote handling tongs are used in cases where medium or low dexterity and a small operating volume are required. They are generally used in containment enclosures with shielding walls, mounted in pairs by means of sphere units (in accordance with ISO 7212 and ISO 9404-1).

The design of the overall assembly must ensure that the shielding effect of the wall is not significantly compromised by this installation.

A similar class of remote handling tongs may also be held by the operator, without any support. When using such devices (sometimes referred to as "reachers"), a sufficient distance between the operator and the radioactive source must be provided to ensure the required protection.

4.2.2 Vertical remote handling tongs

These are remote handling tongs where the central axis of the rod is essentially vertical. The absence of significant bending moments allows the load capacity to be considerably larger than with the horizontal type (see 5.2).

They are used where medium or low dexterity is required, generally in pools. They can be held by the operator or mounted on a carrying system that takes the vertical load, throughout the X and Y positioning axes. The z motion is realized via a separate hoist or crane.

The design of the overall assembly must ensure that the shielding effect provided by the water it displaces is not compromised by this installation (e.g. a gas-filled hollow structure would not generally be advisable).

4.3 Kinematics

4.3.1 General

Remote handling tongs ensure four to six motions and a gripping motion, as described below. Accordingly three different designs of remote handling tongs are distinguished:

— with a rigid rod: four motions;

— with an articulated rod (allowing variation of the inclination of the gripper): five motions;

— with a wrist joint (providing articulation and rotation motion of the gripper): six motions.

4.3.2 Horizontal remote handling tongs

4.3.2.1 Remote handling tongs with a rigid rod

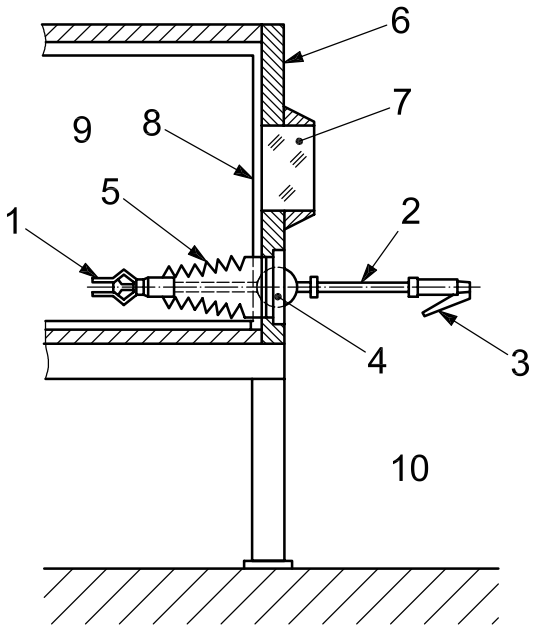
The kinematics of such tongs includes four motions [see Figures 1 a) and 1 b)] and provides (when placed in the basic position):

— the rotation of a sphere unit inserted in a shielding wall: the two motions of rotation around the X and Z axes permit the displacements of the end-effector primarily in the Z and X directions respectively;

— the sliding of the tubular rod within the sphere, along the Y axis;

— the rotation of the tubular rod around the Y axis (β motion).

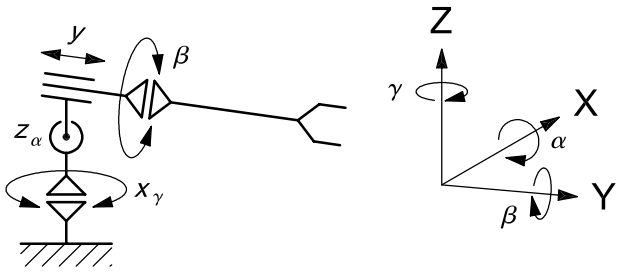
This type of handling device is referred to as “rigid tongs”.



Key

1 tongs
2 rod (rigid)
3 handle
4 sphere unit
5 leak-tight gaiter
6 shielding wall
7 shielding window
8 enclosure wall
9 hot cell
10 operating room

a) General view



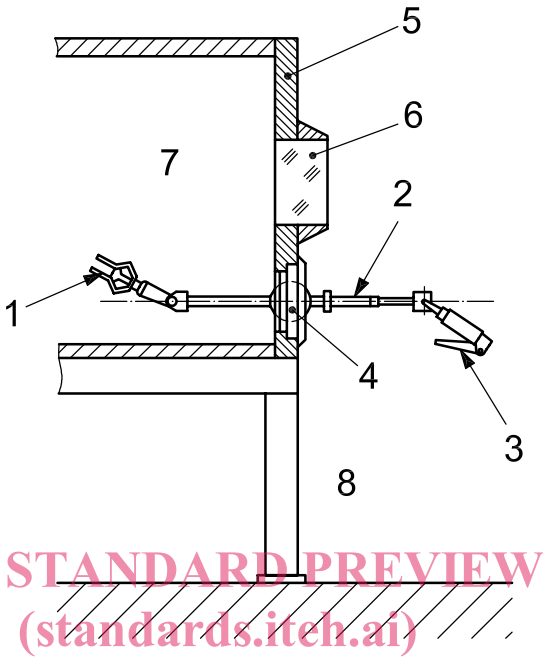
b) Kinematics

Figure 1 — Horizontal remote handling tongs (rigid rod), with a gaiter

4.3.2.2 Remote handling tongs with an articulated rod

Such tongs are equipped with an articulation enabling the tongs to reproduce inclination of the handle as moved by the operator (α rotation). Their kinematics thus provides five motions [see Figures 2 a) and 2 b)].

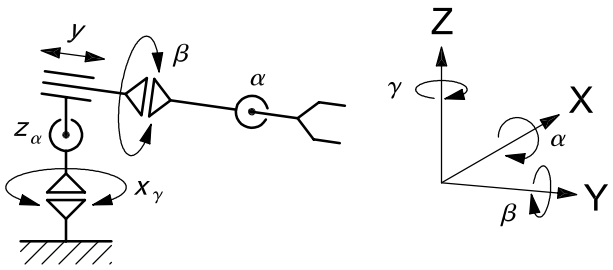
This type of handling device is referred to as “articulated tongs”.



Key

1	tongs	5	shielding wall
2	articulated rod	6	shielding window
3	handle	7	hot cell
4	sphere unit	8	operating room

a) General view, with gaiter



b) Kinematics, without gaiter

Figure 2 — Horizontal remote handling tongs (articulated rod)