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Nuclear energy — Packagings for the transport of uranium hexafluoride (UF6)

Énergie nucléaire — Emballage de l'hexafluorure d'uranium (UF6) en vue de son transport

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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 7195 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 5, *Nuclear fuel technology*.

This third edition cancels and replaces the second edition (ISO 7195:2005) which has been technically revised.

Introduction

The transport of uranium hexafluoride (UF_6) is an essential operation in the nuclear industry. The packaging and transport of UF_6 is subject to the relevant transport regulations for dangerous goods of each of the countries through or into which the material is transported. This International Standard does not take precedence over applicable governmental regulations, nor does it relieve the consignor and other parties from compliance with these regulations. For more detailed information, the user of this International Standard is encouraged to consult the appropriate regulatory document.

The United States Standard ANSI N14.1 (first issued in 1971) has been used internationally as an industry reference and the standard cylinders included in ANSI N14.1 have been used widely for international transport of UF_6. However, in some cases minor adaptations of the American standard were required to meet local conditions in a particular country. For example, equivalent materials may have been used instead of the materials specified. Moreover, the certification of cylinders as pressure vessels can have required equivalent authorization procedures appropriate in the countries concerned, rather than the US certification procedure specified.

This International Standard presents primarily information on UF_6 packagings (including valves, plugs, and valve protectors). It is intended to provide for compatibility of UF_6 packagings among different users within the nuclear industry. It has been developed from ANSI N14.1, but with incorporation of, and allowance for, other equivalent materials and national authorization and certification procedures. ISO 7195 was first issued in 1993 and a revision was published in 2005.

Throughout this International Standard and in conformity with standard ISO practice, SI metric units are used in preference to imperial units (which are given in parenthesis for information). However, generic packaging designations are based on the cylinder diameter expressed in imperial units (48'' for instance)

If a common, commercially available component uses features that are defined in an appropriate non-SI metric-based Standard document, only the relevant base units are quoted.

Nuclear energy – Packagings for the transport of uranium hexafluoride (UF_6)

1 Scope and purpose

This International Standard provides requirements for the procurement and fabrication of new packagings (including valves, plugs, and valve protectors) for transport of 0.1 kg or more of uranium hexafluoride (UF6) and for inspection, cleanliness, and maintenance of packagings in service.

It is intended to provide for compatibility of UF_6 packagings among different users within the nuclear industry.

2 Normative references

The following referenced documents are indispensable for the application of this document.

For dated references, the edition current at the time of publication of this International Standard applies. Editions that supersede these may be adopted with approval of the competent authority.

For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/A5.18:1993, Specification for Nickel and Nickel Alloy Bare Wire Electrodes and Rods
ANSI/API Std 527, Seat Tightness of Pressure Relief Valves
ANSI/ASME, Boiler and Pressure Vessel Code 2011
ANSI/ASME B1.1-2003, Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI/ASME B1.5-1997(R2004), Acme Screw Threads
ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch)
ANSI/ASME B16.11-2005, Forged Steel Fittings, Socket-Welding and Threaded
ANSI/ASME B18.3-2003, Socket Cap, Shoulder, and Set Screws, Hex and Spline Keys (Inch Series)
ANSI/ASME NQA-1-1994, Quality Assurance Program Requirements for Nuclear Facilities
ANSI/AWS A5.8/A5.8M:2004, Specification for Filler Metals for Brazing and Braze Welding
ANSI/AWS A5.14/A5.14M:2005, Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods
ANSI/AWS D1.1/D1.1M:2008, Structural Welding Code—Steel
ANSI/CGA V-1-2005, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections
ANSI/NB-23 (2007), National Board Inspection Code (NBIC)

ASTM A20/A20M-05, Standard Specification for General Requirements for Steel Plates for Pressure Vessels
ASTM A36/A36M-05, Standard Specification for Carbon Structural Steel
ASTM A53/A53M-06, Standard Specification for Pipe, Black and Hot-Dipped, Zinc–Coated, Welded and Seamless
ASTM A105/A105M-05, Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M-06, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108-03e1, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A131/A131M-04ae1, Standard Specification for Structural Steel for Ships
ASTM A193/A193M-06a, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A234/A234M-06a, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M-06b, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A285/A285M-03, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate-Tensile Strength
ASTM A354-07a, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A370-05, Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel for Moderate- and Lower-Temperature Service
ASTM A574-04, Standard Specification for Alloy Steel Socket-Head Cap Screws
ASTM A575-96(2002), Standard Specification for Steel Bars, Carbon, Merchant Quality,MGrades
ASTM B16/B16M-05, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
ASTM B32-04, Standard Specification for Solder Metal
ASTM B127-05, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
ASTM B150/B150M-03, Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B160-05, Standard Specification for Nickel Rod and Bar
ASTM B161-05, Standard Specification for Nickel Seamless Pipe and Tube
ASTM B162-99(2005), Standard Specification for Nickel Plate, Sheet, and Strip
ASTM B164-03, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B165-05, Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
ASTM B171/B171M-04E1, Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers
ASTM B209-06, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211-03, Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B249/B249M-06, Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings
ASTM B366-04b, Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings
ASTM E2375-04, Standard Practice for Ultrasonic Examination of Wrought Products

NUREG/CR-6407-1996, Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety

SAE J512, Rev. April 1997, Automotive Tube Fittings
SAE J513, Rev. January 1999, Refrigeration Tube Fittings—General Specifications

ISO 263, ISO inch screw threads — General plan and selection for screws, bolts and nuts — Diameter range 0.06 to 6 in

ISO 898-1:1999, Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs ISO 9453, Soft solder alloys — Chemical compositions and forms
ISO 9712, Non-destructive testing — Qualification and certification of personnel
ISO 12807, Safe transport of radioactive material – Leakage testing on packages
Note For the purpose of this International Standard, ANSI N14.5-1997, Leakage tests on packages for shipment, may be used in lieu of ISO 12807

IAEA Transport Regulations (Regulations for the Safe Transport of Radioactive Materials - Edition applicable at the time of publication of this standard)

EN 10025:1990, Hot rolled products of non-alloy structural steels — Technical delivery conditions
EN 10025:1990/A1:1993, Amendment 1
EN 10028-3:2003 Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized
EN 10088-2:1995, Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes

Note 1 Codes and standards with corresponding versions using metric units may be used interchangeably.

Note 2 With respect to this International Standard, American Society of Mechanical Engineers (ASME) material and filler metal specifications, identified by the prefix “S,” are interchangeable with corresponding ASTM International (ASTM) and American Welding Society (AWS) specifications referenced herein.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the IAEA Transport Regulations and the following apply.

Note 1 Throughout this International Standard, the word *shall* denotes a requirement; the word *should* denotes a recommendation; the word *may* denotes a permission, neither a requirement nor a recommendation.

Note 2 Units are those of the International System, with other units shown in brackets for information.

Note 3 Throughout this International Standard, the words *suggested* and *typical* denote an example for weld constructions, dimensions and/or layout, and means that other solutions may be used provided they comply with the requirements in the Code and this International Standard, as appropriate.

Note 4 Throughout this International Standard, the words *nominal* and *Schedule* qualify a thickness of a material from stock (plate, bar, pipe, etc.), for which the tolerance is according to the standard specification for the relevant material.

3.1
authorized inspector
individual who is qualified by the jurisdictional / inspection authority

3.2
clean and washed out cylinder
cylinder that has been previously used and has been cleaned to remove residual quantities of uranium and other contaminants ; any material left behind on the inside surface of the cylinder after the cleaning operation shall:

a. not obstruct the internal examination as required in 5.4.2.2-1 of this standard,
b. not influence the quality and chemical purity of the next UF_6 fill, and
c. not react with UF_6

This definition should not be confused with the category of empty packaging classified under UN 2908 in IAEA Transport Regulations

3.3
code or “the Code”
pressure vessel code that is acceptable to the competent authority; Section VIII of ANSI/ASME Boiler and Pressure Vessel Code is an example

3.4
competent authority
national or international regulatory body or authority designated or otherwise recognized as such for any purpose in connection with this International Standard

3.5
competent inspector
individual who is qualified according to the owner’s requirements regarding inspection activities as detailed in its quality assurance program

3.6
cylinders
common term used to refer to the packagings defined by this standard

3.7
fabricator
manufacturer, repairer, or modifier of cylinders

3.8
heel
residual amount of UF_6 and/or nonvolatile reaction products in excess of the tare

3.9
heeled cylinder
a cylinder containing a heel in quantities equal to or less than those specified in Table 8 in this document.

This definition should not be confused with the category of empty packaging classified under UN 2908 in IAEA Transport Regulations

3.10
jurisdictional / inspection authority
entity with the power, right, or authority to interpret and enforce laws, rules, or ordinances pertaining to the Code

3.11
licensee-user
person or organization that is authorized to conduct activities under a license issued by a competent authority

3.12
minimum design metal temperature (MDMT)
minimum value of design metal temperature at the maximum value of cylinder design pressure to meet the Code requirements

3.13
maximum allowable working pressure (MAWP)
maximum value of cylinder design internal gauge pressure at the maximum value of cylinder design temperature

3.14
maximum allowable external working pressure (MAEWP)
maximum value of cylinder design external gauge pressure difference at the maximum value of cylinder design temperature

3.15
new cylinder
cylinder that has been cleaned to remove fabrication debris and contaminants that would react with UF_6 and that has never been filled with UF_6

3.16
owner
individual, agency, contractor, company, or corporation that carries or will carry title to the packaging during its use

3.17
outer protection
mechanical and / or thermal protection for cylinders containing UF_6, during transport

3.18
service life
period of time from initial cylinder acceptance of any radioactive material until the cylinder is no longer suitable for transport of UF_6, in accordance with this International Standard.

3.19
tare
cylinder mass with valve(s), including cap(s), and plug(s) without valve protector with an internal air or nitrogen total pressure corrected to 34,5 kPa (5 lbf/in^2)

Note 1 The tare, colloquially designated tare weight, is denominated in kilograms (pounds).

Note 2 The tare is established before the new cylinder is placed in service and after each five-year periodic inspection

4 Management system

The licensee-user shall have a management system that meets the applicable requirements of the competent authorities, for the manufacture, maintenance, repair, and use of the packaging. Certain quality related activities may be satisfied by obtaining certificates from packaging suppliers (fabricators) stating that their activities were conducted in accordance with a quality management system that meets the requirements of the competent authorities.

Fabricators shall be notified concerning their contribution to the above quality management system.

5 General requirements for cylinders

UF_6 shall be packaged for transport in cylinders meeting the manufacture, inspection, testing, and certification and service requirements of this International Standard.

When shipped, all UF_6 packages shall incorporate a feature, such as a seal that, while intact, shall provide assurance that the cylinder has not been illicitly opened. This also applies when shipping new and clean and washed out cylinders.

5.1 Design of cylinders

Cylinders shall:.

- be as shown in the Figures 3 through 11, and be in accordance with the requirements specified in 6.1 through 6.9 of this International Standard,

and

- comply with the Code.

In order to minimize points of leakage, only one valve and one plug (where applicable) should be installed. However, if the purchaser deems additional valves or plugs necessary, they shall be installed in accordance with the requirements specified in 6.3 through 6.9.

Lifting lugs shall be:

- as shown in Figure 10, and in accordance with the requirements specified in 6.8 of this International Standard; additional holes or slots may be provided in lifting lugs (e.g., for tie-down) and shall be dimensioned such that the fitness for purpose of the lifting lug is not impaired,

or

- designed, using an appropriate safety factor, to allow the gross mass of the cylinder to be lifted and restrained during transport.

Additional holes in skirts are permitted and shall be designed such that the fitness for purpose of the package is not impaired.

Details of cylinder (including skirts, stiffening rings, lifting lugs), valve, plug, and valve protector, as applicable, are given in Figures 1 through 16.

Threads identified in this International Standard shall conform to ISO 263, unless otherwise specified in this International Standard.

Metric units shown in this International Standard may have been converted from Imperial units. Rounding of values is acceptable when not in conflict with the functional specification.

5.1.1 Design conditions

The parameters given in Table 1, along with the values for the minimum volume shown in Table 4, shall be the basis by which the pressure vessel parts of the various cylinders are designed.

Table 1 - UF_6 cylinder design conditions

Cylinder model	Clause	Design pressure / temperature		
		MAEWP	MAWP	MDMT
1S	6.1	172 kPa gauge (25 lbf/in² gauge)	1,38 MPa gauge at 121 °C (200 lbf/in² gauge at 250 °F)	-196 °C at 1,38 MPa gauge (-320 °F at 200 lbf/in² gauge)
2S	6.2			
5B	6.3			
8A	6.4			
12B	6.5			
30B	6.6	172 kPa gauge (25 lbf/in² gauge)	1,38 MPa gauge at 121 °C (200 lbf/in² gauge at 250 °F)	-29 °C at 1,38 MPa gauge (-20 °F at 200 lbf/in² gauge)
30C	6.7			
48X and 48Y	6.8			

Note The requirements regarding the behaviour at low temperature which are included in the transport regulations shall also be taken into account.

5.2 Fabrication of cylinders

5.2.1 General

Cylinders shall be fabricated and stamped in accordance with the Code.

Longitudinal seam, head-to-shell girth seams, skirts, stiffening rings, lifting lugs, etc., shall be welded as shown in the relevant figures. Fillet welds shall be in accordance with 5.24 of ANSI/AWS D1.1 and the Code. All butt welds shall be full penetration unless otherwise specified. Longitudinal skirt welds shall be away from lifting holes, holes for valve protector alternate and weep holes. Circumferential cylinder seams should be welded without backing rings. Optionally, circumferential cylinder seams may be welded with backing rings, as shown in Figure 1.

All welders and welding procedures (brazing included) shall be qualified in accordance with the Code.

Where couplings are to be installed in cylinders, an appropriately sized National Pipe Thread (NPT) plug shall be inserted into the coupling for the purposes of the coupling being welded into the cylinder. After welding is completed, the coupling should be allowed to cool before removal of the plug. The coupling threads shall be inspected following removal of the plug. Tapped threads shall be free of all burrs, gouges, scratches, and the like. An appropriate sized NPT tap shall be used for a light chase only. Prior to installing a valve or plug, the coupling shall be gauged to assure compliance with ANSI/ASME B.1.20.1.

Where the material of construction is steel per 5.7, Table 4, at least one test weld representing each welding procedure to be used in the fabrication of the cylinder shall be Charpy V-notch impact tested. Test plates, including those for the appendages, shall have butt-type weld joints. The weld metal specimens shall be taken across the weld with the notch in the weld metal. Each specimen shall be oriented so that the notch is normal to the surface of the material, and one face of the specimen shall be within 1,6 mm (1/16 in) of the surface of the material. Each weld procedure shall be qualified with impact testing. This testing shall be as specified by the Code utilized for the material being welded. Acceptance criteria shall be in accordance with the grade of steel to be used in fabrication of the cylinder. Procedures and qualifications shall be documented as required by the Code. The fabricator shall receive the purchaser's formal acceptance of the test results prior to cylinder fabrication.

5.2.2 Radiography and other non-destructive examinations (NDEs)

All NDE personnel shall be certified in accordance with ISO 9712 or equivalent and inspections shall be carried out using Code-compliant procedures. The weld imperfections indicated by NDEs shall not exceed the defects permitted by the Code.

Radiography is applicable for 5B, 8A, 12B, 30B, 30C, 48X and 48Y cylinders, in accordance with the appropriate section of the Code.

For 5B, 8A, 12B, 30B, 48X and 48Y cylinders, the minimum number of spot X-ray examinations for each cylinder shall be as required by the Code. Unless otherwise directed by an authorized inspector, the locations of spots shall be as follows:

1. 5B cylinders: at the circumferential head-to-shell weldment, alternating ends for successive cylinders.

2. 8A, 12B, 30B, 48X, and 48Y cylinders: at the junctions of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders.

Alternatively (for the purpose of 5.4.2.2), for 30B, 48X and 48Y cylinders without backing bars, the following may be required:

- complete (100%) radiography of the longitudinal seam and the head-to-shell girth seams for each cylinder, and
- additional magnetic particle (MP) or liquid penetrant (PT) testing of shell longitudinal seam, head-to-shell girth seams, skirt-to-head girth seams, valve and plug coupling welds.

The stiffening ring butt welds shall be examined to ensure full weld penetration. Any weld defects shall be repaired.

The welds of the lifting lugs shall be subjected to appropriate NDEs.

For 30C cylinders, the following shall be required:

- complete (100%) radiography of the longitudinal seam and the head-to-shell girth seams for each cylinder shall be required, and
- additional MP and PT testing of other welds (as listed above for the 30B, 48X and 48Y cylinders) and valve protector cover (VPC) assembly welds.