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Nuclear energy — Packaging of uranium hexafluoride (UF_6) for transport

Énergie nucléaire — Emballage de l'hexafluorure d'uranium (UF_6) en vue de son transport

Reference number
ISO 7195:2005(E)

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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 second edition cancels and replaces the first edition (ISO 7195:1993), which has been technically revised.

Introduction

The packaging of uranium hexafluoride (UF_6) for transport is an essential operation in the nuclear industry. The United States Standard ANSI N14.1 (first issued in 1971) has been used internationally as an accepted procedure for packaging UF_6, and the standard cylinders and protective packages included in ANSI N14.1 have been used widely as accepted designs 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 has been developed from and is based on ANSI N14.1, but with incorporation of, and allowance for, other equivalent technical solutions and national authorization and certification procedures. IAEA recommendations relevant to UF_6 have also been taken into consideration. ISO 7195 was first issued in 1993 and the revision process started in 1998.

This International Standard specifies the internationally accepted guidelines and procedures for packaging of UF_6 for transport. It does not relieve the consignor from compliance with the relevant transport regulations for dangerous goods of each of the countries through or into which the material is transported.

This International Standard is consistent with, but does not replace, the recommendations of the International Atomic Energy Agency contained in IAEA Safety Standards Series No. TS-R-1:1996 (as revised 2003). Quoting from the Introduction to these Regulations,

"The objective of these Regulations is to protect persons, property and the environment from the effects of radiation during the transport of radioactive material. Protection is achieved by requiring containment of the radioactive contents, control of external radiation levels, prevention of criticality and prevention of damage caused by heat. These requirements are satisfied firstly by applying a graded approach to contents limits for packages and conveyances and to performance standards applied to package designs depending upon the hazard of the radioactive contents. Secondly, they are satisfied by imposing requirements on the design and operation of packages and on the maintenance of packagings, including a consideration of the nature of the radioactive contents. Finally, they are satisfied by requiring administrative controls including, where appropriate, approval by competent authorities."

In addition, due to the chemical risks associated with UF_6, there are special requirements for packages containing this material.

It should be noted that the IAEA Regulations form the essential basis of regulations for international transport (Agreement for the safe transport of dangerous goods by rail, RID; European agreement for the safe transport of dangerous goods by road, ADR; International maritime dangerous code, IMDG; and Technical instructions for the safe transport of dangerous goods by air issued by the International Civil Aviation Organization, ICAO) that accordingly form the basis for national regulations. There are nevertheless minor differences in practice in the various countries. However, these minor differences are not considered significant in relation to this International Standard and do not affect the guidelines stated. Individual countries may issue national standards for packaging of UF_6 for transport, for which this International Standard can form the basis. This International Standard does not take precedence over applicable governmental regulations.

This International Standard presents information on UF_6 cylinders, valves, protective packages and shipping. However, it should be emphasized that this information has been derived from widespread practical applications and is therefore the result of international experience. As this experience grows, improved designs of cylinders and valves may come forward. Improvements shall be subject to approval by competent authorities. Authorized improvements may be considered for incorporation in this International Standard on the occasion of future revisions. Annex A of this International Standard is provided for information.

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, if the original type identification of a cylinder is based on its size, the imperial units are maintained (e.g. 48” cylinder, 48Y, 30B, etc.). 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 — Packaging of uranium hexafluoride (UF_6) for transport

1 Scope

This International Standard specifies requirements for packaging of uranium hexafluoride (UF_6) for transport.

It applies to

- packages designed to contain uranium hexafluoride in quantities of 0,1 kg or more,
- design, manufacture, inspection and testing of new cylinders and protective packagings,
- maintenance, repair, inspection and testing of cylinders and protective packagings,
- in-service inspection and testing requirements for cylinders and protective packagings.

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 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 12807, *Safe transport of radioactive materials — Leakage testing on packages*

IAEA Safety Standards Series No. TS-R-1, *Regulations for the Safe Transport of Radioactive Materials, 1996 Edition (as revised 2003)*

ANSI/ASME B1.1:2003, *Unified Inch Screw Threads, UN and UNR Thread Form*

ANSI/ASME B1.20.1:1983 (R2001), *Pipe Threads, General Purpose, inch*

ANSI/ASME B16.11:2001, *Forged Steel Fittings, Socket-Welding and Threaded*

ANSI/AWS A5.8/A5.8M:2004, *Specification for Filler Metals for Brazing and Braze Welding*

ANSI/AWS A5.14/A5.14M:1997, *Specification for Nickel and Nickel Alloy Bare Wire Electrodes and Rods*

ANSI/A5.18:1993, *Specification for Nickel and Nickel Alloy Bare Wire Electrodes and Rods*

ANSI/CGA V-1:2003, *Compressed Gas Cylinder Valve Outlet and Inlet Connections*

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*

ASTM A20/A20M-B:2004a, *Standard Specification for General Requirements for Steel Plates for Pressure Vessels*

ASTM A36/A36M:2004, *Standard Specification for Carbon Structural Steel*

ASTM A53/A53M:2004a, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A105/A105M:2003, *Standard Specification for Carbon Steel Forgings for Piping Applications*

ASTM A106/A106M:2004b, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A108:2003, *Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished*

ASTM A131/A131M:2004ae1, *Standard Specification for Structural Steel for Ships*

ASTM A240/A240M:2004, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

ASTM A285/A285M:2003, *Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength*

ASTM A516/A516M:2004, *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service*

ASTM A575/A575M:1996 (2002), *Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades*

ASTM B16/B16M:2000, *Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines*

ASTM B32:2004, *Standard Specification for Solder Metal*

ASTM B127:1998, *Standard Specification for Nickel-Copper Alloy Plate, Sheet, and Strip*

ASTM B150:1998, *Standard Specification for Aluminum Bronze Rod, Bar, and Shapes*

ASTM B160:1999, *Standard Specification for Nickel Rod and Bar*

ASTM B161:2003, *Standard Specification for Nickel Seamless Pipe and Tube*

ASTM B162:1999, *Standard Specification for Nickel Plate, Sheet, and Strip*

ASTM B164:2003, *Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire*

ASTM B165:1993 (2003)e1, *Standard Specification for Nickel-Copper Alloy Seamless Pipe and Tube*

ASTM B366:2004, *Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the IAEA Safety Standards Series No. TS-R-1:1996 (as revised 2003), Section II, 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.

3.1
clean cylinder
new cylinder that has been cleaned to remove oil and other manufacturing debris, or a cylinder that, after contact with UF_6, has been decontaminated to remove residual quantities of uranium and other contaminants

3.2
effective threads
threads that are capable of providing reasonable engagement in mating threads; the first effective thread at a runout begins one thread length below the runout scratch

3.3
empty cylinder
cylinder containing a heel in quantities equal to or less than those specified in Table 1

Table 1 — Maximum mass and enrichment limits of heel for empty cylinders

Cylinder type	Maximum heel mass kg (lb)	Maximum enrichment g ^{235}U/100 g U
5B	0,045 (0,1)	100
8A	0,227 (0,5)	12,5
12B	0,454 (1,0)	5,0
30B	11,4 (25,0)	5,0
48X	22,7 (50,0)	4,5
48Y	22,7 (50,0)	4,5
48G	22,7 (50,0)	1,0

3.4
heel
residual amount of UF_6 and non-volatile reaction products of uranium, uranium daughters and (if the cylinder has contained irradiated uranium) fission products and transuranic elements

3.5
maximum allowable working pressure
MAWP
maximum value of cylinder design gauge pressure (rounded up to two significant figures) at the maximum value of cylinder design temperature

3.6
minimum design metal temperature
MDMT
minimum value of design metal temperature at the maximum value of cylinder design pressure to meet ASME Code requirements

3.7
protective packaging
outer packaging or device used to provide additional protection to a cylinder during transport

3.8
qualified inspector
pressure-vessel inspector who has a demonstrated level of expertise relevant to the task being undertaken and designated or otherwise recognized as such for any purpose in connection with satisfying the national pressure-vessel code requirements

3.9
tare
as-built cylinder mass without valve protector with an internal air or nitrogen total pressure of 34,5 kPa (5 lbf/in^2)

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

4 Quality assurance

4.1 General

Quality assurance programmes [see IAEA TS-R-1:1996 (as revised 2003), paragraph 310] shall be established for the design, manufacture, testing, documentation, use, maintenance and inspection of UF_6 packagings and for transport and in-transit storage operations to ensure conformity to the regulations and/or particular provisions of the competent national authorities. Where the term “quality assurance programme” is used in this International Standard it can be related or equated to a “Quality management system/programme” as recommended by ISO 9000. If competent authority approval for design or shipment is required, this will take into account and be contingent upon the adequacy of the quality assurance programme. Certification that the design specifications have been fully implemented shall be available to the competent authority. The manufacturer, owner, consignor, consignee or shipper of any package design shall be prepared to provide facilities for competent authority inspection of the packaging during construction and use and to demonstrate to any cognizant competent authority

— that the construction methods and materials used for the construction of the packaging conform to the approved design specifications, and

— that all packagings built to an approved design are periodically inspected, and as necessary, repaired and maintained in good condition so that they conform to all relevant requirements and specifications, even after repeated use.

NOTE The IAEA safety standard series TS-G-1.1:1996[3], Appendix IV, provides advice on acceptable ways of achieving and demonstrating compliance with the quality assurance criteria from package fabrication to transport usage.

4.2 Procedures

The manufacturer or repairer of packaging shall establish and maintain written quality control procedures for materials and components procurement, manufacture, repair, cleaning, inspection and testing to ensure that the finished product conforms to this International Standard. The quality assurance programme shall be acceptable to the competent authority (but prior approval is not necessarily a requirement of the competent authority), and shall be provided to the customer or buyer and should conform to recognized standards such as ISO 9001.

The procedures may consist of, or be based upon, the manufacturer’s written specifications for similar work or should be developed in accordance with specifications for cylinder manufacture.

4.3 Approval

The manufacturer, repairer or servicing agent shall, prior to the manufacturing, repairing or servicing process, submit for purchaser approval, copies of all relevant proposed procedures. Any proposed changes to such procedures shall be agreed and approved in writing by the purchaser before being introduced during manufacture, repair or servicing.

The manufacturer, repairer or servicing agent shall notify the purchaser in advance of the start of the manufacturing, repair or servicing process to allow the purchaser or the purchaser's representative to witness initial production, repair or any other agreed aspect of the subject process. The purchaser or the purchaser's representative shall be granted access to the manufacturing, repair or servicing facilities at any reasonable time to verify that all purchasing requirements, including applicable approved procedures, are being implemented.

Appropriate records, within the applicable quality assurance programme, shall be established and maintained by the manufacturer, repairer, servicing agent or purchaser to confirm compliance with all applicable purchasing requirements and the requirements of this International Standard.

5 General requirements for packagings

5.1 General

Cylinders (see Clauses 6 and 7) and protective packagings (see Clause 8) individually and in combination are examples of packaging and they shall therefore conform to this clause.

UF_6 shall be packaged for transport in cylinders meeting the manufacture, inspection, testing, certification and service requirements of this International Standard and may be shipped in protective packagings meeting the requirements of IAEA TS-R-1.

5.2 Design requirements

Packages shall be designed in accordance with the requirements of this International Standard and so that normal hazards of handling do not damage the package and reduce the effectiveness of containment. Package and packaging designs shall conform to IAEA TS-R-1:1996 (as revised 2003), paragraph 629. Competent authority approval shall be obtained prior to shipment as required in IAEA TS-R-1:1996 (as revised 2003), paragraph 802.

Tie-down arrangements shall be designed, as a minimum, to withstand the stresses due to accelerations or decelerations which occur during normal transport (see Table 2). Additionally, package acceleration factors to be applied shall be determined by reference to national and international transport modal standards and regulations. Tie-down design shall use the worst-case scenario, recognizing, as appropriate, the potential for ambiguity of designation of longitudinal and lateral directions.

Table 2 — Minimum acceleration/deceleration values for tie-down arrangements

Mode of transport	Minimum acceleration/deceleration values to be withstood by tie-down arrangements m/s^2		
	Longitudinal	Lateral	Vertical
Road	20	10	± 10
Rail	20	10	± 10
Water	20	10	± 20
Air	30	15	± 30
Standard acceleration due to gravity ≈ 10 m/s^2.			

5.3 Design certification

Competent authority approval shall be obtained for packages designed to contain 0,1 kg or more of UF_6 [see IAEA TS-R-1:1996 (as revised 2003), paragraph 802 (a) (iii)]. Approved packages shall be marked with the identification mark assigned by the competent authority and indicated on the approval certificate [see IAEA TS-R-1:1996 (as revised 2003), paragraph 538 (a)].

5.4 Preparation for transport

5.4.1 Physical conditions

UF_6 shall be shipped only in the solid state and when the vapour pressure within the cylinder is below atmospheric [see IAEA TS-R-1:1996 (as revised 2003), paragraph 419].

5.4.2 Security seal

Packaging shall be shipped with a feature (a tamper-indicating device), such as a seal, that is not readily breakable and that, while intact, shall be evidence that the packaging has not been opened.

6 General requirements for cylinders

6.1 Design of cylinders

6.1.1 General

Cylinders shall be designed and fabricated in accordance with a pressure vessel code, of which Section VIII of ANSI/ASME Boiler and Pressure Vessel Code is an example, that is acceptable to the competent authority.

Stiffening rings should be relieved to bridge the shell longitudinal weld and minimize the influence of the heat-affected zones.

Lifting lugs shall be designed, using an appropriate safety factor, to allow the gross mass of the cylinder to be lifted and restrained during transport (see 5.2) using two diagonally opposed cylinder lifting lugs loaded perpendicular to their lifting/tie-down plane. Cylinders fitted with lifting lugs and containing more than heel quantity of material shall be handled using a four-point attachment. Additional holes or slots may be provided in lifting lugs, e.g. for tie-down, and shall be designed such that the fitness for purpose of the lifting lug is not impaired.

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

Unless otherwise specified, threads identified in this International Standard shall conform to ISO 263.

Cylinders shall be marked as specified in Clause 7.

In all cases, for transport approval, compliance with the requirements of IAEA TS-R-1:1996 (as revised 2003), paragraphs 629 to 632, as applicable, is mandatory.

6.1.2 Maximum allowable working pressure

The pressure-containing portion of the cylinder shall be designed to withstand the pressure rating specified in Clause 7 for the type of cylinder. The design shall provide a strength margin of at least 10 % between the maximum stress reached when the cylinder is hydrostatically tested at the test pressure specified in 6.2.4.1 and the yield point (or 0,2 % proof stress) of the material used.

During normal operating conditions, the maximum value of the design gauge pressure shall not be exceeded, account being taken of the effects of impurities on the total gas pressure.

6.1.3 Leak-tightness

If valves or pipe plugs are used in addition to those shown on cylinder drawings, they shall be manufactured, prepared, inspected, installed and tested in accordance with the requirements of this International Standard.

Cylinders, valves and pipe plugs shall be leak-tight in accordance with the standard indicated, as demonstrated with equipment able to detect a standardized leak rate of 1×10^{-4} Pa·m^3/s. Detection of leaks shall be made using a suitable test and shall include fittings, connections, valve seat and packing. No detectable leakage shall be permitted. Leakage requirements stated in IAEA TS-R-1 relating to the radioactive-material package category shall also apply.

6.1.4 Maximum allowable temperature range

The pressure-containing portion of the cylinder, its valve and pipe plug shall be able to withstand the service temperature range as specified in Clause 7.

6.1.5 Materials

Materials for cylinder pressure envelopes shall comply with the pressure vessel code and, together with valves and pipe plugs, shall be compatible with UF_6 and shall have chemical and metallurgical properties as specified in Clauses 6 and 7.

6.1.6 Maximum transport fill

Maximum transport-fill limits (see Table 3 for values for existing cylinders) shall conform to IAEA TS-R-1:1996 (as revised 2003), paragraph 419, and be based on liquid UF_6 density at 121 °C (250 °F), 3 257 kg/m^3 (203,3 lb/ft^3), minimum cylinder volume and a minimum UF_6 purity of 99,5 %.

Allowable fill limits for cylinders containing tails with a minimum UF_6 purity of 99,5 % may be higher than the limit shown in Table 3 but shall not result in a free-volume safety margin of less than 5 % of the actual certified volume when the cylinder is at the higher design temperature value. More restrictive allowable fill limits shall be adopted if additional impurities are present.

Cylinders shall not be heated above the design temperature value for the cylinder.

Table 3 — Standard data for UF_6 cylinders

Cylinder type	Minimum wall thickness mm (in)	Minimum volume m^3 (ft^3)	Maximum enrichment g ^{235}U/100 g U	Maximum transport fill kg (lb)
1S	1,59 (1/16)	$1,50 \times 10^{-4}$ ($5,30 \times 10^{-3}$)	100	0,45 (1,0)
2S	1,59 (1/16)	$7,21 \times 10^{-4}$ ($2,55 \times 10^{-2}$)	100	2,2 (4,9)
5B	3,18 (1/8)	$8,04 \times 10^{-3}$ (0,284)	100	24,9 (54,9)
8A	3,18 (1/8)	0,037 4 (1,32)	12,5	115 (255)
12B	4,76 (3/16)	0,067 4 (2,38)	5,0	208 (460)
30B	7,94 (5/16)	0,736 (26,0)	5,0[a]	2 277 (5 020)
48X	12,7 (1/2)	3,084 (108,9)	4,5[a]	9 539 (21 030)
48Y	12,7 (1/2)	4,041 (142,7)	4,5[a]	12 501 (27 560)
48G	6,35 (1/4)	3,936 (139,0)	1,0	12 174 (26 840)

[a] These enrichment percentages require moderation control equivalent to a minimum UF_6 purity of 99,5 %. Without moderation control, the maximum permissible enrichment in ^{235}U shall be 1 g ^{235}U/100 g U.

6.2 Manufacturing process for cylinders

6.2.1 Process

6.2.1.1 General

The manufacturing process for cylinders shall conform to this International Standard and the pressure vessel code requirements as agreed with the cylinder purchaser's competent authority and shall conform to the applicable drawings and specifications. Approval shall be obtained from a qualified inspector.

Couplings, after having cooled from being welded into the pressure envelope and before the valve or pipe plug is inserted, may have a 1 in 11 1/2 NGT or 1 1/2 in 11 1/2 NGT tap, as appropriate, used, if necessary, to lightly chase the threads. Thread forms shall conform to ANSI/CGA V-1. Conformity to specification of the thread and coupling shall be confirmed in accordance with the agreed quality control plan.

6.2.1.2 Welding/brazing

Surfaces to be welded or brazed shall be free from foreign matter (oil, grease, rust, etc.). Interior surfaces of the cylinder shall be inspected and cleaned before closure is effected.

UF_6 cylinder welds and brazes shall be designed such that they conform to the requirements of the pressure vessel code or other code agreed with the competent authority and be formed in accordance with procedures given in the code(s) agreed with the competent authority. Welds detailed in Figures 1, 5 to 8 and 10 to 14 may be taken as typical. All welds shall be full penetration welds unless otherwise specified. Circumferential cylinder seams should be welded without backing rings. Optionally, circumferential cylinder seams may be welded with backing rings, as shown in Figure 1. Welders and brazers shall be qualified to each specific procedure used in cylinder fabrication. Each weld procedure shall be qualified with impact testing. This testing shall be as specified by the pressure vessel code utilized for the material being welded. Procedures and qualifications shall be documented as required by the specified codes.

6.2.1.3 Inspection of welds/brazes

All welds and brazes shall be visually inspected for proper fitting of the joints, full compliance with the previously qualified procedure and absence of imperfections and defects in the finished joints as specified by the pressure vessel code requirements. As a minimum, each cylinder shall be radiographed in accordance with code requirements and shall be spot radiographed at the junction of the longitudinal seam and the circumferential head weld in accordance with code acceptance criteria. Stiffening ring butt welds shall be examined to ensure full weld penetration. The qualified inspector shall examine radiographs.

6.2.2 Cylinder capacity and tare

The manufacturer shall determine the cylinder capacity by completely filling it with water. The mass and temperature of water shall be recorded and shall be accurate to ± 0,1 %. The water capacity, in kilograms (pounds) at 15,6 °C (60 °F), shall be determined and shall be not less than the specified minimum for the cylinder design (see Table 3 or cylinder design parameters).

On completion of the manufacturing process, painting and evacuation of the cylinder, the tare weight, in kilograms (pounds) at the specified internal pressure, shall be determined. The cylinder mass and internal pressure shall be recorded and shall be accurate to ± 0,1 %. The valve protector, if provided, shall not be included in the tare weight.

6.2.3 Cleaning

6.2.3.1 Interior of the cylinders

After hydrostatic testing, the inside of the cylinder shall be inspected and thoroughly cleaned of grease, oil, scale, slag, oxides, dirt, moisture and other foreign matter. The surfaces shall be clean, dry and free of contamination. The cleaning method shall be agreed with the purchaser.

NOTE The cleanliness of UF_6 cylinders is important since UF_6 reacts vigorously with some impurities left from the manufacturing process, particularly hydrocarbon oils.

The cleaning process should involve degreasing with an alkali cleaning solution at between 80 °C and 90 °C (176 °F and 194 °F) followed by a thorough washing with water within the same temperature range. The cylinder should then be blown dry with filtered, oil-free, dry air with a dew-point of – 40 °C (– 40 °F). Drying should be continued until air exhausting from the cylinder has a dew-point of – 35 °C (– 30 °F) or lower.

Other methods of cleaning and drying that achieve the same result may be applied.

6.2.3.2 Exterior of cylinders

The outer surface of the cylinder shall be easily decontaminable. After cleaning the inside of the cylinder and completion of testing, the exterior surface of the cylinder shall be blasted to remove rust, scale, dirt and other foreign matter. Where a protective coating system is to be applied, the cylinder shall be blasted to the protective coating system manufacturer's requirements. A protective coating that should be suitable for service conditions should be applied to the outside of the cylinder and shall be applied in accordance with the coating manufacturer's instructions.

6.2.3.3 Valves

Valves that are procured, cleaned, lubricated and assembled in sealed packages using quality control practices conforming to Clause 4 may be installed in cylinders as received. Otherwise, prior to installation into the cylinder, the valve shall be disassembled and cleaned to remove all traces of machining lubricants, metal chips, oxide film and other foreign substances in accordance with 6.2.3.1.

Prior to re-use, valves that have been removed from cylinders shall be refurbished in accordance with a quality control plan conforming to the requirements of the competent authority and to the drawings and specification of this International Standard.

6.2.4 Testing

6.2.4.1 Hydrostatic testing of cylinders

Cylinders shall be hydrostatically tested. No leakage shall be permitted. The test pressure shall be twice the maximum admissible working pressure, (gauge pressure). The MAWP shall be rounded up to two significant figures. Prior to inspection of the cylinder for leaks, the pressure shall be lowered to 1,5 times the MAWP or to a gauge pressure of 1,38 MPa (200 lbf/in^2 gauge), whichever is the higher. Defects shall be repaired in accordance with the appropriate manufacturing and welding standards within the quality control procedure and as permitted in the relevant code. After being repaired, the cylinder shall then be subjected to a retest in accordance with the original requirements. Packages for transport shall conform to IAEA TS-R-1:1996 (as revised 2003), paragraph 630 (a).

6.2.4.2 Valve and pipe-plug leak test

After installation of the pipe plug and cleaning and installation of the valve, a test air pressure of 690 kPa gauge (100 lbf/in^2 gauge) shall be applied and the fittings, connections and valve seat and packing tested for leaks. Leak detection shall be as specified in 6.1.3. Defects shall be repaired in accordance with the appropriate standards within the quality control procedure and as permitted in this International Standard. After being repaired, the cylinder shall then be subjected to a retest to the original requirements.

Alternative test of equivalent sensitivity as described in ISO 12807 or other standard as authorized by the competent authority may be applied.

6.2.5 Certification

The manufacturer shall certify in writing to the purchaser that cylinders conform to the fabrication, test and cleanliness requirements of this International Standard. The manufacturer shall also provide the following:

a) "as-built" drawings and design calculations;

b) a certified copy of certificates for the materials used in cylinder fabrication and related reports identified against cylinder serial number as follows:

— copies of radiographs properly identified against location information;

— test certificates for chemical analysis and physical tests for each heat of material used in cylinder manufacture;

— copy of completed route sheet certified by a competent official of the manufacturer;

— test certificate for the valve and pipe-plug leak test if the manufacturer has fitted the valve or pipe plug;

— certificate relating to the inspection of welds, brazes and cleaning;

— certificate of the initial test for the cylinder;

— certificate relating to the water capacity of the cylinder.

The manufacturer shall provide evidence that the full weld strength of the stiffening-ring butt welds has been developed (see 6.2.1.3).

Copies of the manufacturer's data report, drawings and certifications shall be retained throughout ownership of the cylinder and for a period following its decommissioning and disposal as required by the cylinder owner's competent authority. Documents shall be transferred with the cylinder upon change of ownership.

6.2.6 Cylinder nameplates

Cylinder nameplates referenced in 7.3.4, 7.4.4, 7.5.4, 7.6.4, 7.7.4, 7.8.4 and 7.9.4 should conform in size and general layout to Figure 2 and shall be marked, as a minimum, with the following information:

— identity of the specification and revision (ISO 7195:2005) to which the cylinder conforms;

— pressure vessel code stamps as appropriate;

— maximum allowable working pressure (MAWP);

— minimum design metal temperature (MDMT);

— minimum design transport temperature;

— model type number;

— manufacturer's name;

— purchaser's name

— purchaser's cylinder serial number;

— water capacity at 15,6 °C;

— maximum fill mass of pure UF_6, in accordance with Table 3;

— month and year of manufacture;

— tare weight;

— date (month and year) of last periodic inspection;

— periodically re-established tare weight (provide four pairs of blank spaces for these periodic data).

The nameplate may be punched with cylinder-specific data in characters that shall be sized in accordance with 7.3.4 or 7.7.4 as specificed and be marked with headings and descriptive text in characters at least 4 mm (5/32 in) high [Figure 2 (a)] or at least 6 mm (1/4 in) high [Figure 2 (b)].

NOTE The requirements of this clause do not remove the requirement for compliance with IAEA TS-R-1 with regard to packaging marking for transport.

6.3 Repair of cylinders

Cylinder repairs shall conform to documented procedures conforming to the requirements of the competent authority. Repairs shall be designed and carried out so that, on completion, the cylinder conforms to the Certificate of Approval of the competent authority. Pressure-envelope welded repairs shall be conducted by organizations holding appropriate qualifications to maintain the relevant code status of the cylinder and shall be referred to the qualified inspector for approval.

Repairs to pressure-containing parts, valves and pipe plugs shall be followed by an appropriate test to demonstrate continuing fitness for purpose in accordance with the requirements of this International Standard.

6.4 Standard UF_6 cylinders

Cylinders manufactured prior to publication of this International Standard shall be acceptable for the purposes of transport provided they

— were designed, manufactured, repaired, inspected and tested in accordance with one or more revision(s) of a standard that remains acceptable to the competent authority,

— are used within their original design limitations,

— are inspected, tested and maintained in accordance with the intent of this International Standard, and

— are acceptable to the competent authority.

6.5 Valve protectors

During shipment of packages, all valves shall be fitted with valve protectors that have been shown to meet the requirements of IAEA TS-R-1 unless

— the cylinders are contained within protective packagings with which the use of a valve protector is not required or permitted by the competent authority, or

— the package design does not incorporate a protective packaging and it has been shown to meet the requirements of IAEA TS-R-1 without a valve protector fitted, and competent authority approval has been granted accordingly.

6.6 Manufacturing process for valves

6.6.1 Process

Manufacturing shall conform to this International Standard and the applicable drawings and specifications. Approval shall be obtained from a qualified inspector.

6.6.2 Material certification

The manufacturer shall furnish mill certification and results of tests to determine the chemical composition, tensile strength, yield strength and hardness of the aluminium bronze materials.

Mill test reports shall be available for each separate lot of material produced by a different mill manufacturing process or of a different size, such as forging stock, as-extruded bar and rolled and tempered (stress-relieved) bar. Mill test reports shall include heat numbers from which the manufactured products were produced. Each pour shall have been analysed for its chemical composition and the results reported.

Nickel-copper alloy stem material shall have a manufacturer's material certification.

6.6.3 Manufacturing and marking requirements

All parts shall conform to the applicable drawing and, additionally, acceptable practices such as deburring and breaking the corners shall be used in machining and finishing of parts. Close control over the manufacture of threaded elements shall be maintained.

The valves specified in 7.1 and in 7.2 shall be manufactured from solid bar stock and shall be etched or similarly permanently marked on the body with a lot number that is traceable to material test certificates.

The valve body specified in 7.10 and in 7.11 shall be forged and shall contain no laps, seams, porosity or other objectionable defects. The seller's name and a forging identification symbol, traceable to the heat number(s) from which the forgings were produced, shall be forged, stamped or engraved into the body. Forgings shall be cleaned either to a bright or matt finish and shall have the die-flash removed. So that surface defects are not masked, no mechanical finishing of the valve body (such as buffing, peening, grinding or blasting) shall be permitted.

Where required by this International Standard, valve components shall be stress relieved for a minimum of 1 h after completion of finish machining at 371 °C ± 5,6 °C (700 °F ± 10 °F) for UNS C63600 [Copper Development Association (CDA)], alloy 636, 593 °C ± 5,6 °C (1 100 °F ± 10 °F) for ASTM B164:2003 material UNS N04400, or 427 °C ± 5,6 °C (800 °F ± 10 °F) for ASTM B150:1998 material UNS C61300 (CDA alloy 61300), or for a minimum of 1,5 h after completion of finish machining at 551,7 ± 5,6 °C (1 025 °F ± 10 °F) for ASTM B164:2003 class A or B material. Surface hardness measurements of the packing nuts after stress relieving shall be made on the top of the nut as shown in the applicable drawing.

6.6.4 Cleaning

If tinning is required, the valve bodies specified in 7.10 and 7.11 shall be degreased prior to tinning. Prior to assembly, all parts, including the valve bodies, shall be cleaned to remove all traces of machining lubricants, metal chips, oxide film and other foreign substances in accordance with 6.2.3.3.

6.6.5 Tinning of the valves specified in 7.10 and 7.11

If tinning is required, prior to assembly, the purchaser may require one valve body out of each fifty be selected at random for shipment without tinning. Valve bodies shall have the inlet thread tinned over its full length with a uniform coating of the solder as specified in Table 5. Thread roots shall be filled approximately half full. Tinning flux shall be suitable for use with the aluminium bronze alloy. The composition of the solder in the pot shall be verified by a test as meeting specification requirements prior to use.

Tinning shall be accomplished by dipping the tapered thread into a pot of solder maintained at the temperature recommended by the solder manufacturer. The tinning temperature range shall be included in the valve manufacturer's procedures. The inlet shall be plugged to prevent entry of solder or flux into the port, or solder and flux entering the port shall be completely removed. The body shall be preheated prior to dipping. Excess solder shall be removed and the valve allowed to cool without quenching before the flux residue is removed. All traces of flux shall be removed.

6.6.6 Assembly of the valves specified in 7.10 and 7.11

Parts shall be assembled as shown in the applicable drawing. Cleanliness control shall be exercised to ensure that parts and assemblies are not contaminated during or after assembly. Care shall be exercised during assembly to avoid damage to the threaded elements and to ensure that all packing parts, including a full complement of packing, are installed. During assembly, a very light coat of fluorinated lubricant shall be carefully applied only to the Acme thread of the stem, the tapered surface of the stem and the packing nut thread; see Figures 15 and 16. No lubricant shall be used on any other component.

After packing parts have been installed and with the valve stem fully closed, the packing nut shall be tightened to compress the packing. Only a six-point socket wrench shall be used to apply or break the torque on the nut. The wrench shall be manually operated. An impact wrench shall not be used. The initial packing compaction shall, as measured by an indicating torque wrench, be within the ranges specified in 7.10.4 or 7.11.4 as applicable.

The maximum torque permitted to tighten or retighten the port cap shall be 68 N·m (50 lbf·ft).

6.6.7 Testing of the valves specified in 7.10 and 7.11

Each valve shall be pressure tested for leak-tightness, as follows.

a) On a test bench or fixture, couple the inlet to a high-pressure source of clean dry nitrogen, oil-free air or air filtered for elimination of oil.

b) Open and close the valve stem twice, using no more than the torque specified in 7.10.4 or 7.11.4 as applicable, to seat the valve. Excessive torque can damage the valves and shall be cause for rejection. An adjustable or indicating torque wrench shall be used.

c) Pressure test for seat leakage at a gauge pressure of 2,76 MPa (400 lbf/in^2 gauge) by bubble bottle, by striking a soap bubble across the face of the valve outlet, or by immersing the valve in water. No leakage shall be permitted. Do not over-torque the valve stem to stop a leak.

d) If no seat leakage is found, bleed off the pressure, cap the outlet securely and open the valve approximately halfway. Pressure test the entire valve to a gauge pressure of 2,76 MPa (400 lbf/in^2 gauge). No leakage shall be permitted past the stem, around the cap or packing nut, or through the body, as determined by application of the soap test solution all over the exterior of the valve or by immersion in water.

CAUTION — Air pressure tests should be applied with extreme caution to prevent personal injury. Raise the pressure slowly to the test pressure. Do not tighten the valve packing nut, cap and body threads with the valve at high pressure. Bleed off the pressure before retightening any components and restore the test pressure slowly. Valve off the air pressure source when the test pressure is attained.

e) If leakage at the stem or at either cap occurs, the corresponding packing or gasket may be retightened (see caution above) and the test repeated. The maximum torque permitted to tighten and retighten the packing nut shall be as specified in 7.10.4 or 7.11.4 as applicable for initial packing compaction and 6.7 for in-service leakage elimination. The maximum torque permitted to tighten or retighten the port cap shall be as specified in 6.6.6. An adjustable or indicating torque wrench shall be used for retorquing. Valves that show leakage at the juncture of the packing nut, cap or coupling threads with the body threads shall be carefully examined for possible porosity in the valve body in the threaded areas. Parts showing any evidence of porosity shall not be used.

f) Valves that fail to pass either pressure test shall be removed from the test fixture and tagged to prevent mixing with valves that pass the test. Valves rejected due to packing leaks or cap gasket leaks may have the packing or gasket replaced and may be retested.

g) Wash soap solution off the valves that pass the test and blow-dry while still coupled to the test fixture.

6.6.8 Packaging

If possible, all valves in one lot shall be sent in a single shipment. Each valve shall be packaged in an individual carton together with a protective packing material to fill the voids in the carton and protect the valve during shipment and handling. Each carton shall be identified with the lot number appearing on the inspection report. Individual valve cartons shall be placed in containers for shipment and a copy of the inspection report shall be placed inside each container. Each container shall be constructed to prevent damage to the contents during shipping and shall be identified with the purchase order number and lot number, in addition to the purchaser’s name and address.

If valves tinned in accordance with 6.6.5 are required and if stipulated by the purchaser, one untinned valve shall accompany each lot of up to fifty valves.

6.6.9 Certification

The manufacturer shall certify in writing that the valves conform to the material, fabrication, test and cleanliness requirements of this International Standard.

6.7 Packing-nut retorquing of the valves specified in 7.10 and 7.11

Following initial valve installation, valves that exhibit a stem leakage shall have the packing nut retorqued to stop the leakage. The torque applied to the packing nut should be the minimum required to stop the leak. 1 in valves that require more than 136 N·m (100 lbf·ft) at room temperature to stop leakage shall not be heated but shall be replaced or repaired using a new packing in accordance with 6.8.

6.8 Refurbishment and reuse of valves

The valves and components specified in 7.10 and 7.11 removed from cylinders may be reused only after refurbishment to ensure that the used valve conforms to this International Standard. During the initial installation test, new valves or newly refurbished valves may have inspection and refurbishment limited to the inlet threads if the valve is removed from the cylinder because of leakage around the inlet threads. Valves that fail to conform to this International Standard in service, shipment or storage shall only be used after complete refurbishment. Packing shall be replaced and all parts inspected for damage. Refurbishment shall be performed in accordance with a documented quality control plan. All valves shall conform to the design requirements of this International Standard, including tinning if specified.

After reinstallation, the valve shall be leak tested in accordance with 6.2.4.2.

The valves specified in 7.1 and 7.2 cannot be refurbished.

7 Specific requirements for cylinders

7.1 1S Cylinder

7.1.1 Design

1S cylinders shall conform to Figure 3 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;

— design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);

— minimum volume: 0,150 l (9,16 in^3).

7.1.2 Materials and manufacture

Materials for the manufacture of 1S cylinders shall conform to the provisions specified in a) to e), unless otherwise authorized by the competent authority.

a) Cylinders shall be manufactured from nickel-copper alloy conforming to ASTM B127, UNS N04400 which may have a Hoke part number 1932001(M), or ASTM B165, UNS N04400 which may have a Hoke part number 4 HSM 150; or from nickel conforming to ASTM B162 which may have a Hoke part number 1932001(N), or ASTM B161.

b) Adaptor A shall be manufactured from nickel conforming to ASTM B160 which may have a Hoke part number 120960-[N]; or nickel-copper alloy conforming to ASTM B164 which may have a Hoke part number 120960-[M]; or from brass conforming to ASTM B16/B16M which may have a Hoke part number 120960-[B].

c) Adaptor B shall be manufactured from nickel conforming to ASTM B160 which may have a Hoke part number 411-17-[N] or nickel-copper alloy conforming to ASTM B164 which may have a Hoke part number 411-17-[M] or brass conforming to ASTM B16/B16M which may have a Hoke part number 411-17-[B], part of a high-vacuum tube union, with a Hoke part number 62076.

d) Valves shall be fabricated from nickel-copper alloy conforming to ASTM B164, UNS N04400, diaphragm-sealed, which may have a Hoke part number 4613 N4M or a Hoke part number 4618 N4M (straight through valves).

e) Filler metal for brazes shall conform to ANSI/AWS A5.8/A5.8M:2004, classification BAg-7 or BAg-8 used with a flux as specified in the qualified brazing procedure.

Cylinder internal surfaces shall be free of cracks, fissures or folds. Smooth ripples as a result of forming may be permitted. If the optional seal ring is provided, no portion of the seal ring shall protrude beyond the cylinder outer diameter.

7.1.3 Valve installation

The valve shall be inspected to assure it is clean prior to installation. Care shall be taken to keep the valve body cool when the adapters are silver-brazed onto the inlet and outlet connections. The valve and connections shall be clean, dry and free of contamination before the valve is installed.

The valve shall be closed to seat the valve using not more than 4,5 N·m (40 lbf·in) torque. The valve stem shall not be over-torqued to stop a leak. An indicating or calibrated pre-set type torque wrench shall be used for valve closure.

7.1.4 Cylinder markings

The following data shall be etched or similarly permanently marked on the valve end of the cylinder using 3 mm (1/8 in) characters:

— manufacturer's identification;

— maximum allowable working pressure (MAWP);

— minimum design metal temperature (MDMT);

— model 1S;

— purchaser's name;

— purchaser's serial number;

— maximum fill mass of pure UF_6 in accordance with Table 3;

— month and year of manufacture.

Care shall be taken to prevent cylinder deformation when stamping data on the cylinder.

7.2 2S Cylinder

7.2.1 Design

2S cylinders shall conform to Figure 4 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;

— design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);

— minimum volume: 0,721 l (44 in^3).

7.2.2 Materials and manufacture

Materials for the manufacture of 2S cylinders shall conform to 7.2.2 a) to 7.2.2 c) unless otherwise authorized by the competent authority.

a) Cylinders shall be made from materials as specified in 7.1.2 a), which may have a Hoke part number 6S1933-725-[M] or a Hoke part number 6S1447-727-1 or a Hoke part number 8 HSM 1000 or a Hoke part number 6S1933-725-[N] respectively.

b) Adaptors, filler metal and flux shall be in accordance with 7.1.2 b), c) and e), which may have a Hoke part number 120953-[N] or a Hoke part number 120953-[M] or a Hoke part number 120953-[B].

c) Valves shall be in accordance with 7.1.2 d) or shall be fabricated from nickel-copper alloy, ASTM B164, UNS N04400, diaphragm-sealed, which may have a Hoke part number 4628 N4M or a Hoke part number 4623N4M (angle valves).

Cylinder internal surfaces shall be free of cracks, fissures or folds. Smooth ripples as a result of forming may be permitted.

7.2.3 Valve installation

The valve shall be inspected to assure it is clean prior to installation. Care shall be taken to keep the valve body cool when the adapters are silver-brazed onto the inlet and outlet connections. The valve and connections shall be clean, dry and free of contamination before the valve is installed.

7.2.4 Cylinder markings

Cylinder markings shall conform to 7.1.4.

7.3 5B Cylinder

7.3.1 Design

5B cylinders shall conform to Figure 5 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;

— design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);

— minimum design transport temperature: – 40 °C (– 40 °F);

— minimum volume: 8,040 l (491 in^3).

7.3.2 Materials and manufacture

7.3.2.1 General

Materials for manufacture of 5B cylinders shall conform to 7.3.2.2 to 7.3.2.6 unless otherwise authorized by the competent authority.

7.3.2.2 Pressure envelope

a) Shells shall be manufactured from nickel pipe conforming to ASTM B161.

b) Heads shall be semi-ellipsoidal with 2:1 axis ratio, manufactured from nickel weld cap conforming to ASTM B366:2004, grade WPN.

c) Foot, neck and support rings shall be manufactured from nickel-copper alloy conforming to ASTM B165.

d) Filler metal for welds shall conform to ANSI/AWS A5.14/A5.14M:1997 (ERNi-1, ERNiCu-7).

e) Couplings shall be “3/4 in 3 000 lb” half-couplings conforming to ANSI/ASME B16.11 made from nickel conforming to ASTM B160 or ASTM B161 with a 3/4-in 14 NGT threaded socket.

f) Filler metal for brazes shall conform to ANSI/AWS A5.8:2004, classification BAg-7.

Couplings shall be contoured to be flush or concave to head inner surface.

7.3.2.3 Valve protection

Valve protector caps shall be manufactured from carbon steel pipe conforming to ASTM A53/A53M:2004a, grade B, carbon steel plate conforming to ASTM A285/A285M:2003, grade C, and carbon steel rod conforming to ASTM A575/A575:1996(2002), grade 1008-1020.

7.3.2.4 Nameplate

Nameplates shall be manufactured from nickel-copper alloy conforming to ASTM B127:1998.

7.3.2.5 Handles

Handles shall be manufactured from nickel-copper alloy rod conforming to ASTM B164:2003, class A.

7.3.2.6 Dip pipe and tab

Dip pipes shall be manufactured from nickel-copper alloy conforming to ASTM B165.

Dip pipe tabs shall be manufactured from nickel-copper alloy conforming to ASTM B127.

7.3.3 Valve installation

The valve shall be inspected and installed in accordance with 7.10.5. The dip pipe shall be brazed to the valve as shown in Figure 5.

7.3.4 Cylinder nameplate

The cylinder nameplate shall conform to 6.2.6. Cylinder-specific data may be punched on the cylinder nameplate in characters that shall be at least 7 mm (9/32 in) high.

7.4 8A Cylinder

7.4.1 Design

8A cylinders shall conform to Figure 6 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

- design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;
- design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);
- minimum design transport temperature: – 40 °C (– 40 °F);
- minimum volume: 0,037 4 m^3 (1,32 ft^3).

7.4.2 Materials and manufacture

7.4.2.1 General

Materials for manufacture of 8B cylinders shall conform to 7.4.2.2 to 7.4.2.5 unless otherwise authorized by the competent authority.

7.4.2.2 Pressure envelope

a) Shells, semi-ellipsoidal heads with 2:1 axis ratio with 50 mm (2 in) straight flange, foot and head rings shall be manufactured from nickel-copper alloy plate conforming to ASTM B127.

b) Neck rings, filler metal for welds, couplings and filler metal for brazes shall conform to 7.3.2.2.

Couplings shall be contoured to be flush or concave to head inner surface.

7.4.2.3 Valve protection

Valve-protector caps shall conform to 7.3.2.3.

7.4.2.4 Nameplate

Nameplates shall conform to 7.3.2.4.

7.4.2.5 Dip pipe and tab

Dip pipes and tabs shall conform to 7.3.2.6.

7.4.3 Valve installation

The valve shall be inspected and installed in accordance with 7.10.5. The dip pipe shall be brazed to the valve as shown in Figure 6.

7.4.4 Cylinder nameplate

Cylinder nameplates shall conform to 7.3.4.

7.5 12B Cylinder

7.5.1 Design

12B cylinders shall conform to Figure 7 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

- design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;
- design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);
- minimum design transport temperature: – 40 °C (– 40 °F);
- minimum volume: 0,067 4 m^3 (2,38 ft^3).

7.5.2 Materials and manufacture

7.5.2.1 General

Materials for manufacture of 12B cylinders shall conform to 7.5.2.2 to 7.5.2.4 unless otherwise authorized by the competent authority.

7.5.2.2 Pressure envelope

a) Shells, heads and foot and head rings shall conform to 7.4.2.2.

b) Neck rings, filler metal for welds, couplings and filler metal for brazes shall conform to 7.3.2.2.

Couplings shall be contoured to be flush or concave to head inner surface.

7.5.2.3 Valve protection

Valve-protector caps shall conform to 7.3.2.3.

7.5.2.4 Nameplate

Nameplates shall conform to 7.3.2.4.

7.5.2.5 Dip pipe and tab

Dip pipes and tabs shall conform to 7.3.2.6.

7.5.3 Valve installation

The valve shall be inspected and installed in accordance with 7.10.5. The dip pipe shall be brazed to the valve as shown in Figure 7.

7.5.4 Cylinder nameplate

Cylinder nameplates shall conform to 7.3.4.

7.6 30B Cylinder

7.6.1 Design

30B cylinders shall conform to Figure 8 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

— design gauge pressure:	172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;
— design temperature:	– 29 °C to 121 °C (– 20 °F to 250 °F);
— minimum design transport temperature:	– 40 °C (– 40 °F);
— minimum volume:	0,736 m^3 (26,0 ft^3).

7.6.2 Materials and manufacture

7.6.2.1 General

Materials for manufacture of 30B cylinders shall conform to 7.6.2.2 to 7.6.2.4 unless otherwise authorized by the competent authority.

7.6.2.2 Pressure envelope

a) Shells shall be manufactured from code-approved steels and may be of normalized steel conforming to ASTM A516/A516M:2004, grade 55, 60, 65 or 70, meeting heat treatment and supplementary requirements S5, or from coil steel meeting all requirements of ASTM A516/A516M material, or from steel conforming to EN 10028-3:2003, grade P275NL1 or P355NL1.

   If the cylinder shell is fabricated using the spiral weld process, the weld start shall be positioned 50 mm (2 in) below the horizontal centre line.

b) Heads and skirts shall be manufactured from code-approved steels and may be as specified for shells (above), excluding coil material.

c) Seal loops shall be manufactured from steel conforming to ASTM A36/A36M or from steel conforming to EN 10025:1990, grade S235 JRG2/11.

d) Filler metal shall be compatible and code-approved for use with the materials to be joined and may conform to ASME-approved materials, such as ANSI/AWS A5.1/A5.1M:1997, ANSI/AWS A5.17/A5.17M:1997 or ANSI/AWS A5.18/A5.18M:2001.

e) Backing rings shall be manufactured from a code-approved steel and may be as specified for heads and skirts (above) or from normalized steel conforming to ASTM A36/A36M.

f) All shell, head, skirt and backing-ring steel shall be impact tested in conformance with the approved code. ASTM steel shall meet the impact requirements of ASTM A20/A20M for the material and grade. Coil material shall meet impact acceptance criteria for normalized plate of the material and grade.

g) Valve and plug couplings shall be adapted in accordance with Figure 9 from half-couplings that conform to ANSI/ASME B16.11 made from forged steel conforming to ASTM A105/A105M:2003 or ASTM A106-A:2004b, grade C. “1 in 6 000 lb” half-couplings shall have a 1 in 11 1/2 NPT threaded socket and “1 1/2 in 6 000 lb” half-couplings shall have a 1 1/2 in 11 1/2 NPT threaded socket. Thread forms shall conform to ANSI/ASME B1.20.1.

h) Pipe plugs shall be manufactured from upset forged or extruded, or extruded and drawn, aluminium bronze UNS C61300 conforming to ASTM B150:1998, with solid hexagonal head and either 1 in 11 1/2 or 1 1/2 in 11 1/2 NPT threads conforming to ANSI/ASME B1.20.1. After machining, they shall be stress relieved in conformance with 6.6.3.

An effective procedure shall be implemented to ensure that the number of threads engaged can be determined. Acceptable methods include marking the pipe plug head with the number of effective threads, dimensional measurements and ultrasonic monitoring. The actual number of effective threads on the plug shall be punched on the pipe plug head as indicated in Figure 9.

7.6.2.3 Valve Protection

Valve protectors shall be manufactured from weldable carbon steel with a minimum tensile strength of 310 MPa (45 000 lbf/in^2) and a maximum carbon content of 0,26 % or steel conforming to EN 10025:1990, grade S 235 JRG2.

Valve-protector cover positioners (Figure 8) shall, when positioned for welding, be parallel to each other and accurately located on the cylinder. The valve protector may be used as a locating jig.

7.6.2.4 Nameplate

Nameplates shall be manufactured from stainless steel conforming to ASTM A240/A240M-A:2004ae1, type 304 or EN 10088-2 and may be affixed directly to the pressure envelope or to a backing plate welded to the pressure envelope.

7.6.3 Valve and pipe plug installation

Installation and welding of couplings for valves and plugs shall conform to Figure 10.

Valves shall be inspected and installed in accordance with 7.11.5.

Pipe-plug threads shall be tinned with a thin uniform coating of the solder specified in Table 5 prior to installation. The pipe plug shall be installed with a minimum of 5 threads and a maximum of 8 threads engaged in the cylinder coupling. The torque applied for a 1 in coupling shall be between 203 N·m (150 lbf·ft) and 881 N·m (650 lbf·ft) and, for a 1 1/2 inch coupling, shall be between 271 N·m (200 lbf·ft) and 1 803 N·m (1 330 lbf·ft). An indicating torque wrench shall be used for pipe plug installation.

7.6.4 Cylinder nameplate

Cylinder nameplates shall conform to 7.3.4.

7.7 48X Cylinder

7.7.1 Design

48X cylinders shall conform to Figure 11 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

- design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;
- design temperature: – 29 °C to 121 °C (– 20 °F to 250 °F);
- minimum design transport temperature: – 40 °C (– 40 °F);
- minimum volume: 3,084 m^3 (108,9 ft^3).

7.7.2 Materials and manufacture

7.7.2.1 General

Materials for manufacture of 48X cylinders shall conform to 7.7.2.2 to 7.7.2.5 unless otherwise authorized by the competent authority.

7.7.2.2 Pressure envelope

a) Shells shall be manufactured from code-approved steels and may be of normalized steel conforming to ASTM A516/A516M:2004, grade 55, 60, 65 or 70, meeting heat treatment and supplementary requirements S5; or from coil steel meeting all requirements of ASTM A516/A516M material; or from steel conforming to EN 10028-3:1993, grade P275NL1 or P355NL1. Steels shall be made by a practice (with inclusion shape control) to limit the sulfur content to not more than 0,01 %. Shells fabricated using the spiral welding process shall conform to 7.6.2.2.

b) Stiffening rings shall be manufactured from a code approved steels as specified for shells [7.7.2.2 a)], excluding coil material, or may be normalized steel conforming to ASTM A131/A131M:2004ae1, grade E.

   All steel shall conform to the impact test requirements in 7.6.2.2. Shell steel shall be demonstrated to have a minimum transverse impact strength at not more than 65 °C (150 °F) of not less than 64 J (47 ft·lbf) with an average impact strength of at least 75 J (55 ft·lbf).

c) Heads, skirt, seal loops, filler metal, backing rings, couplings and pipe plugs shall conform to 7.6.2.2.

7.7.2.3 Valve Protection

Valve protectors (Figure 16) shall conform to 7.6.2.3 and set screws shall conform to 7.9.2.3. Other valve protectors that comply with the requirements of IAEA TS-R-1 shall conform to the designs approved by the competent authority.

7.7.2.4 Nameplate

Nameplates shall conform to 7.6.2.4.

7.7.2.5 Lifting Lug

Lifting lugs shall conform to Figure 12 and shall be manufactured from steel conforming to ASTM A516/A516M:2004, grade 55, 60 or 65, meeting heat treatment and supplementary requirements S5 or to EN 10028-3:1993, grade P275NL1 or P355NL1.

7.7.3 Valve and pipe-plug installation

Valve inspection and installation and pipe plug preparation and installation shall conform to 7.6.3.

7.7.4 Cylinder nameplates

Cylinder nameplates shall conform to 6.2.6. Cylinder-specific data may be punched on the cylinder nameplate in characters that shall be at least 8 mm (5/16 in) high.

7.8 48Y Cylinder

7.8.1 Design

48Y cylinders shall conform to Figure 13 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;

— design temperature: – 29 °C to 121 °C (– 20 °F to 250 °F);

— minimum design transport temperature: – 40 °C (– 40 °F);

— minimum volume: 4,041 m^3 (142,7 ft^3).

7.8.2 Materials and manufacture

7.8.2.1 General

Materials for manufacture of 48Y cylinders shall conform to 7.8.2.2 to 7.8.2.5 unless otherwise authorized by the competent authority.

7.8.2.2 Pressure envelope

a) Shells and stiffening rings shall conform to 7.7.2.2.

b) Heads, skirt, seal loops, filler metal, backing rings, couplings and pipe plugs shall conform to 7.6.2.2.

7.8.2.3 Valve protection

Valve protectors shall conform to 7.7.2.3.

7.8.2.4 Nameplate

Nameplates shall conform to 7.6.2.4.

7.8.2.5 Lifting Lug

Lifting lugs shall conform to 7.7.2.5.

7.8.3 Valve and pipe-plug installation

Valve inspection and installation and pipe-plug preparation and installation shall conform to 7.6.3.

7.8.4 Cylinder nameplate

Cylinder nameplates shall conform to 7.7.4.

7.9 48G Cylinder

7.9.1 Design

48G cylinders shall conform to Figure 14 unless otherwise authorized by the competent authority and shall be designed as pressure vessels conforming to the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 690 kPa (100 lbf/in^2 gauge) internal;

— design temperature: – 29 °C to 113 °C (– 20 °F to 235 °F);

— minimum design transport temperature: – 40 °C (– 40 °F);

— minimum volume: 3,936 m^3 (139,0 ft^3).

7.9.2 Materials and manufacture

7.9.2.1 General

Materials for manufacture of 48G cylinders shall conform to 7.9.2.2 to 7.9.2.5 unless otherwise authorized by the competent authority.

7.9.2.2 Pressure envelope

a) Shells and stiffening rings shall conform to 7.7.2.2.

b) Heads, skirt, seal loops, filler metal, backing rings, couplings and pipe-plugs shall conform to 7.6.2.2.

7.9.2.3 Valve protection

a) Valve protectors shall conform to 7.6.2.3.

b) Set screws shall be manufactured from carbon steel conforming to ASTM A108:2003, grade 1095 or 1045 or ISO 898-1:1999, grade 8.8 or 10.9.

7.9.2.4 Nameplate

Nameplates shall conform to 7.6.2.4.

7.9.2.5 Lifting lug

Lifting lugs shall conform to 7.7.2.5.

7.9.3 Valve and pipe-plug installation

Valve inspection and installation and pipe-plug preparation and installation shall conform to 7.6.3.

7.9.4 Cylinder nameplate

Cylinder nameplates shall conform to 7.7.4.

7.10 3/4 in Cylinder valve (Type 50)

7.10.1 Design

3/4 in cylinder valves shall conform to Figure 15 and the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;

— design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);

— medium: UF_6.

7.10.2 Materials and manufacture

Materials shall conform to Table 4 unless otherwise authorized by the competent authority.

Dimensions of parts shall conform to Figure 15 and manufacturing shall conform to 6.6.3.

Table 4 — Materials for 3/4 in cylinder valves

Item	Applicable standards
Valve body	Forging, aluminium bronze alloy UNS C63600 (CDA alloy 636)
Port cap	The following are acceptable materials: a) bar aluminium bronze alloy UNS C63600 (CDA alloy 636), stress relieved in accordance with 6.6.3, surface hardness Rockwell B85 to B70, ultimate tensile strength 310 MPa (45 000 lbf/in^2) minimum, yield strength (0,5 % extension) 172 MPa (25 000 lbf/in^2) minimum, elongation in 2 in 30 % minimum; b) nickel-copper alloy conforming to ASTM B164:2003 N04400, stress relieved in accordance with 6.6.3, meeting mechanical properties of ASTM B164 hot-worked, stress relieved material; or c) bar aluminium bronze UNS C61300, stress relieved in accordance with 6.6.3, conforming to ASTM B150:1998 mechanical properties for UNS C61300 stress relieved material.
Packing nut	Acceptable materials are as port cap (above) materials b) or c), treated as specified
Packing follower and packing ring	Acceptable materials are as port cap (above) materials a) and c), treated as specified
Stem	Nickel-copper alloy bar conforming to ASTM B164:2003, class A or B, cold drawn and stress relieved in accordance with 6.6.3
Packing and port cap gasket	Teflon, 100 % virgin TFE unfilled
Fluorinated lubricant	Occidental-Hooker HO-125 or valve-buyer approved equivalent

7.10.3 Tinning

If specified by the purchaser, valve-inlet-thread tinning shall conform to 6.6.5.

7.10.4 Assembly

The valve assembly shall conform to 6.6.6 and this subclause.

The packing-nut torque to initially compress the packing shall be within the range of 136 N·m to 149 N·m (100 lbf·ft to 110 lbf·ft).

The valve shall be closed to seat the valve using not more than 13,6 N·m (10 lbf·ft) torque. The valve stem shall not be over-torqued to stop a leak.

7.10.5 Valve installation

The valve shall be disassembled, cleaned and inspected to ensure that it is clean prior to brazing and installation. The dip pipe shall be brazed to the applicable valve. Valve bodies shall be installed with a minimum of 7 threads and a maximum of 12 threads engaged in the cylinder coupling. An indicating torque wrench shall be used for valve installation. The applicable valve shall be brazed to the dip pipe coupling before the valve is reassembled.

After installation, leak test the valve in accordance with 6.2.4.2.

7.11 1 in Cylinder valve (Type 51)

7.11.1 Design

1-in cylinder valves shall conform to Figure 16 and the following design parameters:

— design gauge pressure: 172 kPa (25 lbf/in^2 gauge) external and 1,38 MPa (200 lbf/in^2 gauge) internal;

— design temperature: – 40 °C to 121 °C (– 40 °F to 250 °F);

— medium: UF_6.

7.11.2 Materials and manufacture

Materials shall conform to Table 5 unless authorized by the competent authority:

Dimensions of parts shall conform to Figure 16 and manufacturing shall conform to 6.6.3.

Table 5 — Materials for 1 in cylinder valve

Item	Applicable Standards
Valve body	As “Valve body”, in Table 4
Port cap	As “Port cap”, in Table 4
Packing nut	As “Packing nut”, in Table 4
Packing follower and packing ring	As “Packing follower and packing ring”, in Table 4
Stem	As “Stem”, in Table 4
Packing and port cap gasket	As “Packing and port cap gasket”, in Table 4
Fluorinated lubricant	As “Fluorinated lubricant”, in Table 4
Solder	Tin-lead shall conform to ASTM B32 or to ISO 9453 and shall have a minimum tin content of 45 %, such as alloy ASTM B32 SN50.

7.11.3 Tinning

The valve inlet thread tinning shall conform to 6.6.5.

7.11.4 Assembly

Valves shall be assembled in accordance with 6.6.6 and this subclause.

After packing parts are installed and with the valve stem fully closed, the packing nut shall be tightened in accordance with 6.6.6 using an initial packing compaction torque in the range of 163 N·m to 203 N·m (120 lbf·ft to 150 lbf·ft) to compress the packing. After the packing is compressed, the top surface of the packing nut shall be flush with, or not more than 2,38 mm (3/32 in) below, the shoulder of the wrench grip of the stem. Variations outside this range indicate improper packing or non-conforming parts and the deficiency shall be corrected.

The valve shall be closed to seat the valve using not more than 74,6 N·m (55 lbf·ft) torque. The valve stem shall not be over-torqued to stop a leak.

7.11.5 Valve installation

The valve shall be inspected to ensure that it is clean prior to installation. The valve shall have a thin uniform coating of the specified solder covering the inlet threads prior to installation in the cylinder. Valve bodies shall be installed with a minimum of 7 threads and a maximum of 12 threads engaged in the cylinder coupling using a minimum of 271 N·m (200 lbf·ft) and a maximum 542 N·m (400 lbf·ft) torque. An indicating torque wrench shall be used for valve installation.

After installation, the valve shall be leak tested in accordance with 6.2.4.2.

8 General requirements for protective packagings

8.1 General

In order to conform to regulatory packaging requirements, an outer protective packaging may be necessary to provide additional protection to a cylinder. The extent of protective packaging depends on the classification of the package. Packages, as presented for transport, shall comply with the requirements in IAEA TS-R-1 for packages containing UF_6.

Because protective packagings are designed to enhance protection against risks, e.g. chemical hazard, explosion, release of activity, criticality incident, due to the cylinder contents, protective packagings shall be properly maintained so that the integrity of the package as a fire- and shock-resistant assembly is ensured. The protective packaging shall be sound and fit for purpose. If the protective packaging provides additional mechanical protection, it shall be provided with a tight seal between the cover and base.

8.2 Fabrication

Manufacturing methods and materials shall conform to design specifications approved by the competent authority. The manufacturer shall fabricate the protective packaging conforming to a Certificate of Approval from the competent authority.

The manufacturer shall provide the purchaser with a certificate for each item of packaging, identified by packaging number, to show that the packaging conforms to the Certificate of Approval of the competent authority.

8.3 Repair

Repairs to protective packagings shall conform to documented procedures in accordance with the requirements of the competent authority. Repairs shall be designed and carried out so that, on completion, the protective packaging conforms to the Certificate of Approval from the competent authority.

Repairs made to protective packagings shall conform to the original approved design so that the certification remains applicable and shall be performed by competent persons.

9 In-service inspections

9.1 Cylinders

9.1.1 Routine operational inspection

All cylinders shall be routinely examined prior to filling, emptying or shipping operations in order to ensure that they remain in a safe, usable condition.

Additionally, 1S and 2S cylinders shall be leak tested (see 6.1.3) prior to each use. During the examination of 1S and 2S cylinders, particular attention shall be given to shell dents and non-destructive detection of possible cap-collar cracks.

Cylinders shall be removed from service (for repair or replacement) if found, on inspection, to contain corrosion, leaks, defective valves or plugs, or other condition that, in the opinion of the qualified inspector, render it unserviceable or unsafe. Repairs and alterations to pressure-containing parts of cylinders shall conform to 6.3 and 6.8 as appropriate.

If inspection reveals damage of the following types, the cylinder shall be scrapped, or repaired and, on satisfactory completion of a hydrostatic retest, may be returned to service:

— visible cracks in the pressure envelope, i.e. cylinder shell or head;

— skirt torn from head with visible loss of head material;

— stiffening ring torn from shell with visible loss of shell material;

— pressure-envelope bulge;

— pressure-envelope dent, cut or gouge (i.e. cut with material loss) with a depth greater than 2,54 mm (0,1 in) and a noticeable material loss;

— pressure-envelope dent, cut or gouge with depth from 2,54 mm to 12,7 mm (0,1 in to 0,5 in) and with a ratio of maximum length to depth of less than 12;

— pressure-envelope dent, cut or gouge with a depth greater than 12,7 mm (0,5 in);

— pressure-envelope dent, visible crack, cut or gouge (with significant loss of material) in or adjacent to a head weld or a seam weld.

If inspection reveals damage of the following types, the cylinder shall be scrapped, or repaired and may be returned to service without a hydrostatic retest:

— broken or cracked stiffening ring;

— skirt torn from shell without visible loss of head material;

— stiffening ring torn from shell without visible loss of shell material;

— visible crack in the stiffening-ring weld;

— visible hole in the stiffening-ring weld.

Damage of the following types shall not require repair:

— pressure-envelope dent, cut or gouge (i.e. cut with material loss) with a depth not greater than 2,54 mm (0,1 in);

— bent stiffening ring;

— stiffening ring or skirt dent or cut;

— pressure-envelope shallow curved dent with a depth not greater than 12,7 mm (0,5 in) with a ratio of maximum length to depth of not less than 12.

Damage to valves or plugs shall be rectified by their replacement provided that no damage has been done to the coupling. Prior to use of a cylinder in the vertical position, it shall be inspected to ensure that there are no dents, cracks or other damage to the supporting skirt which could impair its capability to support the cylinder.

NOTE The requirements of this subclause do not remove the requirement for compliance with IAEA TS-R-1.

Prior to transport, surface contamination levels shall meet the requirements of IAEA TS-R-1.

9.1.2 Periodic inspection and tests

Cylinders shall not be filled with UF_6 if their periodic inspection and test is out of date.

At intervals not exceeding 5 years, empty cylinders shall be cleaned internally as appropriate and retested and a test certificate obtained from the qualified inspector in the country of inspection. The test shall consist of the following:

— external and internal examination;

— hydrostatic pressure test in accordance with 6.2.4.1 or an equivalent procedure acceptable to the competent authority;

— valve and pipe-plug leak test in accordance with 6.2.4.2 following removal, inspection and replacement of components; all couplings and plugs shall then conform to the original or current design requirements, including tinning;

— measurement of wall thickness, if there is evidence of excessive corrosion of the cylinder or if the cylinder has been out of use in storage for more than 10 years. Cylinders with pressure vessel wall or head thickness less than the minimum values given in Table 3 shall not be used for containing UF_6 without an engineering assessment being completed indicating continued fitness for purpose to the satisfaction of a qualified inspector.

Any defects may be repaired, if appropriate. Repaired cylinders shall be retested prior to use to confirm conformity to this International Standard and to obtain the approval of a qualified inspector for continuing service.

After testing, the cylinder may have the outer shell cleaned and repainted in accordance with 6.2.3.2. The cylinder shall have its tare weight re-established in accordance with 6.2.2. Cylinders that pass the periodic inspection and tests shall be re-punched with the re-established tare weight, month and year in which the hydrostatic test was performed. Stamping shall be placed in close proximity to the previous stamping and shall expire on the last day of the stamped month. Records of periodic inspections and tests shall be retained at least until the subsequent periodic inspection and tests have been performed and recorded.

Cylinders that contain greater than heel quantities at the end of the periodic inspection period need not be emptied for inspections and tests and may be so transported after inspection in accordance with a programme approved by the competent authority. After emptying and prior to refilling, the cylinders shall be cleaned, re-inspected, retested and re-stamped in accordance with this subclause.

9.1.3 In-service cleaning

After emptying a cylinder, remove the heel either for the periodic inspection (see 9.1.2) or for contractual reasons before refilling. Heel removal may be performed by washing the inside of the cylinder with water, followed by steam cleaning and drying as specified in 6.2.3.1.

If the dimensions of the cylinder are not geometrically safe for the enrichment level of the uranium heel, monitor and check the use of water in the cleaning operation. It may be necessary to obtain the following for each cylinder:

— dates for the last filling and emptying operations;

— isotopic abundance of the UF_6 last contained in the cylinder;

— quality of the UF_6 (whether from an irradiated or unirradiated source);

— quantity of the heel.

The quantity of heel acceptable during the cleaning process shall be determined with reference to the extant criticality clearances for the process, accuracy of weighing machines for tare and gross weight assessment, the source of the feed stock from which the material was enriched, the heel quantity and the cleaning method used. If the cleaning of cylinders containing residual quantities of UF_6 is carried out, a procedure with full approval of nuclear safety personnel shall be used. In particular, the amounts of wash solution added to the cylinders shall be carefully checked and a neutron absorber (e.g. boron solution) shall be added if necessary for criticality control. After cleaning and drying, the cylinder shall be kept dry and free of contamination.

9.2 Protective packaging

9.2.1 Inspection documentation

Inspections shall be documented on an inspection form prepared specifically for each type of protective packaging used.

Inspections shall be carried out as specified in the operating and maintenance instructions approved by the competent authority which form part of the relevant Certificate of Approval of the competent authority.

9.2.2 Routine operational inspection

Protective packagings and packages shall be inspected prior to each use in accordance with written inspection procedures to ensure its continued integrity and ability to comply with regulatory and operational requirements. Non-conforming conditions found shall be referred to personnel suitably qualified and experienced to evaluate the use, repair or condemnation of the protective packaging.

If the protective packaging provides additional mechanical protection, the following shall, as a minimum, be cause for further investigation or removal from service for repair:

a) excessive warping;

b) distortion;

c) other damage to the liner or shell;

d) uptake of moisture;

that would

— prevent a tight closure of the package,

— allow excessive clearance between the protective packaging and the protected packaging,

— reduce the assembly fastener strength of the container,

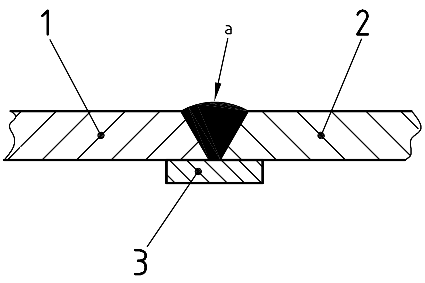
— reduce the thermal-insulation thickness in any area,

— otherwise make the integrity of the protective packaging questionable as a fire and/or shock resistant housing.

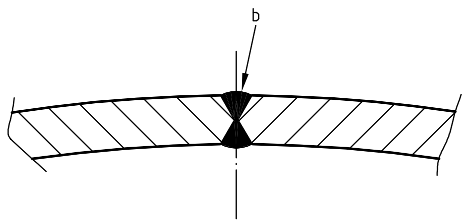
9.2.3 Periodic inspection

Protective packagings shall be inspected at the intervals specified in and in accordance with operating and maintenance instructions, which form part of the relevant Certificate of Approval from the competent authority.

Dimensions in millimetres
(Dimensions in inches in parentheses)

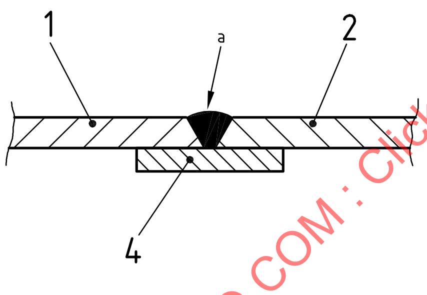


Suggested head to shell seam showing optional backing ring

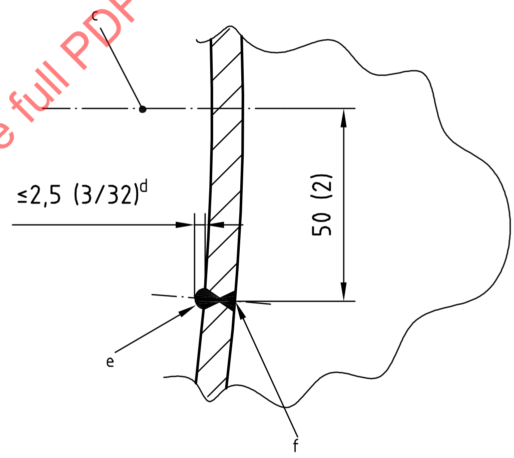


Suggested longitudinal shell seam

a) Weld details for the UF_6 cylinder 30B



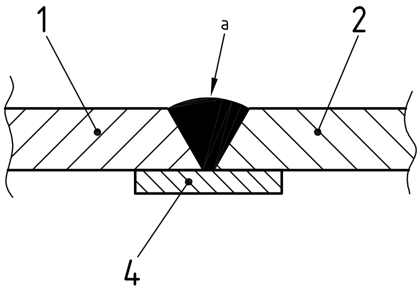
Suggested head to shell seam showing optional backing ring



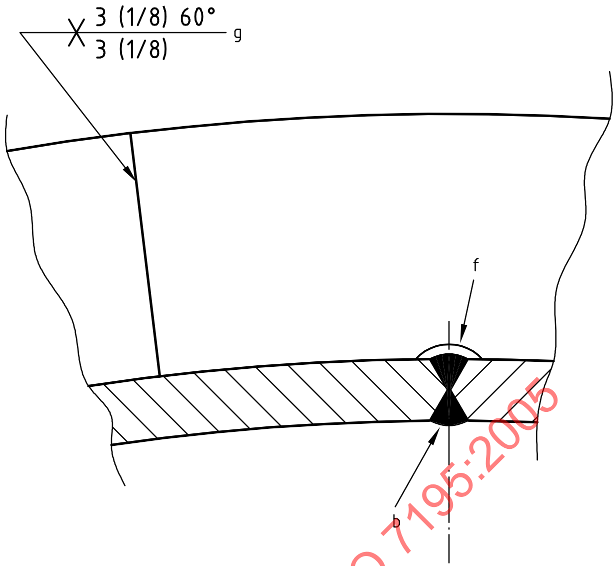
Suggested longitudinal shell seam

b) Weld details for the UF_6 cylinder 48G

Figure 1 — Type 30 and Type 48 cylinder weld details



Suggested head to shell seam showing optional backing ring



Suggested longitudinal shell seam

c) Weld details for the UF_6 cylinders 48X and 48Y

Key

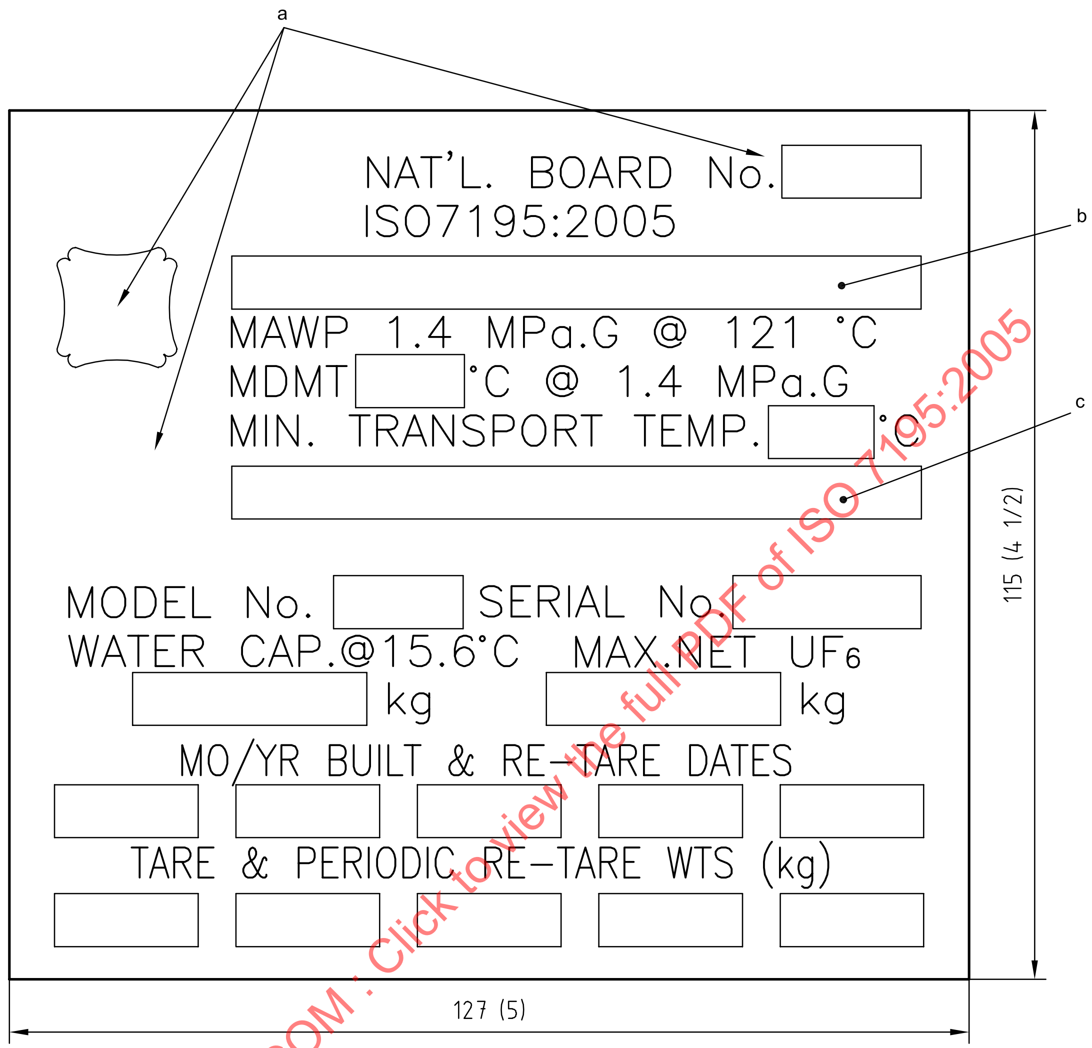
1 head
2 shell
3 backing ring [25 (1 1/2) min. × 6 1/4)]
4 backing ring [38 (1 1/2) max. × 6 (1/4)]

Break sharp edges.

[a] Full-penetration vee butt weld.
[b] Full-penetration double vee butt weld on vertical centreline at top.
[c] Cylinder horizontal centreline.
[d] Typical both sides.
[e] Full-penetration double vee butt weld.
[f] Grind flush at stiffening ring.
[g] Full-penetration from both sides of the stiffening rings; locate joint near top between lifting lugs.

Figure 1 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)



a) 5B, 8A, 12B and 30B cylinder nameplates

Key

The nameplate shall be attached by continuous welding.

Typical plate thickness for 5B, 8A, 12B and 30B cylinders: 0,912 (20 gauge).

Imperial data may be substituted for the above metric data.

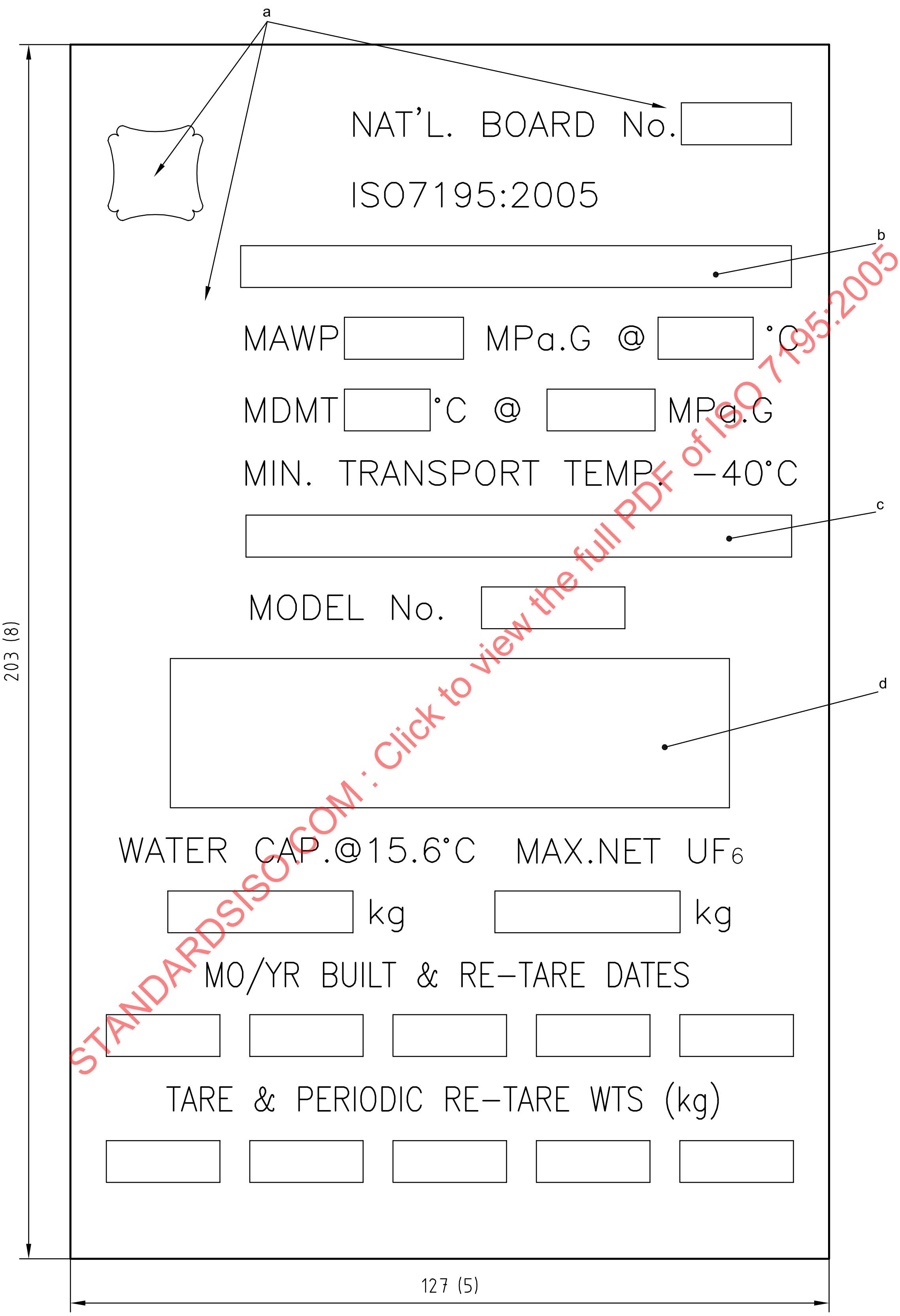
[a] Spaces for the appropriate inspection stamp(s) and national registration number.

[b] Manufacturer's name.

[c] Owner's name.

Figure 2 — Nameplate for cylinders

Dimensions in millimetres
(Dimensions in inches in parentheses)



b) 48G, 48X and 48Y cylinder nameplates

Figure 2 (*continued*)

Key

The nameplate shall be attached by continuous welding.

Typical plate thickness for 48G, 48X and 48Y cylinders: 2,28 (13 gauge).

Imperial data may be substituted for the above metric data.

[a] Spaces for the appropriate inspection stamp(s) and national registration number.

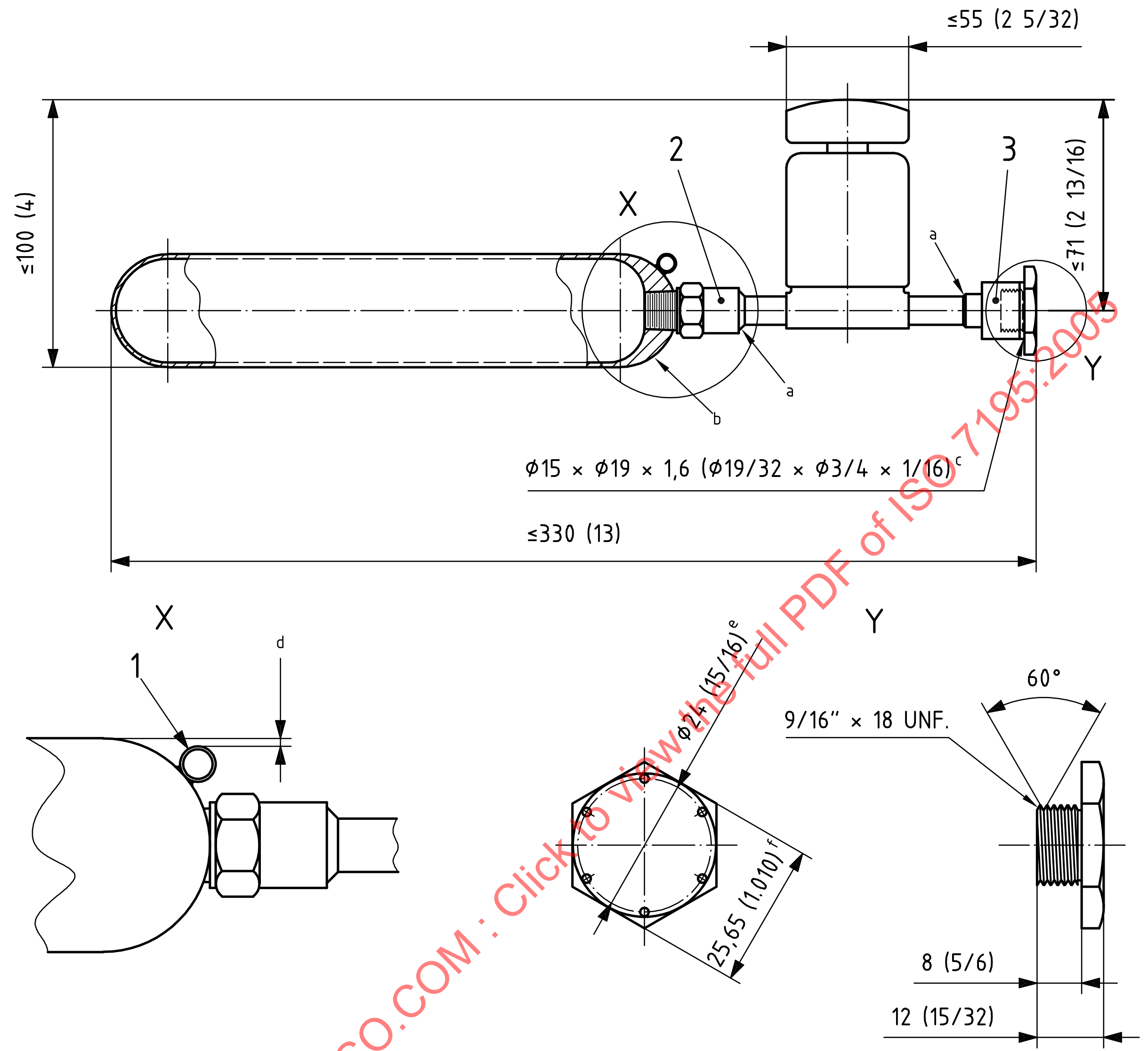
[b] Manufacturer's name.

[c] Owner's name.

[d] Space for serial number 25 mm (1 in) high.

Figure 2 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)



Key

1 typical seal loop, outside Ø 6,3 × 6,3 long (Ø 1/4 × 1/4 long)

2 adaptor "A" (see Figure 4)

3 adaptor "B"

Modify the valve to fit end connections shown.

The internal surface of the cylinder shall be free from cracks, fissures or folds; smooth ripples incident to forming may be permitted.

No portion of the seal loop shall protrude beyond the outer diameter of the cylinder.

[a] Silver braze.

[b] Location of stamped cylinder data.

[c] Aluminium sealing washer.

[d] Keep this dimension to a minimum.

[e] 6 holes Ø 1,6 (1/16) equispaced.

[f] Distance across flats of the hex-head bolt.

Figure 3 — 1S Cylinder

Dimensions in millimetres
(Dimensions in inches in parentheses)

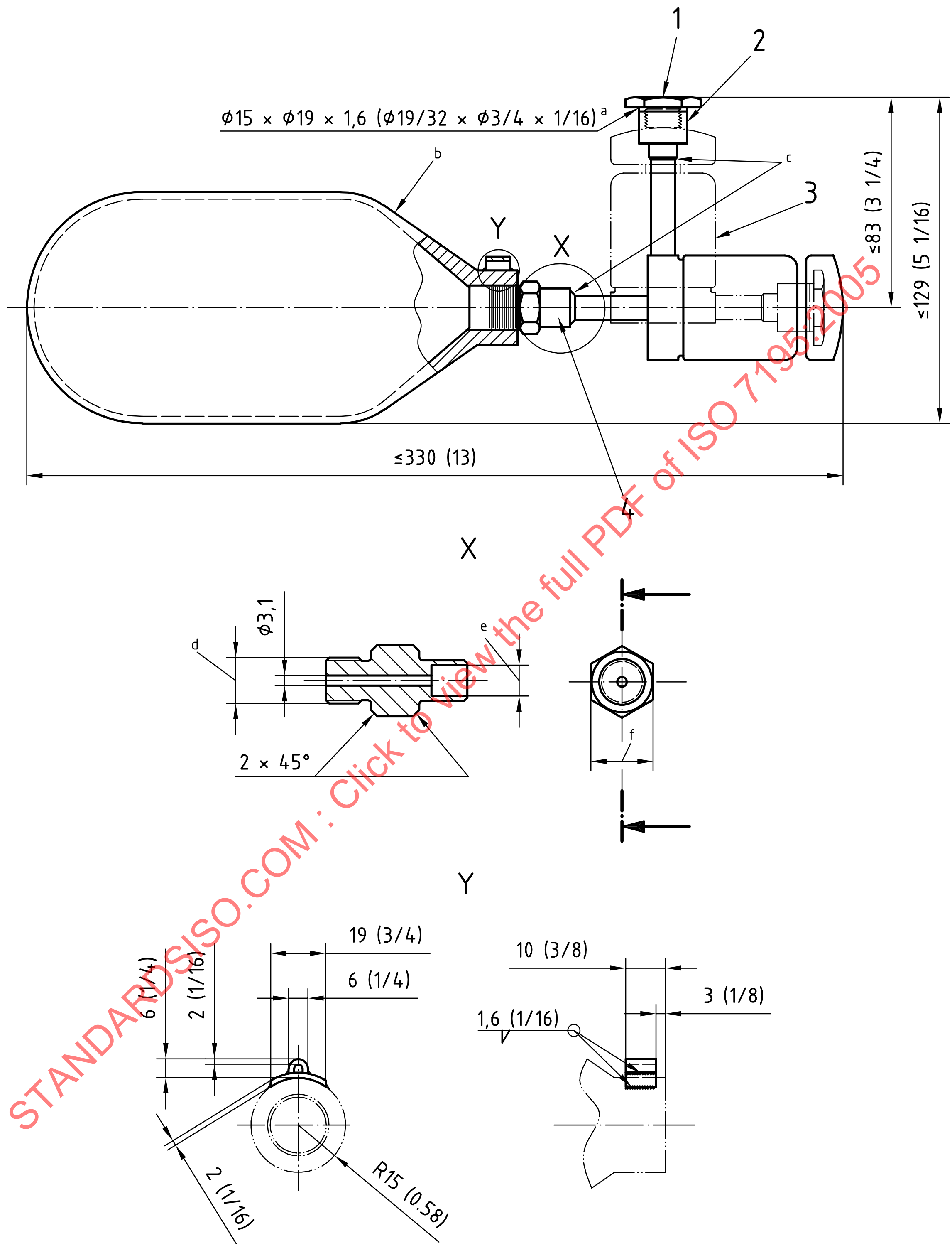


Figure 4 — 2S Cylinder

Key

1 pipe plug (see Figure 3, “Y”)
2 adaptor “B”
3 alternative valve position
4 adaptor “A”

Modify the valve to fit the end connections shown.

The internal surface of the cylinder shall be free from cracks, fissures or folds; smooth ripples incident to forming are permitted.

[a] Aluminium sealing washer.
[b] Location of stamped cylinder data.
[c] Silver braze.
[d] Thread to suit cylinder.
[e] Dimension to suit valve stub.
[f] Hexagonal stock to suit cylinder.

Figure 4 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)

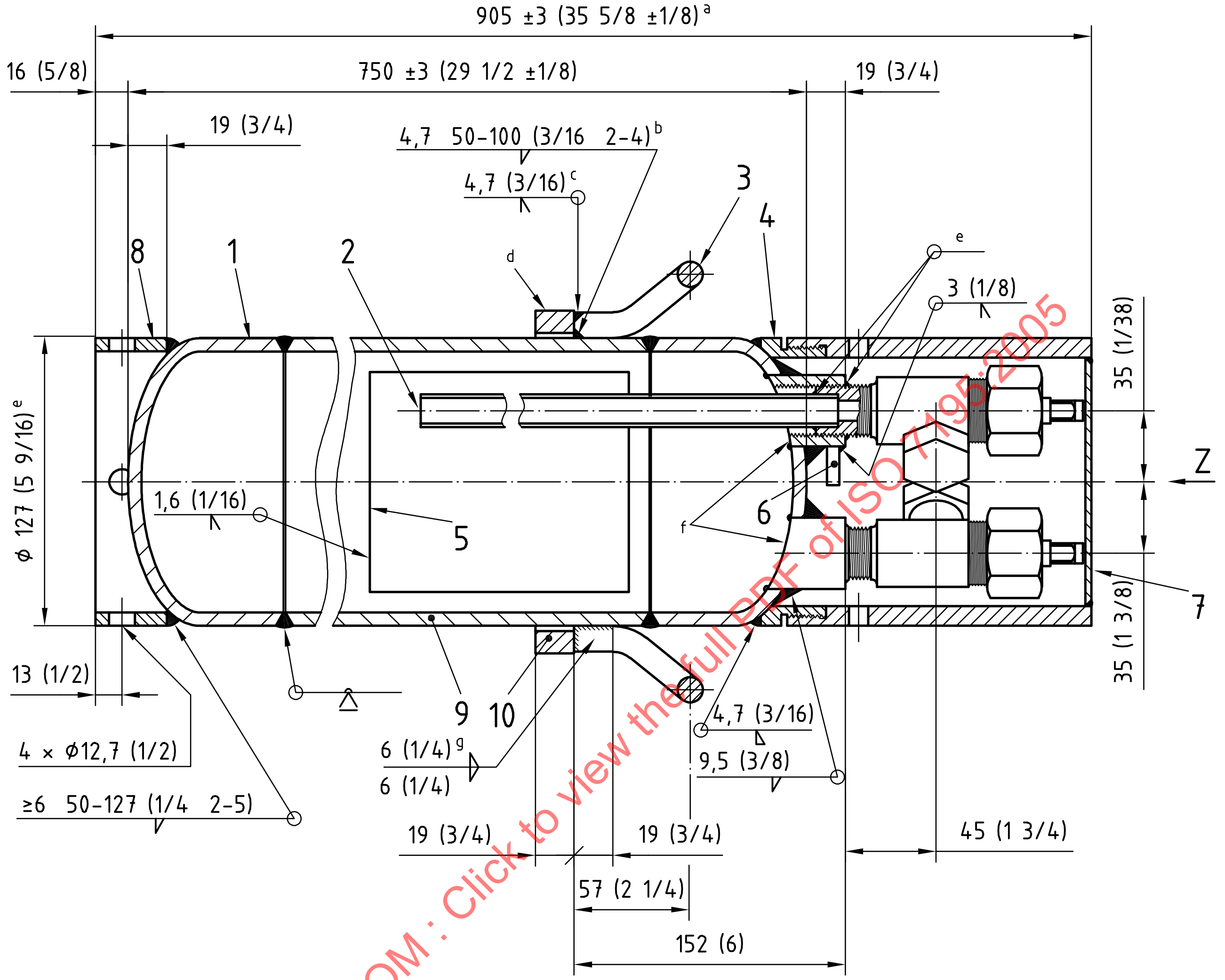
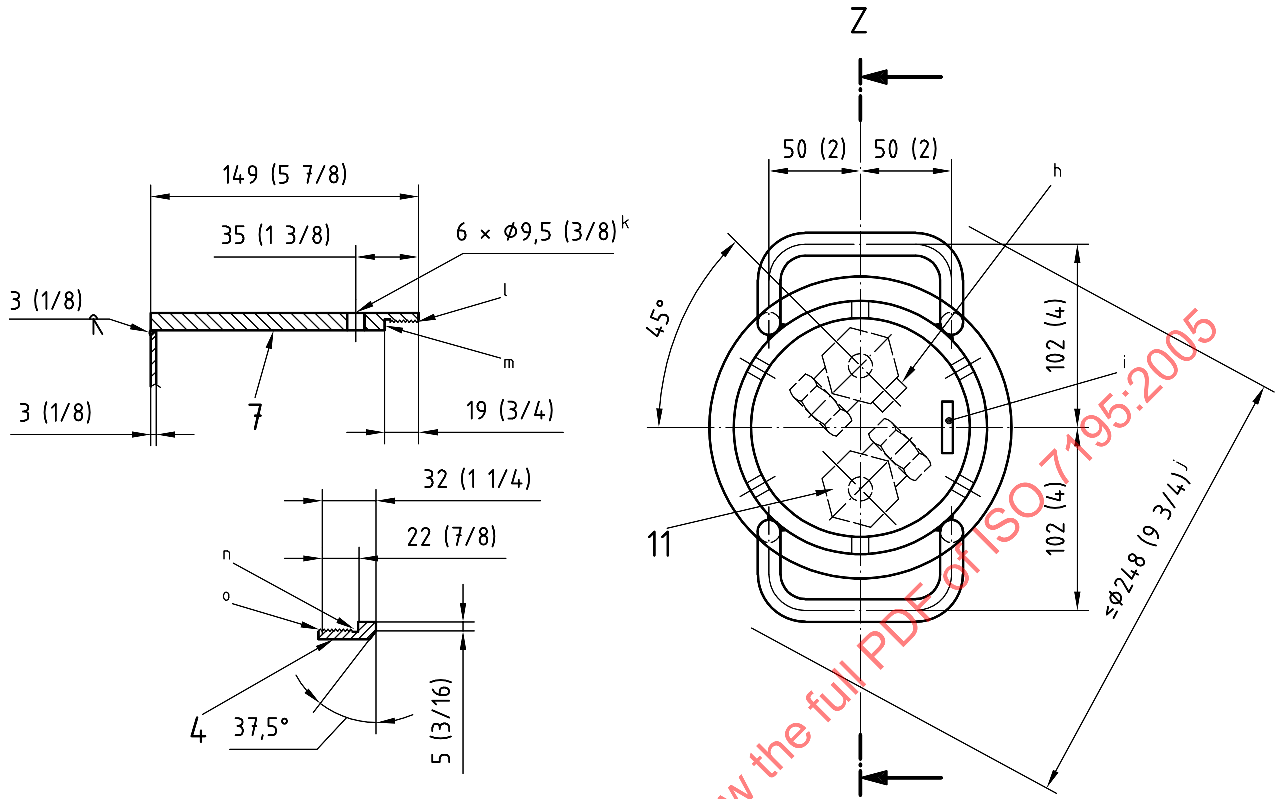


Figure 5 — 5B Cylinder

Dimensions in millimetres
(Dimensions in inches in parentheses)



Key

1 127 (5) weld cap
2 dip pipe, outside Ø 15,9 × 1,65 wall thickness × 356 ± 12,7 (5/8 × 0,065 × 14 ± 1/2)
3 handles Ø 12,7 (1/2) (two off)
4 neck ring; 5″ schedule 80 pipe, (see Figure 5)
5 cylinder nameplate [see Figure 2 a)]
6 dip pipe tab, 19 square × 6 (3/4 × 1/4); weld to coupling
7 valve protector cap, 5″ schedule 80 pipe (see Figure 5)
8 foot ring, 5″ schedule 40 pipe
9 shell, 5″ schedule 40 pipe
10 support ring, 6″ schedule 80 pipe
11 two 3/4″ valves (see Figure 15)

Dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

a Valve protector cap seated.
b Support ring to shell weld.
c Handle to support ring weld.
d Cylinder serial number shall be stamped on support ring.
e Silver braze.
f Contour couplings flush or concave to pipe cap inner surface.
g Handle to shell weld.
h Stamp "DP" in characters 8 (5/8) high on dip pipe tab.
i Stamp company's ID and serial number on head.
j Maximum protrusion.
k 6 holes equally spaced drilled Ø 9,5 (3/8).
l 5 1/4-12 UN-2B thread.
m 3 wide × 134,1 ± 0,25 internal Ø (0,125 × 5,280 ± 0,010 internal Ø).
n 3 wide × 130,25 ± 0,25 internal Ø (0,125 × 5,128 ± 0,010 internal Ø).
o 5 1/4-12 UN-2A thread.

Figure 5 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)

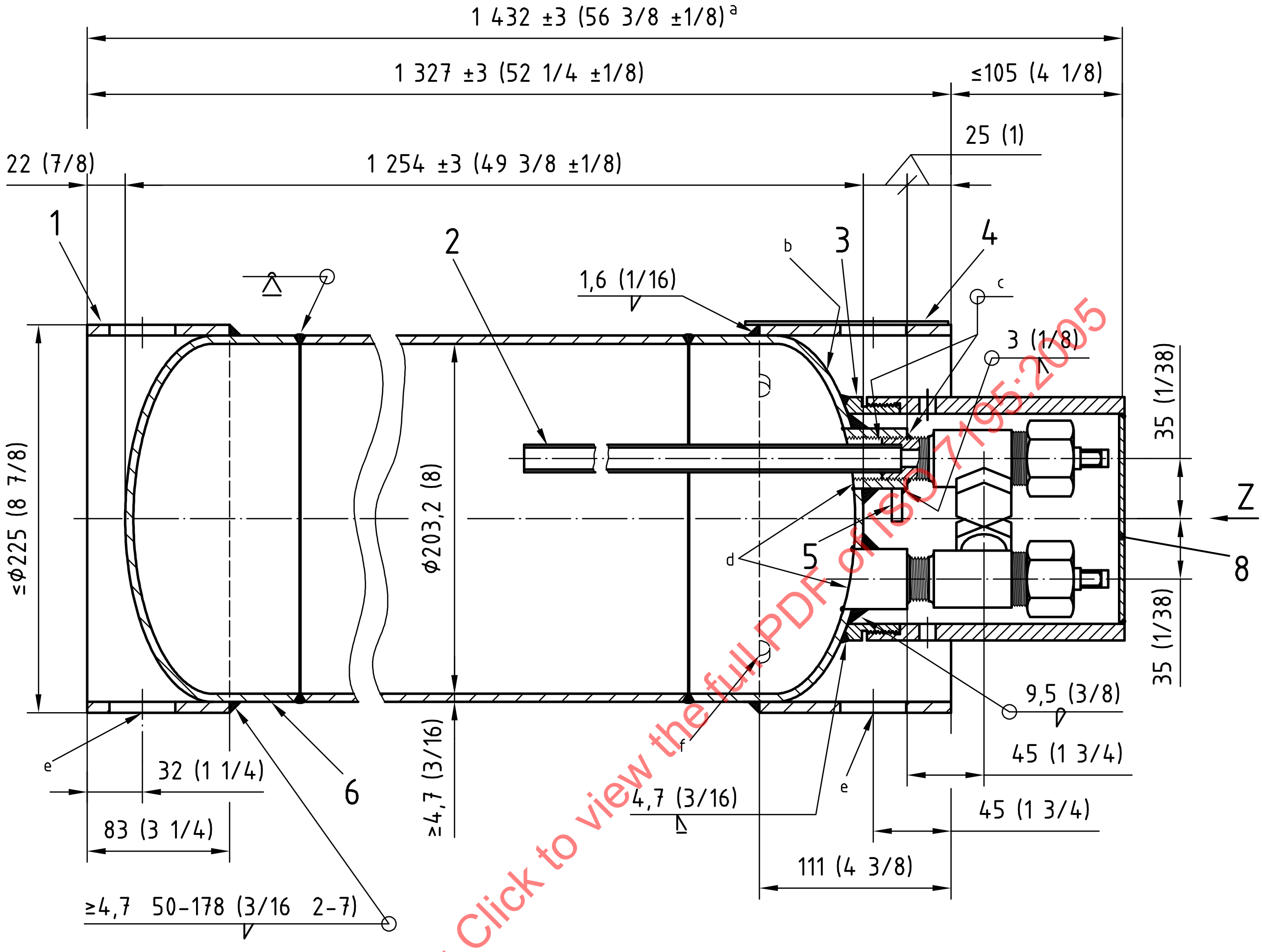
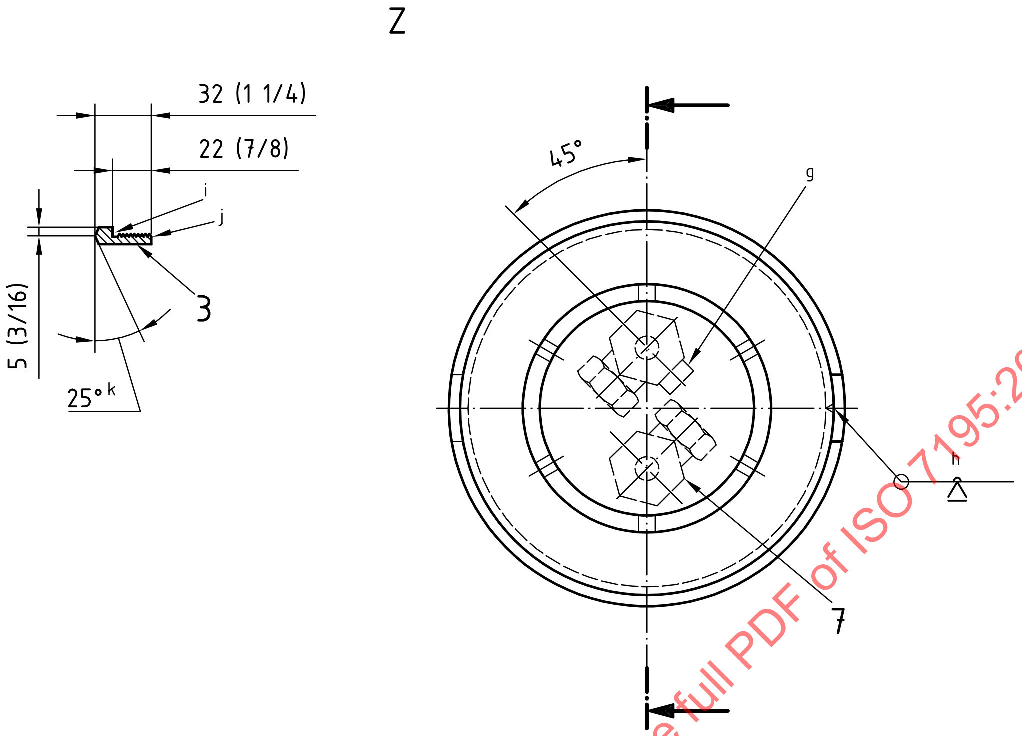


Figure 6 — 8A Cylinder

Dimensions in millimetres
(Dimensions in inches in parentheses)



Key

1 foot ring, steel plate, 4,7 (3/16)

2 dip pipe, outside Ø 15,9 × 1,65 wall thickness × 660 ± 12,7 (5/8 × 0,065 × 26 ± 1/2)

3 neck ring, 5″ schedule 80 pipe, (see Figure 6)

4 cylinder nameplate, (see Figure 2 a)]

5 dip pipe tab

6 ellipsoïdal head, thickness 4,7 (3/16)

7 two 3/4″ values (see Figure 15)

8 valve protector cap, 5″ schedule 80 pipe

Dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

For valve protector details, (see Figure 5).

a Valve protector cap seated.

b Stamp company's ID and serial number on the head.

c Silver braze.

d Contour couplings flush or concave to pipe cap inner surface.

e Drill two holes ∅ 38 (1 1/2) equally spaced in the foot and head ring.

f Four semi-circular drainholes, radius 6 (1/4) equally spaced in head ring only.

g Stamp "DP" in characters 8 (5/8) high on 19 square × 6 (3/4 × 1/4); weld to coupling.

h Longitudinal weld.

i 3 wide × 130,25 ± 0,25 internal Ø (0,125 × 5,128 ± 0,010 internal Ø).

j 5-1/4-12 UN-2A threads.

k Both sides.

Figure 6 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)

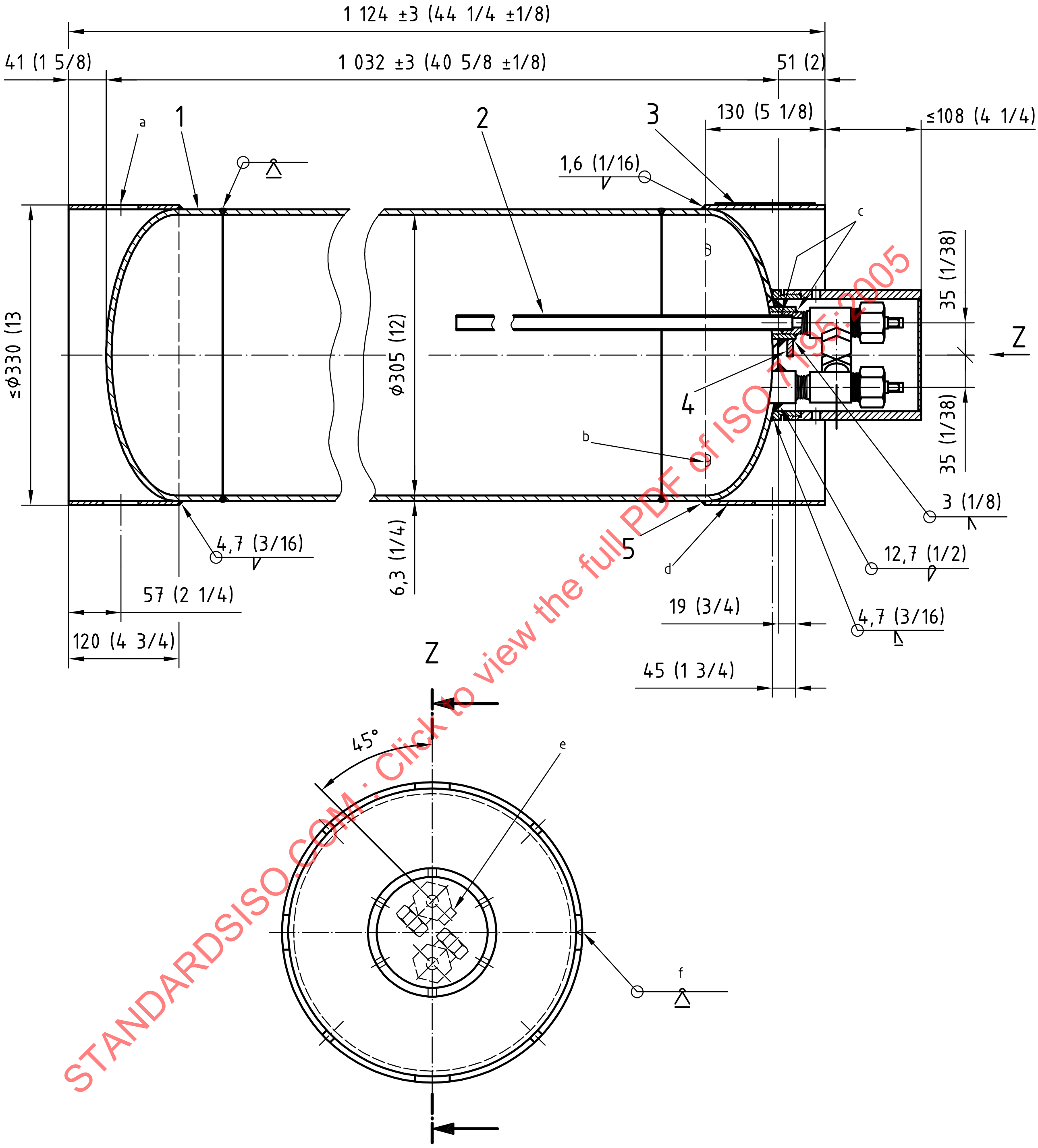


Figure 7 — 12B Cylinder

Key

1 ellipsoidal head, nominal thickness 4,7 (3/16)

2 dip pipe, outside ∅ 15,9 × 1,65 wall thickness × 508 ± 12,7 (5/8 × 0,065 × 20 ± 1/2)

3 cylinder nameplate, [see Figure 2 a)]

4 dip pipe tab

5 head ring, 5 (3/16) steel plate

Dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

Contour couplings flush or concave to pipe cap inner surface.

For valve protector cap and neck ring details (see Figure 5).

Grind neck ring at weld interface.

a Drill two holes ∅ 38 (1 1/2) equally spaced in the foot and head ring.

b Four semi-circular drainholes, radius 6 (1/4), equally spaced in head ring only.

c Silver braze.

d Stamp company's ID and serial number on head.

e Stamp "DP" in characters 8 (5/8) high on 19 square × 6 (3/4″ square × 1/4) thick and weld to the coupling (paint this valve red).

f Longitudinal seam weld.

Figure 7 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)

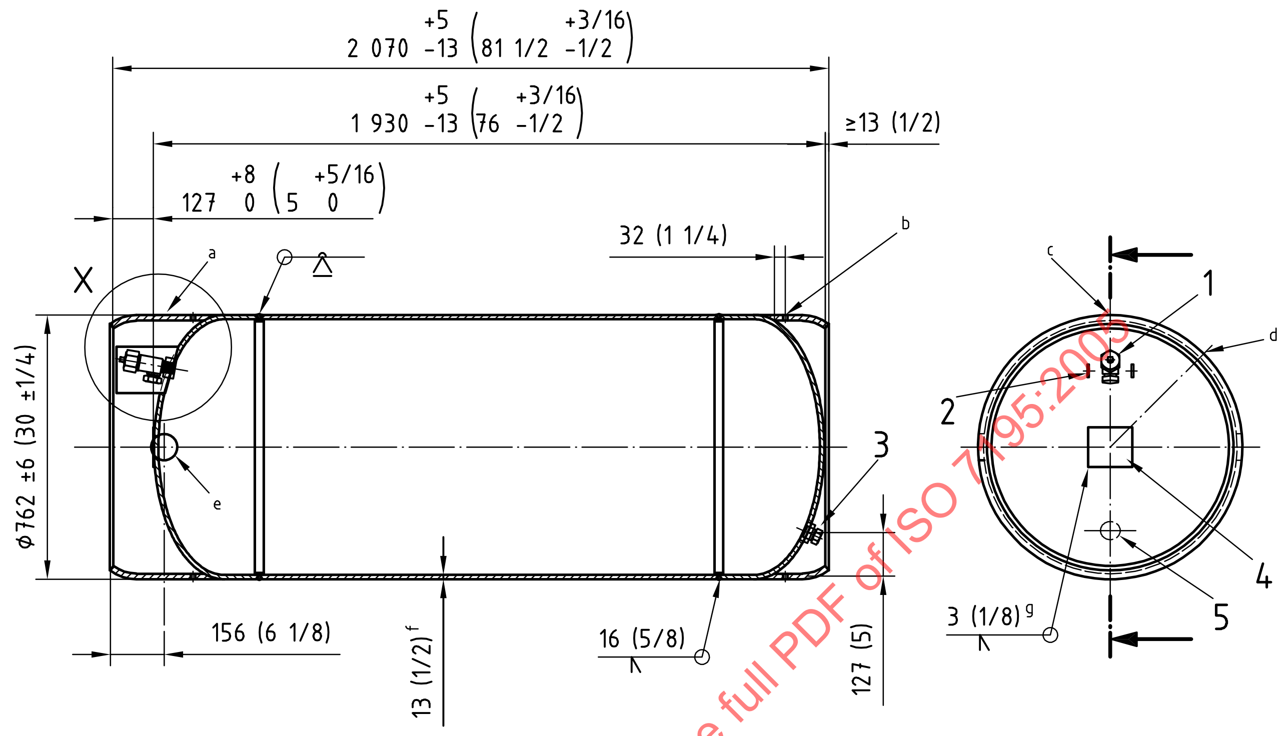


Figure 8 — Cylinder 30B

Dimensions in millimetres
(Dimensions in inches in parentheses)

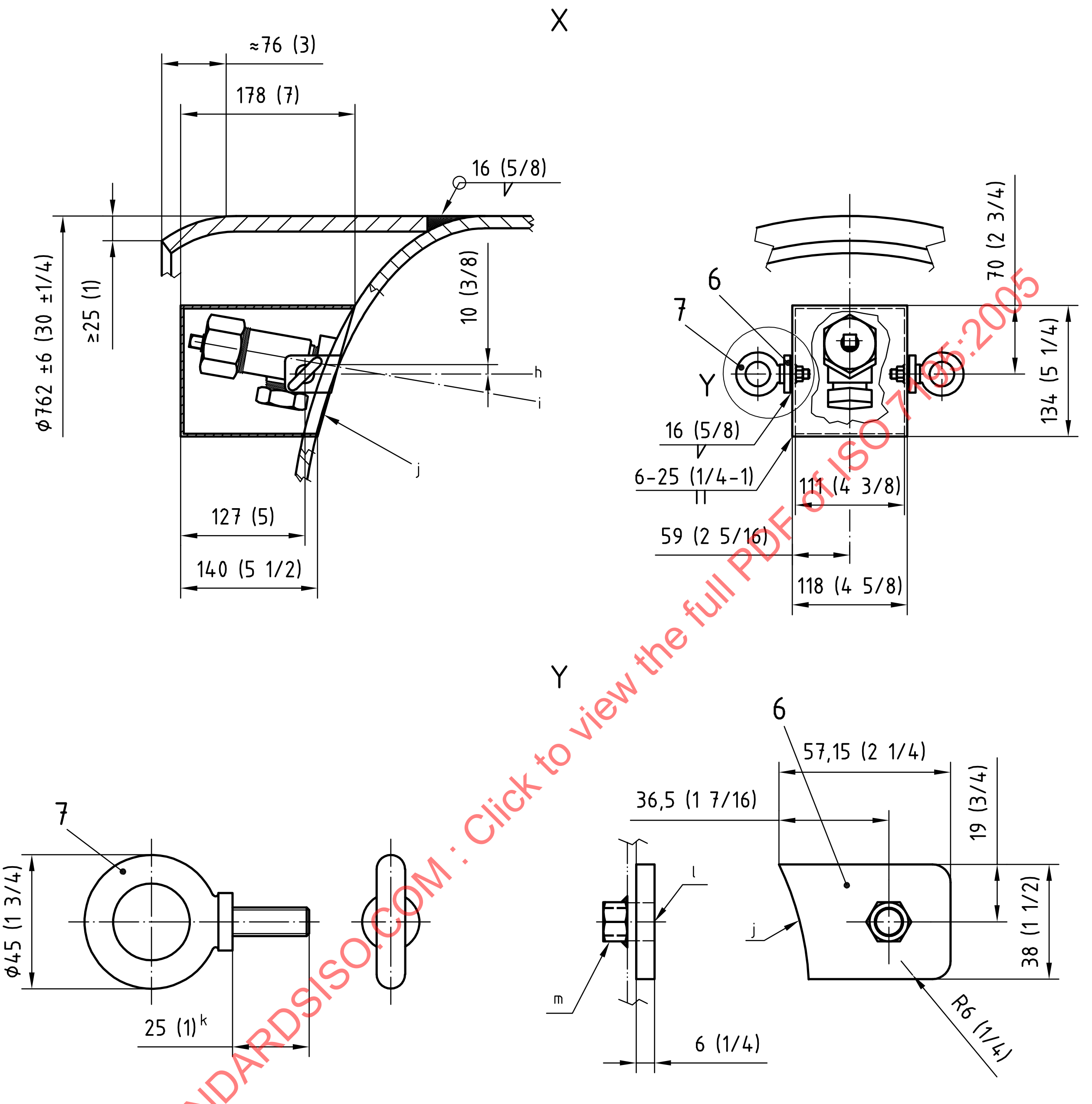


Figure 8 (*continued*)

Key

1 1″ valve [see Figure 10 d)]
2 valve protector positioners (see Figure 8)
3 plug and half coupling (installation optional)
4 nameplate [see Figure 2 a)]
5 optional plug (far end) [see Figure 10 a)]
6 valve protector positioner lug
7 eye bolt

Other than the pressure envelope thickness, dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

For a cylinder fabricated using the spiral weld process, the spiral weld shall start 50 (2) below the horizontal centreline.

For typical components and weld details, see Figures 1 a), 2 a), 9, 10 a), 10 d) and 16.

Optionally, a nameplate backing plate may be welded to the head and have the nameplate welded to the backing plate.

Modify half couplings as shown in Figure 9 c) or 9 d) prior to installation as shown in Figure 10 a) and 10 d). Chase the half-coupling thread after welding.

1 1/2″ 11-1/2 NPT plug and half coupling may be used as an alternative 1″ 11-1/2 NPT plug and half coupling.

The valve protector positioners shall be parallel to each other and accurately located on the cylinder before welding in position.

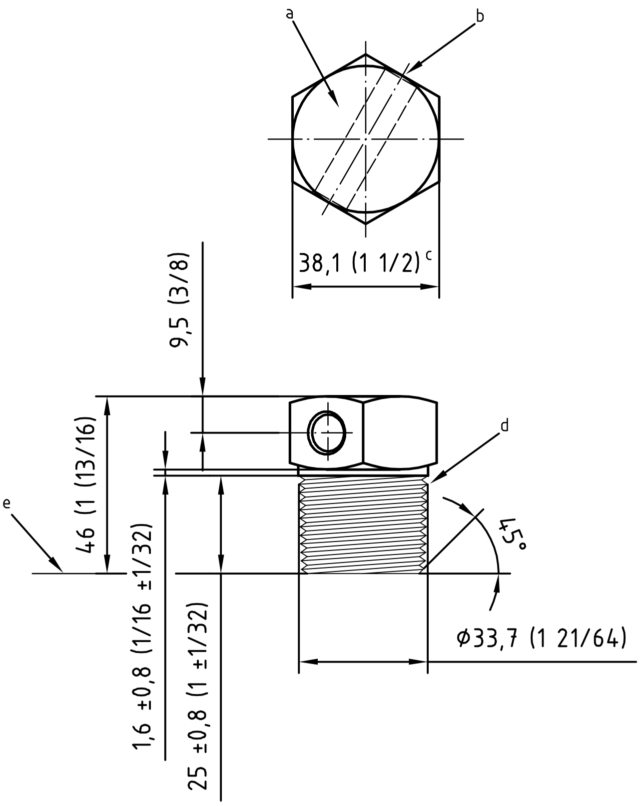
The valve protector may be used as a locating jig for positioners.

The valve protectors shall be fabricated from 2,9 (11 gauge) material unless otherwise indicated.

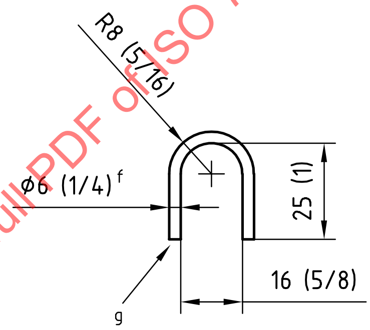
a Stamp cylinder serail number on the head end skirt.
b Drill four weep holes per skirt, ∅ 13 (1/2) equally spaced on the centre line.
c Cylinder longitudinal weld joint.
d Skirt longitudinal weld joint.
e Drill two holes ∅ 76 (3) on horizontal centres.
f Shell and heads nominal thickness 13 (1/2).
g Optional nameplate backing plate weld.
h Positioner centreline.
i Valve centreline.
j Contour valve protector to suit the cylinder head.
k 9,5 (3/8) 16-NC thread, or similar strength.
l Drill ∅ 13 (1/2) hole through the lugs and both sides of the valve protector before tack welding.
m Hexagonal head nut 9,5 (3/8) 16-NC thread or similar to suit eye bolt (Figure 8).

Figure 8 (*continued*)

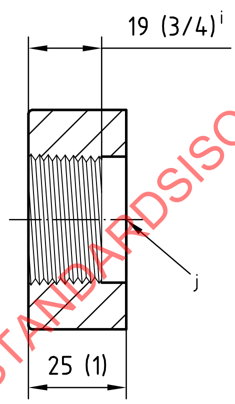
Dimensions in millimetres
(Dimensions in inches in parentheses)



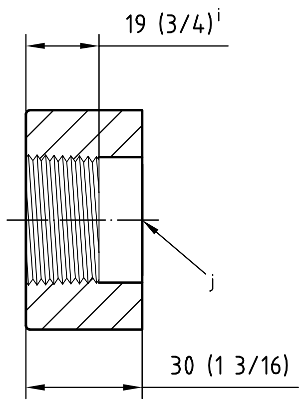
a) **Pipe plug**[h]



b) **Seal loop**



c) **Plug half coupling**[k]



d) **Valve half coupling**[l]

Figure 9 — Plug, half coupling machining and seal loop details

Dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

a Stamp actual number of effective threads on the plug head.

b ∅ 9,5 (3/8) hole with 1 (1/32) chamfer.

c Distance across flats or the hex-head plug.

d 1″ 11-1/2 NPT, ANSI/ASME B1.20.1.

e Pitch diameter of the location indicated shall be 30,82 (1,213 6).

f Rod.

g Weld to head.

h Plug hexagonal body and thread dimensions may be changed to accommodate optional 1 1/2″ 11-1/2 NPT. The longitudinal dimensions shall remain as shown

i Full threads.

j Counterbore the small end of the coupling to the thread major dimater as shown in the figure.

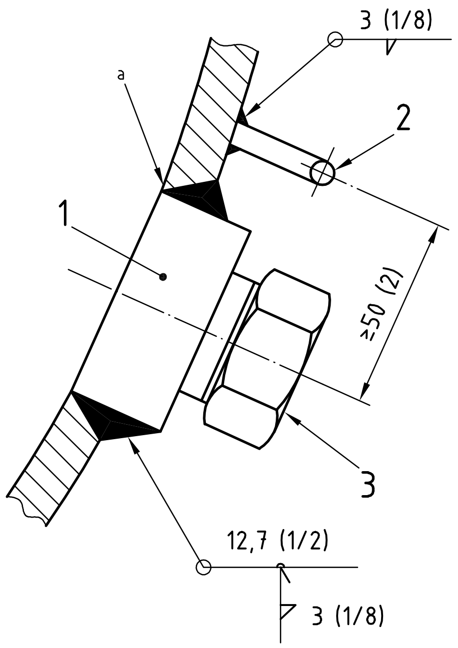
k The longitudinal dimensions shall be as shown in the figure.

l Modification of the 1″ or 1 1/2″, 6 000 lb half coupling.

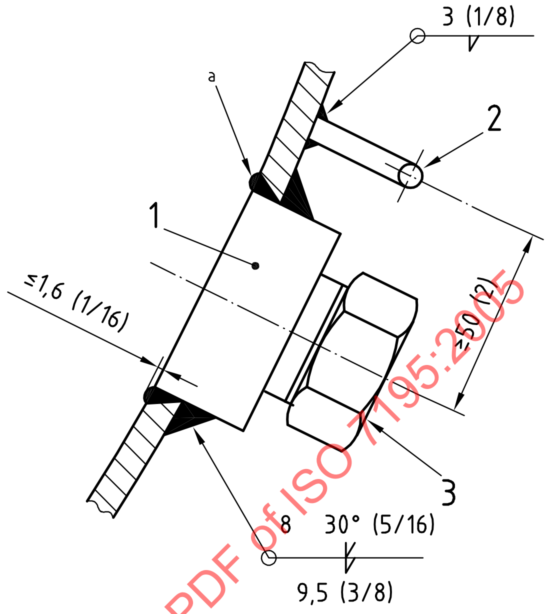
m Modification of the 1″, 6 000 lb half coupling.

Figure 9 (*continued*)

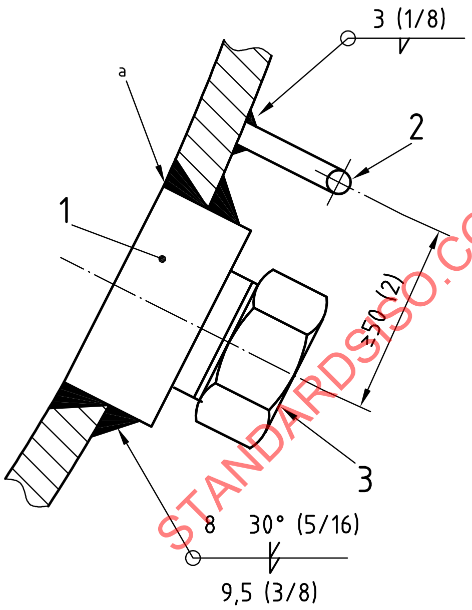
Dimensions in millimetres
(Dimensions in inches in parentheses)



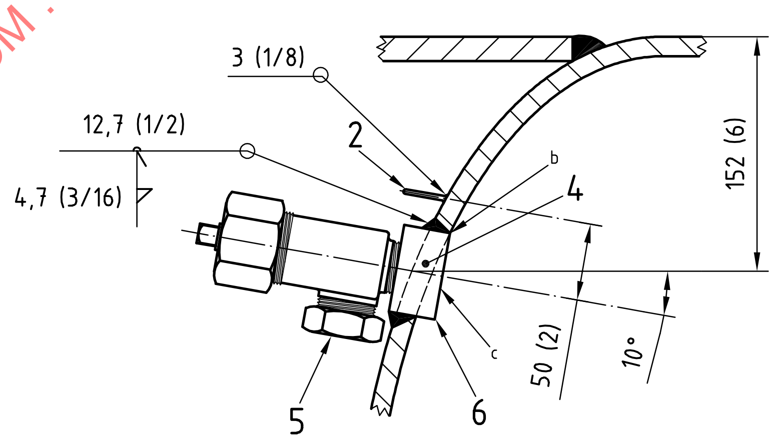
a) 30B cylinder optional plug detail



b) 48G plug detail



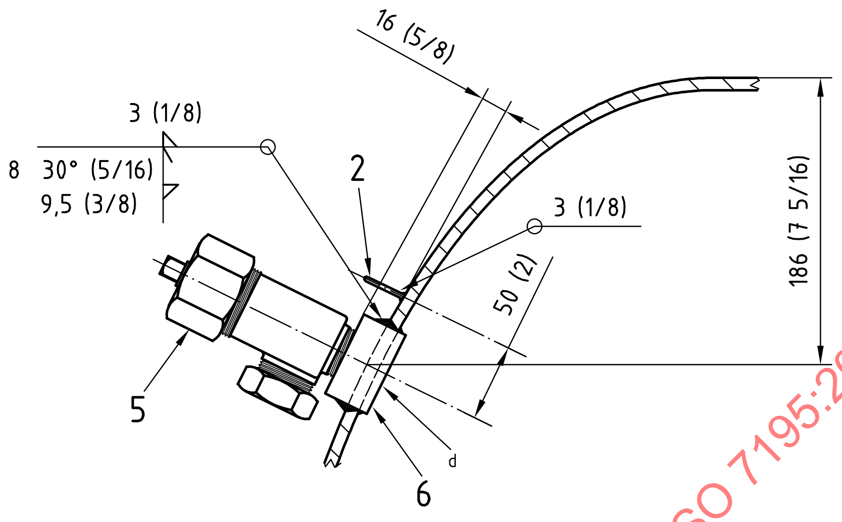
c) 48X and 48Y plug detail



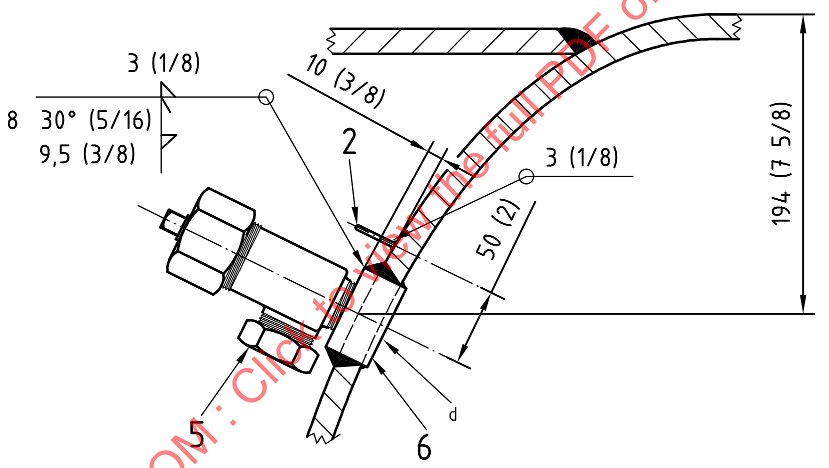
d) 30B cylinder valve location

Figure 10 — Plug and valve insertion details

Dimensions in millimetres
(Dimensions in inches in parentheses)



e) 48G cylinder valve location



f) 48X and 48Y cylinder valve location

Key

1 plug half coupling [see Figure 9 c)]
2 seal loop [see Figure 9 b)]
3 pipe plug [see Figure 9 a)]
4 valve half-coupling [see Figure 9 d)]
5 1″ valve (see Figure 16)
6 valve half coupling [see Figure 9 d)]

Dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

a Make flush inside; chase threads after welding.

b Make flush at position indicated.

c Install under longitudinal weld joint of cylinder.

d Install perpendicular to the head tangent; chase threads after welding.

e The valve outlet shall line up on the centre line of the cylinder as shown.

Figure 10 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)

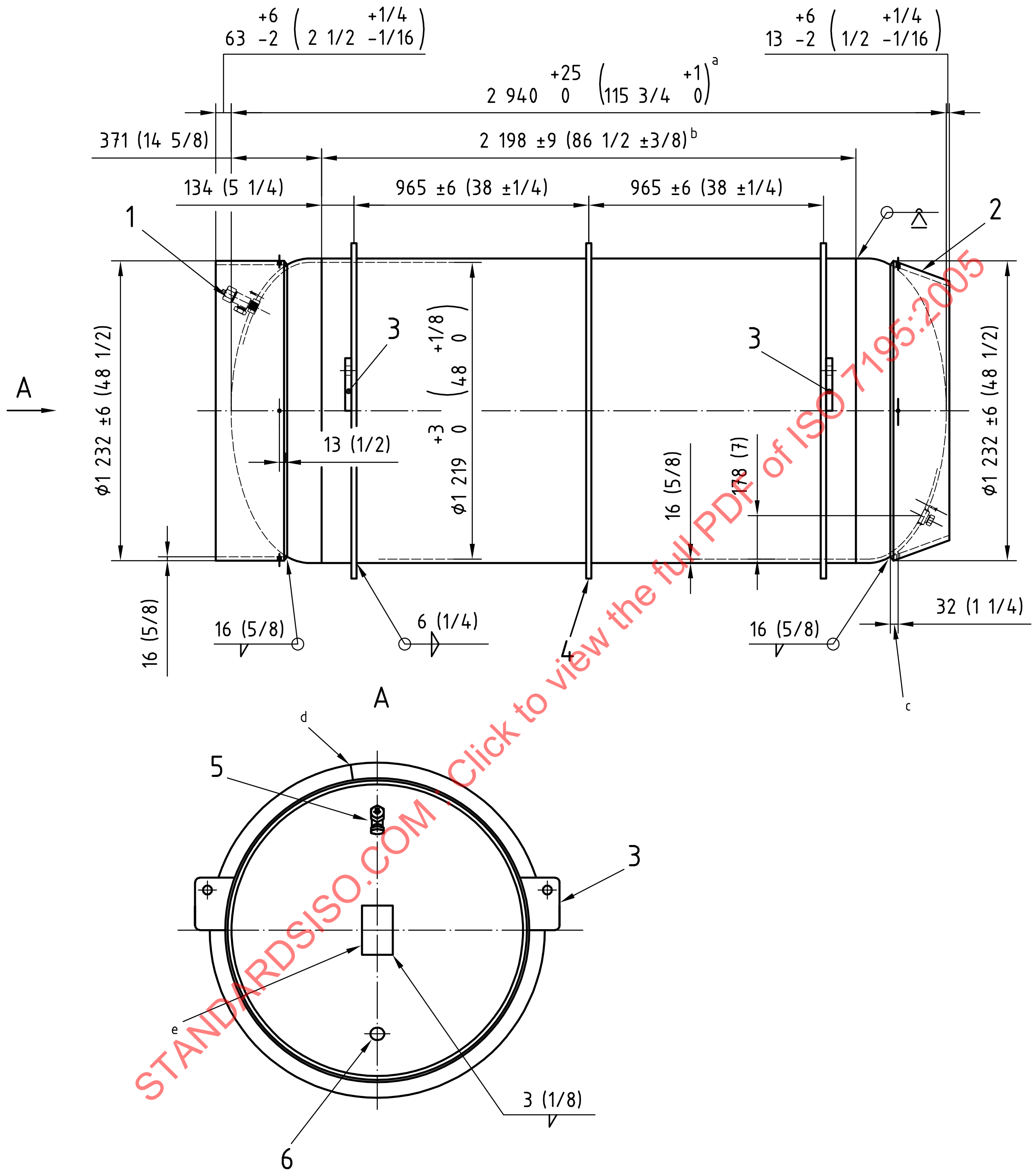
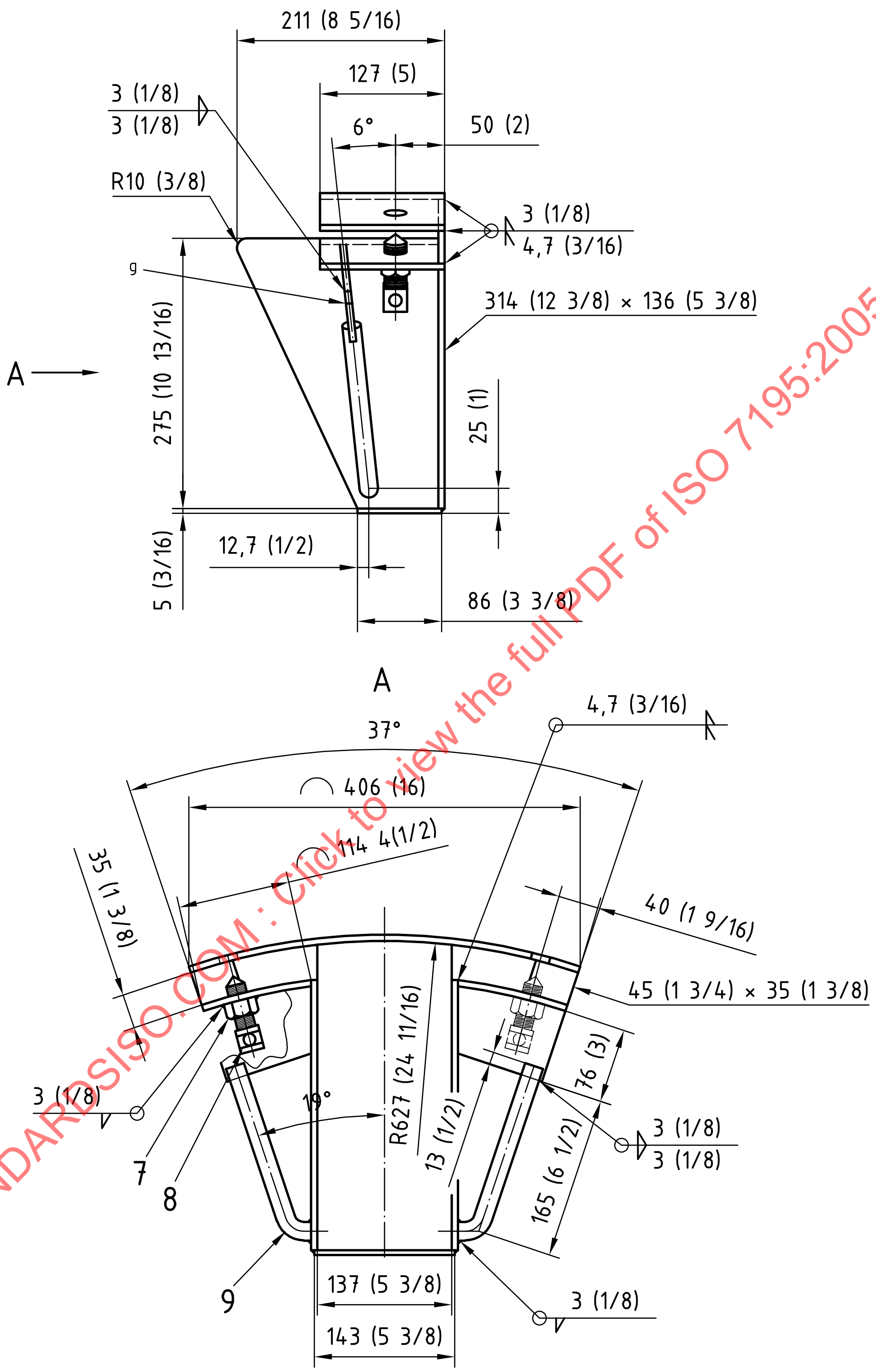


Figure 11 — 48X cylinder

Dimensions in millimetres
(Dimensions in inches in parentheses)



Valve protector

Figure 11 (*continued*)

Key

1 1″ valve, [see Figure 16; for location of valve, see Figure 10 f)]
2 straight or tapered skirt, 16 (5/8) thick
3 lifting lugs (two per side); (see Figure 12)
4 three stiffening rings, 22 (7/8) × 63 (2 1/2)
5 nameplate [see Figure 2 b)]
6 plug (far end); [see Figure 10 c)]
7 hex-head nut to suit the set screw (two required)
8 set screw, [see Figure 14 d)]
9 handle; 3/4″ NB schedule 40 steel pipe

Other than pressure envelope thickness, the dimensional tolerances are ± 1,6 (1/16) unless otherwise indicated. Angular tolerances are ± 2°.

Optionally, a nameplate backing plate may be welded to the head and have the nameplate welded to the backing plate.

For a cylinder fabricated using the spiral process, the spiral weld shall start 50 (2) below the horizontal centreline.

Modify half couplings as shown in Figure 9 c) or 9 d) prior to installation as shown in Figure 10 c) and 10 f). Chase the half-coupling thread after welding.

1 1/2″ 11-1/2 NPT plug and plug coupling may be used as an alternative to the 1″ 11-1/2 NPT plug and half coupling.

For typical components and weld details, see Figures 1 c), 2 b), 9, 10 c), 10 f), 12 b) and 16.

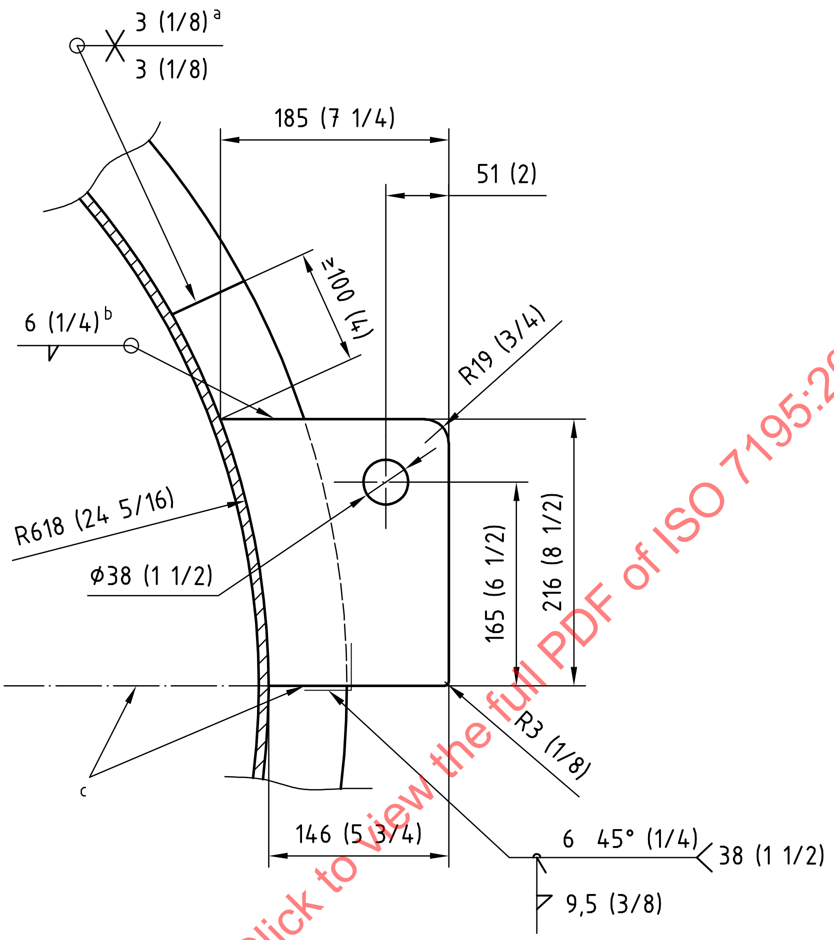
A straight skirt (see Figure 13) may be used on the cylinder plug end in lieu of the conical 20° tapered skirt shown.

The valve protectors shall be fabricated of 6 (1/4) material unless otherwise indicated.

a Overall body length.
b Seam to seam length.
c Drill four weep holes per skirt, ∅ 13 mm (1/2 in) drilled equally spaced on centrelines.
d Butt weld, see Figure 1 c).
e Valve protector location (see Figure 11).
f Optional nameplate backing plate weld.
g Drill ∅ 13 (1/2).

Figure 11 (*continued*)

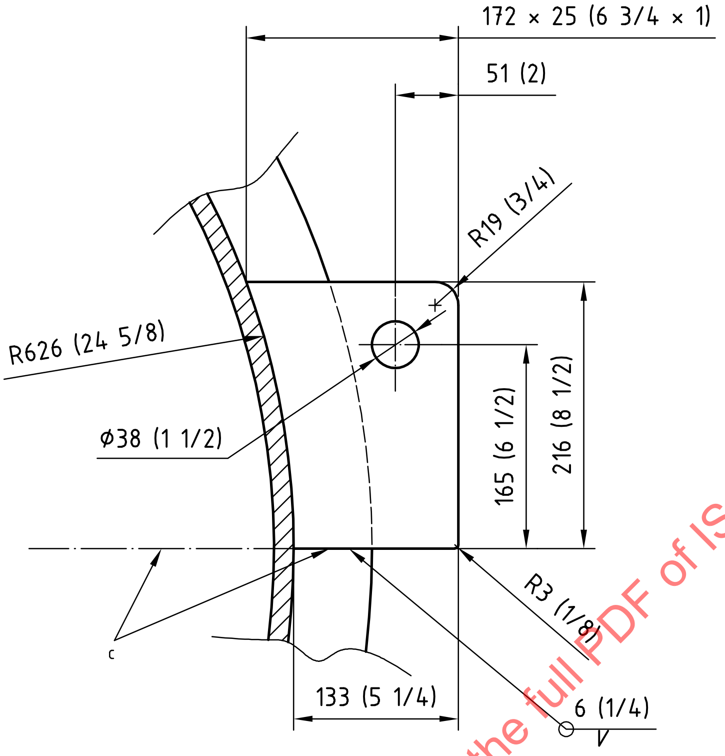
Dimensions in millimetres
(Dimensions in inches in parentheses)



a) 48G cylinder lifting lug

Figure 12 — Lifting lug details

Dimensions in millimetres
(Dimensions in inches in parentheses)



b) 48X and 48Y cylinder lifting lug detail

a Full penetration from both sides of the stiffening rings. Typical for all stiffeners.

b Typical except where shown otherwise.

c Lifting lug bases shall lie within ± 3 (1/8) of the horizontal plane passing through the cylinder centre line.

Figure 12 (*continued*)

Dimensions in millimetres
(Dimensions in inches in parentheses)

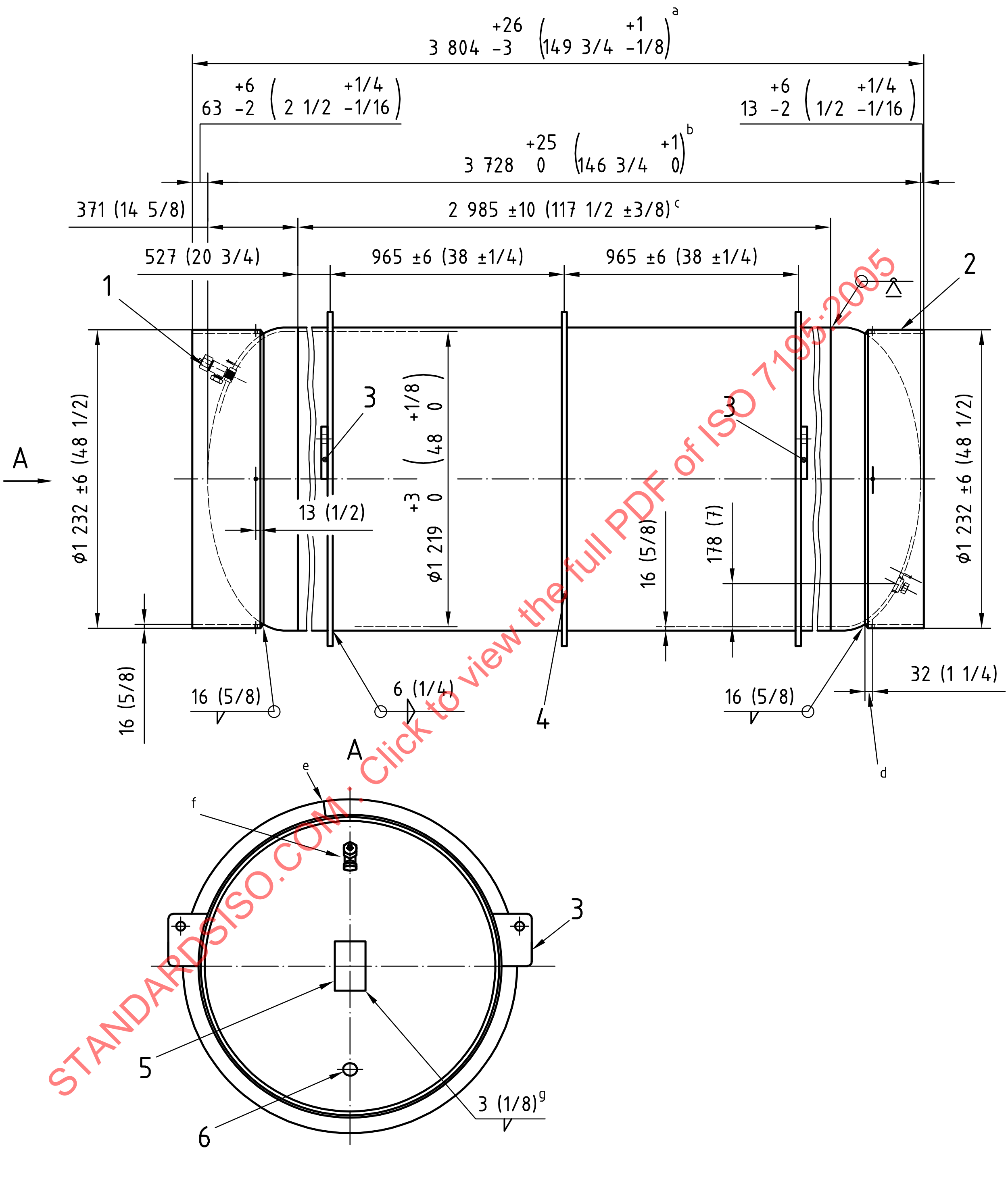


Figure 13 — 48Y cylinder

Key

1 1″ valve, see Figure 16; for location of valve, [see Figure 10 f)]
2 straight or tapered skirt 16 (5/8) thick
3 lifting lugs (two per side), (see Figure 12)
4 three stiffening rings, 22 × 63 (7/8 × 2 1/2)
5 nameplate, [see Figure 2 b)]
6 plug (far end), [[see Figure 10 c)]

Other than pressure envelope thickness, the dimensional tolerances are ± 1,6 (1/16), unless otherwise indicated. Angular tolerances are ± 2.

For a cylinder fabricated using the spiral weld process, the spiral weld shall start 50 (2) below the horizontal centre line.

Modify half couplings as shown in Figure 9 c) or 9 d) prior to installation as shown in Figure 10 c) and 10 f). Chase the half-coupling thread after welding.

1 1/2″ 11-1/2 NPT plug and plug coupling may be used as an alternative to the 1″ 11-1/2 NPT plug and half coupling.

For typical components and weld details, see Figures 1 c), 2 b), 9, 10 c), 11, 12 b) and 16.

A 20° tapered skirt (see Figure 11) may be used on the cylinder plug end in lieu of the straight skirt shown.

Optionally, a nameplate backing plate may be welded to the head and have the nameplate welded to the backing plate.

[a] Overall length.
[b] Overall body length.
[c] Seam to seam length.
[d] Drill four weep holes ∅ 13 (1/2) equally spaced on the centre line.
[e] Butt welds; see Figure 1 c).
[f] Valve protector location: see Figure 11.
[g] Optional nameplate backing plate weld.

Figure 13 (*continued*)

