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

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

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Published in Switzerland

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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 10276 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 5, *Nuclear fuel cycle*.

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Introduction

This International Standard has been produced to enable package owners, designers, users and regulatory organizations to have at their disposal a comprehensive document covering all aspects of trunnions. Experience has been drawn from the extensive knowledge of owners, designers, users and competent authorities. Contained herein are the recommended minimum criteria covering various aspects of trunnions.

It is intended that quality assurance, although referred to separately in Clause 8, be applied during the application of part or all of this International Standard.

No account is taken in this International Standard of any intermediate device that can be used between the packaging trunnions and the transport vehicle with respect to the relevant energy-absorbing effects. Intermediate devices (sometimes referred to as transport frames, supports or cradles) are used to support and secure the package to the transport vehicle.

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

1 Scope

This International Standard covers trunnions fitted to radioactive-material transport packages that are subject to the approval and licensing by competent authorities in accordance with the IAEA No. TS-R-1. Aspects included are design, manufacture, maintenance and quality assurance.

Subject to agreement between the interested parties, it can also be applied to packages that are not subject to the approval by competent authorities.

This International Standard covers trunnion systems used for tie-down during transport and trunnions used for tilting and/or lifting.

This International Standard does not supersede any of the requirements in the IAEA No. TS-R-1, nor any of the requirements of international or national regulations, concerning trunnions used for lifting and tie-down.

This International Standard is applicable to new package design.

2 Normative references

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International Atomic Energy Agency (IAEA) No. TS-R-1, *Regulations for the Safe Transport of Radioactive Material*, 2009

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 No. TS-R-1:2009, Section II, and the following apply.

3.1.1

areas of special concern

areas defined by the designer as exhibiting the highest risk of failure of the trunnion and attachment system, taking into account stress concentrations, fatigue, stress intensity, etc.

3.1.2

bending stress

variable component of normal stress, which might or might not be linear across the thickness

3.1.3

independent competent 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

3.1.4

linearized stress

sum of the membrane stress and of the linear component of the bending stress

3.1.5

membrane stress

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

3.1.6

normal stress

component of stress normal to the plane of reference

3.1.7

owner/operator

organization responsible for maintaining the condition of the packaging for transport in accordance with IAEA No. TS-R-1

3.1.8

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

3.1.9

periodic inspection

inspection of the trunnion system at predetermined periodicities during the "in-service" life of the packaging

3.1.10

periodic testing

testing at predetermined periodicities of the trunnion system, provided as a primary means for the lifting, tie-down, supporting or tilting of packages

3.1.11

primary stress

normal or shear stress developed by an imposed loading that is necessary to satisfy the laws of equilibrium of external and internal forces and moments

NOTE The basic characteristic of a primary stress is that it is not self-limiting.

3.1.12

primary trunnion system

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

3.1.13

relevant indication

indication specified by the designer that can lead to an unacceptable reduction in safety factor

3.1.14

removable trunnion

cylindrically shaped projection on a package secured by non-permanent methods, e.g. bolting

3.1.15

schedule

<maintenance> document that gives, in appropriate detail, the applicable frequency/periodicity of maintenance items and details of methods to be employed

3.1.16**secondary stress**

normal or shear stress developed by the constraint of adjacent material or by self-constraint of the structure

NOTE The basic characteristic of a secondary stress is that it is self-limiting (e.g. general thermal stresses, bending stress at a gross structural discontinuity).

3.1.17**secondary trunnion system**

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

3.1.18**shear stress**

component of stress tangent to the plane of reference

3.1.19**significant**

(damage) (corrosion) specified by the designer as possibly leading to an unacceptable reduction in the safety factor

3.1.20**stress intensity**

maximum mechanical and thermal stress, calculated according to von Mises's theory

3.1.21**tie-down**

securing of the package to the transport vehicle

3.1.22**total mass (lifting)**

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

3.1.23**total mass (transport)**

maximum mass of a package fitted with all ancillaries (shock absorbers, neutron shields, covers, transport frame as appropriate, etc.), as presented fully laden for transport

3.1.24**transport cycle**

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

3.1.25**trans-shipment**

change of transport vehicle at any time during a transport cycle, e.g. from road to rail

NOTE This applies also when a vehicle is substituted, e.g. from one rail vehicle to another rail vehicle.

3.1.26**trunnion**

cylindrically shaped projection on a packaging, attached by various means and used for lifting, tie-down, supporting or tilting packages from horizontal and vertical modes

3.1.27**trunnion attachment**

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

3.1.28

trunnion attachment components

trunnion attachment components excluding the trunnion, e.g. bolts, threads in the packaging body, baseplates, etc.

3.1.29

trunnion system

assembly of trunnion and components to the packaging, including the trunnion attachment components to the packaging and the female threads in the packaging body, as appropriate

3.1.30

welded trunnion

cylindrically shaped projection on a packaging, directly secured to the packaging by welding

3.2 Symbols

K_{Ic} plane strain fracture toughness

$R_e(T)$ clearly defined yield point or minimum yield strength of 0,2 % of residual elongation (0,2 % proof stress) at the operating temperature, T

$R_m(T)$ guaranteed minimum tensile strength at the operating temperature, T

S stress intensity

T operating temperature

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3.3 Abbreviations

IAEA	International Atomic Energy Agency
ILO	International Labour Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization
MT	Magnetic particle test
NDE	Non-destructive examination
PT	Liquid penetrant test
RE	Radiographic examination
SCC	Stress corrosion cracking
UN ECE	United Nations Economic Commission for Europe
UT	Ultrasonic test

4 Regulatory requirements

4.1 General

In this International Standard, 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 with this International Standard, all operations shall be performed in accordance with its requirements, but not necessarily with its recommendations.

The words “can” and “could” denote possibility rather than permission.

The word “will” denotes that an event is certain to occur rather than a requirement.

4.2 Relevant regulations

The main applicable document is IAEA No. TS-R-1.

Other relevant national or international regulations should also be considered to ensure that any differences with the IAEA regulations are taken into account. This International Standard does not relieve the relevant parties of the responsibility for compliance with any requirement of the government of any country through or into which the package is being transported, including regulations applicable within the nuclear power plants.

4.3 Quality assurance

Quality assurance, although referred to separately in Clause 8, shall be applied during the application of parts or all of this International Standard.

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5 Design

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5.1 General

5.1.1 Trunnion systems shall be designed so that, under routine, normal and accident conditions, in accordance with IAEA No. TS-R-1, the forces in the trunnions and trunnion attachments shall not impair the ability of the package to meet the requirements of those regulations.

5.1.2 Trunnion attachment to a packaging may be carried out by welding, bolting, interference fit and bolting, or any combination of these methods. This International Standard applies to these methods of trunnion attachment; see Figure 1 a) and 1 b).