
**Nuclear energy — Fuel technology —
Trunnion systems for packages used
to transport radioactive material**

*Énergie nucléaire — Technologie du combustible — Systèmes de
tourillons pour colis de transport de matières radioactives*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 5, *Nuclear installations, processes and technologies*.

This second edition cancels and replaces the first edition (ISO 10276:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

- The scope is extended to trunnion attachment components (trunnion systems are defined as being the trunnions and their attachment components);
- The normative references have been updated (IAEA TS-R-1 replaced by IAEA SSR-6) and enlarged to the IAEA SSG-26 (Appendix IV-1 - Package stowage and retention during transport);
- Quality Assurance is replaced by Management Systems;
- The load cases are to be defined by use of the minimum acceleration factors given in table IV-1 of the Appendix IV of IAEA SSG-26;
- The calculation methods (analytical and finite element analysis) and the minimum associated criteria are more precisely detailed;
- The bibliography has been updated and enlarged to the most recent recommendations, guidance and standards as acceptable by most of the Competent Authorities;
- The structure of the document has been slightly modified to enhance its legibility and understanding.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document has been produced to enable package owners, designers, users and regulatory organizations to have at their disposal a comprehensive document covering all aspects of trunnion systems. Experience has been drawn from the extensive knowledge of owners, designers, users and competent authorities. This document contains the minimum requirements and makes recommendations covering various aspects of trunnion systems.

Intermediate devices (sometimes referred to as transport frames, supports or cradles) can be used between the packaging trunnions and the transport conveyance to support and secure the package during transport; however, the energy-absorbing effects that may be provided by these intermediate devices are not taken into consideration in this document.

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Nuclear energy — Fuel technology — Trunnion systems for packages used to transport radioactive material

1 Scope

This document covers trunnion systems used for tie-down, tilting and/or lifting of a package of radioactive material during transport operations.

Aspects included are the design, manufacture, maintenance, inspection and management system. Regulations which can apply during handling operation in nuclear facilities are not addressed in document.

This document does not supersede any of the requirements of international or national regulations, concerning trunnions used for lifting and tie-down.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IAEA SSR-6, *International Atomic Energy Agency (IAEA) Safety Standard No. SSR-6, Regulations for the Safe Transport of Radioactive Material*

IAEA SSG-26, *International Atomic Energy Agency (IAEA) No. SSG-26, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material*

3 Terms, abbreviated terms, symbols and definitions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IAEA SSR-6 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1.1

bending stress

variable component of *normal stress* (3.1.10), which might not be linear across the thickness

3.1.2

bolts

fasteners including bolts, screws and studs

3.1.3

designer

organization responsible for the design of the package

3.1.4

independent expert organization

organization administratively and managerially separate from the designers, manufacturers or owners of the subject package, constituted of specialized experts, or an insurance organization used to verify, oversee, witness or check

3.1.5

linearized stress

sum of the *membrane stress* (3.1.9) and of the linear component of the *bending stress* (3.1.1)

3.1.6

load case

specific configuration of transport or lifting associated to a total mass (transport or lifting), specified value and direction of acceleration, a given number of acting trunnions, and a given point/area of application of the load on the trunnion

3.1.7

maintenance schedule

document drawn up by the designer that gives, in appropriate detail, the applicable frequency/periodicity of maintenance items and details of methods to be employed; applied by the owner/operator

3.1.8

maximum service load

greater of *total mass (lifting)* (3.1.19) and *total mass (transport)* (3.1.20), subjected to gravity (1 g)

3.1.9

membrane stress

component of *normal stress* (3.1.10) that is uniformly distributed and equal to the average stress across the thickness of the section under consideration

3.1.10

normal stress

component of stress normal to the plane of reference

3.1.11

owner

operator

organization responsible for maintaining the condition of the packaging for transport

Note 1 to entry: The condition of packaging shall be in accordance with IAEA SSR-6.

3.1.12

peak stress

maximum stress that occurs in a component by reason of geometry, local discontinuities or local thermal stress, including the effects, if any, of stress concentration

3.1.13

periodic inspection

inspection of the trunnion system during the in-service life of the packaging at predetermined periodicities defined in the *maintenance schedules* (3.1.7)

3.1.14

primary trunnion system

trunnion system provided as a primary means for lifting and/or tilting, tie-down and supporting of the package

3.1.15

quality plan

document, or several documents, that together specify quality standards, practices, resources, specifications, and the sequence of activities relevant for manufacture

3.1.16**removable trunnion**

trunnion, on a package secured by non-permanent methods, e.g. bolting

3.1.17**secondary trunnion system**

trunnion system provided as an additional or alternative means for lifting and/or tilting, tie-down and supporting of the package

3.1.18**tie-down**

securing of the package to the conveyance

3.1.19**total mass (lifting)**

maximum mass of a package as supported by the trunnion systems during lifting, fitted with all necessary ancillaries and equipment, and including the radioactive material and water as appropriate

3.1.20**total mass (transport)**

maximum mass of a package fitted with all ancillaries (shock absorbers, neutron shields, covers, transport frame as appropriate, etc.), as presented for transport and as supported by the trunnion systems

3.1.21**transport cycle**

complete round-trip journey of a package between two complete loadings

3.1.22**trunnion**

projection, typically cylindrical in shape, attached on a packaging by various means and used for lifting, tilting and/or *tie-down* (3.1.18) of the package; parts permanently attached to the trunnion are considered as being part of the trunnion

Note 1 to entry: A trunnion is an example of an attachment point as defined in IAEA SSG-26, Appendix IV.

3.1.23**trunnion attachment method**

method of attaching the trunnion (e.g. welding, bolting, threaded attachment, interference fitting and bolting, or any combination of these methods) to the packaging body

3.1.24**trunnion attachment components**

attachment components, e.g. welding to the packaging body, bolts, removable shear discs, female threads or housing in the packaging body, removable baseplates, etc., used to secure the trunnion to the packaging body

3.1.25**trunnion system**

assembly of *trunnion* (3.1.22) and *trunnion attachment components* (3.1.24)

3.1.26**welded trunnion**

trunnion directly secured to the packaging by welding

3.2 Symbols

K_{Ic}	plane strain fracture toughness
$R_e(T)$	guaranteed yield strength or guaranteed 0,2 % proof strength at the operating temperature, T
$R_m(T)$	guaranteed minimum tensile strength at the operating temperature, T
T	operating temperature

3.3 Abbreviations

FEA	Finite Element Analysis
MT	Magnetic particle test
NDE	Non-destructive examination
PT	Liquid penetrant test
SCC	Stress corrosion cracking
UT	Ultrasonic test
VT	Visual inspection test

4 Regulatory requirements

4.1 General

In this document, the word “shall” denotes a requirement; the word “should” denotes a recommendation; and the word “may” denotes permission, i.e. neither a requirement nor a recommendation. Imperative statements also denote requirements. To conform to this document, all operations shall be performed in accordance with its requirements, but not necessarily with its recommendations.

The word “can” denotes possibility rather than permission.

4.2 Relevant regulations

The main applicable document is IAEA SSR-6. Other relevant national or international transport regulations should also be considered to ensure that any differences with the IAEA Transport Regulations are taken into account.

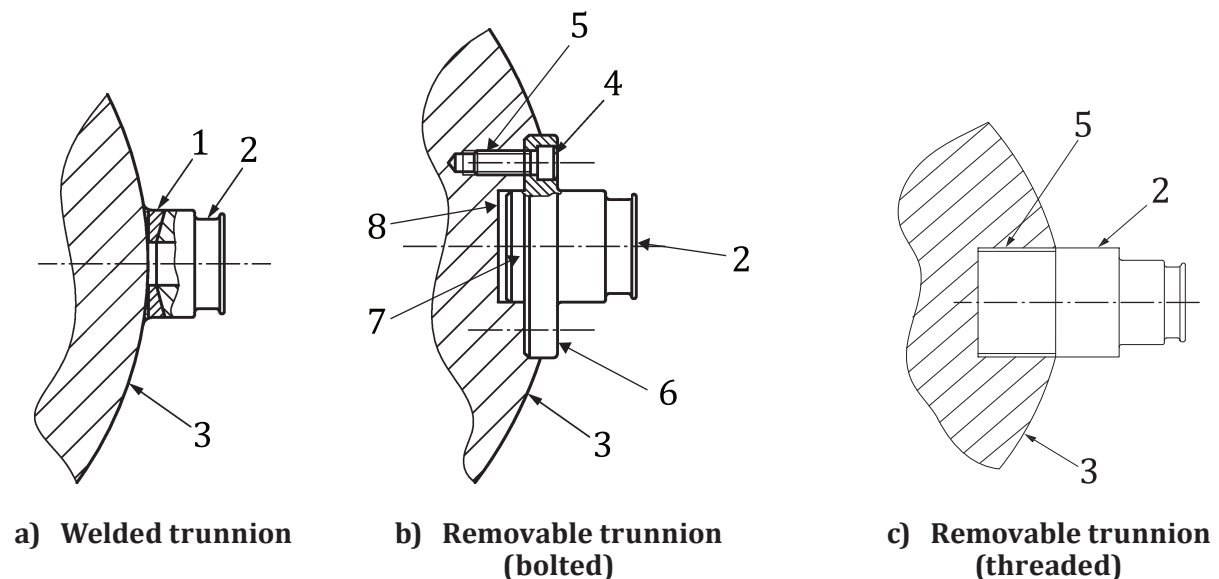
This document does not relieve the relevant parties of the responsibility for compliance with any requirement of the regulations applicable within the nuclear power plants (e.g. KTA 3905^[3] or ANSI N 14.6^[4]).

5 Design

5.1 General

5.1.1 Trunnion systems as part of a package design shall be designed in accordance with IAEA SSR-6 with consideration of IAEA SSG-26, and in particular its Appendix IV.

5.1.2 Trunnion attachment to a packaging may be carried out by welding, bolting, threaded attachment, interference fitting and bolting, or any combination of these methods. This document applies to these methods of trunnion attachment; see [Figure 1](#) a), b) and c).



Key

1	weld	5	body thread
2	trunnion	6	removable baseplate
3	packaging body	7	removable shear disc
4	attachment bolt	8	body housing

Figure 1 — Examples of trunnions

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5.1.3 Trunnions are fitted to the packaging to provide the following:

- a means of tie-down of the package during transport; and/or
- a means of providing lifting, or lifting and tilting, the package (with particular designs of package, the trunnions are used in tilting the package from horizontal to vertical position and vice-versa).

5.1.4 The designer shall consider how the package is supported during transport and lifting and/or tilting with respect to the trunnions. For these situations the load distribution for the trunnion system shall be derived. The designer shall consider the number of trunnions on the package required to fulfil a particular function (e.g. lifting, tilting, supporting) and the value, the direction of forces that are imposed on the trunnions and the way they are applied (point of application, width, angle of repartition...). See [5.4](#) for more details.

The load transferred by the trunnion system to the packaging body needs to be considered but is not part of this document.

5.1.5 The design of the trunnion system shall be capable of performing for a temperature range as defined in the IAEA Transport Regulations. In particular, minimum and maximum operating temperatures due to design heat load and worst case ambient conditions shall be considered. Differential thermal expansion between the conveyance means and the packaging may add stresses to the trunnion system unless specific design arrangements are made to avoid those effects.

5.1.6 The designer should ensure that the combination of environment, component materials, bolt coatings, bolt strength, grade, and tensile stress do not render the trunnion system vulnerable to the