BRITISH STANDARD

BS ISO 17874-1:2010

Remote handling devices for radioactive materials

Part 1: General requirements

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee NCE/2, Radiation protection and measurement.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Part 1: General requirements

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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 17874-1 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

This second edition cancels and replaces the first edition (ISO 17874-1:2004), which has been technically revised.

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 3: Electrical master-slave manipulators*

— *Part 4: Power manipulators*

— *Part 5: Remote handling tongs*

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Introduction

This part of ISO 17874 deals mainly with multipurpose remote handling devices for nuclear applications.

These devices replace hands and arms in areas inaccessible to personnel (mostly behind shielding walls).

There are special remote handling devices designed for narrow fields of application or for special purposes only, but these are beyond the scope of this part of ISO 17874.

Multipurpose remote handling devices have five to ten, or even more, possibilities of movement in order to cope with the planned range of tasks.

Four categories of such remote handling devices are used worldwide for the handling of radioactive materials. These categories are the following:

— mechanical master-slave manipulators;

— electrical master-slave manipulators;

— power manipulators;

— remote handling tongs.

Various special designs, hydraulic or pneumatic machines, prototypes, experimental devices and obsolete types cannot be assigned to any category or do not correspond to all requirements of this part of ISO 17874. These devices are not covered by this part of ISO 17874.

The main applications of the different categories are explained in Clause 4.

Remote handling devices were originally developed for hot cells designed for research and development in nuclear power reactor fuel elements. They are now also in widespread use in other nuclear installations, such as plants for fabrication or reprocessing of fuel elements, waste treatment stations and decommissioning of nuclear facilities.

Remote handling devices are sometimes used for non-nuclear applications. This part of ISO 17874 does not address the special requirements of any of these fields, although designers can take advantage of standardized components from the nuclear sector to achieve cost-effective designs for other purposes, where appropriate.

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Remote handling devices for radioactive materials —

Part 1:
General requirements

1 Scope

This part of ISO 17874 describes requirements concerning devices for remote handling of radioactive materials. The classification of these devices (categories and different designs within a category) and the distribution in the different parts are shown in Figure 1.

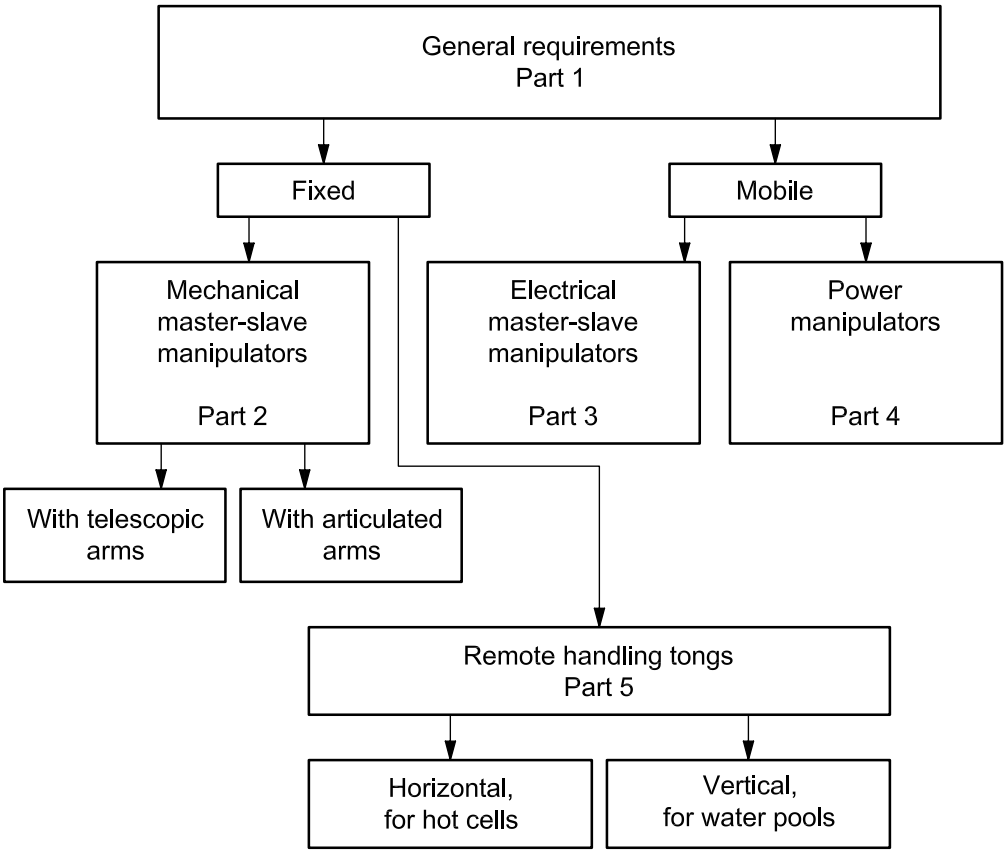

Figure 1 — Categories of remote handling devices and location in all parts of ISO 17874

Concerning the working volume, two principal designs are to be considered.

a) Fixed remote handling devices:

these devices are fitted in the shielding wall or sometimes in the ceiling of hot cells and accordingly can function only in a rather limited volume. Such devices are mechanical master-slave manipulators and remote handling tongs.

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b) Mobile remote handling devices:

these devices are fitted on a transporter (e.g. a moveable bridge or a vehicle on the ground). The working volume depends mainly on the possible motion of the transporter. Such devices are electrical master-slave manipulators and power manipulators.

NOTE This part of ISO 17874 is intended to provide assistance to designers of nuclear process plants, as well as manufacturers, users and licensing authorities.

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

ISO 17874-3, *Remote handling devices for radioactive materials — Part 3: Electrical master-slave manipulators*

ISO 17874-4, *Remote handling devices for radioactive materials — Part 4: Power manipulators*

ISO 17874-5, *Remote handling devices for radioactive materials — Part 5: Remote handling tongs*

3 Terms and definitions

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

3.1
mechanical master-slave manipulator
manipulator reproducing the movements of the hand and arm of the operator by means of isokinematic master and slave arms with back-drivable mechanical transmissions

NOTE The manipulator is generally mounted on a shielding wall.

3.2
electrical master-slave manipulator
manipulator reproducing the movements of the hand and arm of the operator by means of isokinematic master and slave arms with bilateral electrical position control (force reflection)

NOTE 1 The word “bilateral” refers to the property of the system to be indifferently moved by acting on the master arm or on the slave arm.

NOTE 2 The slave arm is generally mounted on a transporter (mobile).

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3.3
power manipulator
manipulator driven by switch-operated motors

3.4
remote handling tongs
mechanical device consisting of a gripper, a handle and a rod between them

NOTE Remote handling tongs are either installed in a shielding wall by using a mounting device or hung on a carrying system for use in a water pool or carried by an operator.

3.5
isokinematic
property of a manipulator, where from base to free end, master arm and slave arm, presents the same type of motion (rotation or translation) in the same order and with the same relative orientations

4 Application of multipurpose remote handling devices

4.1 General

The different categories of remote handling devices are used for various applications, as described in this clause.

4.2 Mechanical master-slave manipulators

4.2.1 Mechanical master-slave manipulators with telescopic arms

These manipulators allow the transmission of forces up to the maximum magnitude required for the tasks to be achieved manually by an unaided operator. Depending on the type of manipulator, maximum load capacities up to 45 kg can be reached (see 7.2). They are suitable for complicated tasks and are usually installed in pairs on a working station. They are designed for hot cells of all sizes with shielding walls of concrete or also of lead in some cases. They constitute the main working devices in such kinds of cells.

Different lengths of arms are available according to the size of the hot cell to be equipped. However, versions with short arms provide higher forces and, reversely, versions with long arms reduce the forces to be applied. There also exist compact manipulators with a double telescope in the slave arm, available for hot cells with restricted height.

4.2.2 Mechanical master-slave manipulators with articulated arms

These manipulators allow not only the execution of forces equivalent to those an unaided operator can achieve, but also forces up to a much higher level. Depending on the type of manipulator, maximum load capacities up to 100 kg can be reached (see 7.2). They are suitable for complicated tasks, and are usually installed in pairs on a working station. They are designed for hot cells of all sizes with shielding walls typically of lead or also of cast iron in some cases. They are also used in containment enclosures. They have small dimensions and therefore provide a relatively small working volume. They are used instead of remote handling tongs as described in 4.5, if a larger working volume and/or more dexterity are needed.

4.3 Electrical master-slave manipulators

These manipulators allow not only the execution of forces equivalent to those an unaided operator can achieve, but also (depending on the type) forces up to a much higher level. They are suitable for complicated tasks, and often they are installed in pairs. They allow the performance of complicated work throughout the whole volume of large hot cells and not only near the operation walls, by means of the mobility of the slave arm. As a result of their load capacities they can be used also in place of light and medium load capacity power manipulators. They can be used, not only inside facilities, but also on vehicles (also in the open air).

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4.4 Power manipulators

These manipulators allow the execution of high forces and therefore the handling of heavy objects, typifying their application. According to the load capacity of their hoist, they can also be used like a crane of light load capacity. They are not suitable for complicated tasks. They are used in medium-sized or large hot cells. Normally, they have large dimensions and are used to assist mechanical master-slave manipulators. They are used for tasks to be performed in areas that cannot be reached by mechanical master-slave manipulators and for transportation of objects over significant distances. They can also be used on vehicles (also in the open air).

4.5 Remote handling tongs

4.5.1 Remote handling tongs, used horizontally

These devices allow the transmission of forces of a low level, which any operator working unaided would consider small. They can be used only if a moderate level of dexterity and a small working volume are required. In the horizontal mode of use, remote handling tongs are mostly installed in pairs. They are typically used in hot cells with shielding walls made of lead. The installation on the shielding wall is realized using standardized ball mountings called sphere units (see ISO 7212 and ISO 9404-1).

NOTE These remote handling tongs can also be used without any mounting and shielding. In this case, protection is achieved by the operator maintaining an appropriate distance from the radioactive sources.

4.5.2 Remote handling tongs, used vertically

These devices allow the transmission of forces up to a high level (depending on the type), close to the maximum magnitude that an operator would employ in unaided manual activity. They can be used if dexterity only up to a moderate level is required. In this mode of use, remote handling tongs are typically installed above water pools. They can be handled manually by the operator or fixed in a carrying system, which would typically have three positioning motions.

NOTE To facilitate understanding in this part of ISO 17874, only the four common categories of remote handling devices listed above and their usual applications are considered. This does not exclude the development of equipment with more specialist features.

5 Kinematic systems for multipurpose remote handling devices

A multipurpose remote handling device shall have several possibilities of movement (termed motions) so as to be able to achieve a great variety of remotely handling tasks. The motions are executed mechanically either by the hands and arms of the operator or by electric motors.

A fully articulate remote handling device, which should in principle not be limited concerning its motions, shall have at least seven independent motions. It shall be able to execute three independent translation movements (and forces) on an object in the directions of the three coordinate axes throughout the working volume. It shall also be able to execute three independent rotation movements (and torques) on an object around the three coordinate axes without any special prior adjustment, again throughout the working volume. The seventh motion corresponds to the gripping movement.

NOTE Specific aspects of kinematic systems for handling are described in Annex A.

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