

Petroleum and natural gas industries — Downhole equipment — Subsurface safety valve equipment

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Industries du pétrole et du gaz naturel - Equipement de
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10432:1999)

This European Standard was approved by CEN on 17 September 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

The text of the International Standard ISO 10432:1999 has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries" in collaboration with Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum and natural gas industries", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2000, and conflicting national standards shall be withdrawn at the latest by May 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

NOTE FROM CEN/CS: The foreword is susceptible to be amended on reception of the German language version. The confirmed or amended foreword, and when appropriate, the normative annex ZA for the references to international publications with their relevant European publications will be circulated with the German version.

Endorsement notice

The text of the International Standard ISO 10432:1999 was approved by CEN as a European Standard without any modification.

INTERNATIONAL STANDARD

EN ISO 10432:1999

**ISO
10432**

Second edition
1999-11-01

Petroleum and natural gas industries — Downhole equipment — Subsurface safety valve equipment

*Industries du pétrole et du gaz naturel — Équipement de forage vertical —
Vannes de protection de fond de puits*



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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.

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.

This International Standard was developed by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

This second edition cancels and replaces the first edition (ISO 10432:1993) and includes the changes in API 14A, ninth edition, 1994, and its Supplement dated December 1997.

Annex B and Annex E form a normative part of this International Standard. Annexes A, C, D and F are for information only.

Introduction

This International Standard has been developed by users/purchasers and suppliers/manufacturers of subsurface safety valve equipment intended for use in the petroleum and natural gas industry worldwide. This International Standard is intended to give requirements and information to both parties in the selection, manufacture, testing and use of subsurface safety valve equipment. Further, this International Standard addresses requirements that set the minimum parameters with which the supplier/manufacturer must comply to claim conformity with this standard.

Users of this International Standard should be aware that further or differing requirements might be needed for individual applications. This International Standard is not intended to inhibit a supplier/manufacturer from offering, or the user/purchaser from accepting, alternative equipment or engineering solutions. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the supplier/manufacturer should identify any variations from this International Standard and provide details.

Upon publication of ISO 16070, *Petroleum and natural gas industries — Downhole equipment — Lock mandrels and landing nipples*, as an International Standard, the requirements for lock mandrels and landing nipples in this International Standard 10432 will be superseded.

Petroleum and natural gas industries — Downhole equipment — Subsurface safety valve equipment

1 Scope

This International Standard was formulated to provide the minimum acceptable requirements for subsurface safety valve (SSSV) equipment. It covers subsurface safety valves, safety valve locks, safety valve landing nipples and all components that establish tolerances and/or clearances which may affect performance or interchangeability of the SSSV equipment. Safety valve locks, safety valve landing nipples and SSSVs manufactured by different facilities or manufacturers may be supplied as separate items.

NOTE Limits: The subsurface safety valve is an emergency safety device, and is not intended or designed for operational activities, such as production/injection reduction, production stop, or as a backflow valve.

2 Normative references

The following normative documents contain provision which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality level (AQL) for lot-by-lot inspection*.

ISO 3601-1:1988, *Fluid systems — Sealing devices — O-rings — Part 1: Inside diameters, cross-sections, tolerances and size identification code*.

ISO 3601-3:—¹⁾, *Fluid power systems — O-rings — Part 3: Quality acceptance criteria*.

ISO 10417:1993, *Petroleum and natural gas industries — Subsurface safety valve systems — Design, installation, operation and repair*.

ISO 11960:—²⁾, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*.

ANSI/NCSL Z540-1:1994, *General requirements for calibration laboratories and measuring and test equipment*.

API Spec 5B:1996, *Threading, gauging, and thread inspection of casing, tubing, and line pipe threads*.

API RP 13B1:1990 (and 1993, 1996 supplements), *Standard procedure for field testing water-based drilling fluids*.

API Manual of Petroleum Measurement Standards, Chapter 10.4:1988 (reaffirmed 1993), *Determination of sediment and water in crude oil by the centrifuge method (field procedure)*.

1) To be published. (Revision of ISO 3601-3:1987)

2) To be published. (Revision of ISO 11960:1996)

- ASME Boiler and Pressure Vessel Code, Section II:1998, *Materials specification*.
- ASME Boiler and Pressure Vessel Code, Section V:1998, *Nondestructive testing*.
- ASME Boiler and Pressure Vessel Code, Section VIII:1998, *Pressure vessels*.
- ASME Boiler and Pressure Vessel Code, Section IX:1998, *Welding and brazing qualifications*.
- ASTM A 370:1997, *Standard test methods and definitions for mechanical testing of steel products*.
- ASTM A 388/A 388M:1995, *Standard practice for ultrasonic examination of heavy steel forgings*.
- ASTM A 609/A 609M:1991, *Standard practice for castings, carbon, low-alloy, and martensitic stainless steel, ultrasonic examination thereof*.
- ASTM D 395:1998, *Standard test methods for rubber property — Compression set*.
- ASTM D 412:1998, *Standard test methods for vulcanized rubber and thermoplastic rubbers and thermoplastic elastomers — Tension*.
- ASTM D 1414:1994, *Standard test methods for rubber O-rings*.
- ASTM D 1415:1988, *Standard test methods for rubber property — International hardness*.
- ASTM D 2240:1997, *Standard test methods for rubber property — Durometer hardness*.
- ASTM E 10:1998, *Standard test method for Brinell hardness of metallic materials*.
- ASTM E 18:1997, *Standard test methods for Rockwell hardness and Rockwell superficial hardness of metallic materials*.
- ASTM E 92:1982, *Standard test method for Vickers hardness of metallic materials*.
- ASTM E 94:1993, *Standard guide for radiographic testing*.
- ASTM E 140:1997, *Standard hardness conversion tables for metals*.
- ASTM E 165:1995, *Standard test method for liquid penetrant examination*.
- ASTM E 186:1993, *Standard reference radiographs for heavy-walled [2 to 4 1/2-in. (51 to 114-mm)] steel castings*.
- ASTM E 280:1993, *Standard reference radiographs for heavy-walled [4 1/2 to 12-in. (114 to 305-mm)] steel castings*.
- ASTM E 428:1992, *Standard practice for fabrication and control of steel reference blocks used in ultrasonic inspection*.
- ASTM E 446:1993, *Standard reference radiographs for steel castings up to 2 in. (51 mm) in thickness*.
- ASTM E 709:1995, *Standard guide for magnetic particle examination*.
- MIL-H-6875H:1989, *Process for heat treatment of steel*.
- NACE MR0175:1992, *Sulfide stress cracking resistant metallic materials for oilfield equipment*.
- SNT-TC-1A:1988, *Personnel qualification and certification in nondestructive testing*.
- BS 2M 54:1991, *Specification for temperature control in the heat treatment of metals*.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply:

3.1

AQL

acceptance quality level

3.2

bean

the orifice or designed restriction causing the pressure drop in velocity-type SSCSVs

3.3

chloride stress corrosion cracking

cracking under the combined action of tensile stress and corrosion in the presence of chlorides and water

3.4

design acceptance criteria

defined limits placed on characteristics of materials, products, or services, established by the manufacturer to ensure conformance to the product design

3.5

end connection

SSSV equipment/tubular connecting interface

3.6

failure

any condition of SSSV equipment that prevents it from performing the design function

3.7

fit

the geometric relationship between parts

NOTE This would include the tolerance criteria used during the design of a part and its mating parts, including seals adjusted to or shaped for their purpose.

3.8

form

the essential shape of a product including all its component parts

3.9

function

the operation of a product during service

3.10

functional test

test performed to confirm proper operation of SSSV equipment

3.11

heat treatment

heat treating

alternate steps of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties

3.12

interchangeable

conforming in every detail, within specified tolerances, to both fit and function of a safe design but not necessarily to the form

3.13

manufacturer

the principal agent in the design, fabrication and furnishing of SSSV equipment, who chooses to comply with this International Standard

3.14

model

SSSV equipment with unique internal part(s) and operating characteristics which differentiate it from other SSSV equipment of the same type

NOTE It may have any of a variety of end connections.

3.15

NDE

nondestructive examination

3.16

operating manual

a publication issued by the manufacturer which contains detailed data and instructions related to the design, installation, operation and maintenance of SSSV equipment

3.17

operator

a user of SSSV equipment

3.18

SCSSV

a surface-controlled subsurface safety valve

3.19

SSCSV

a subsurface-controlled subsurface safety valve

NOTE An SSCSV is actuated by the characteristics of the well.

3.20

SSSV

a subsurface safety valve (a device whose design function is to prevent uncontrolled well flow when closed)

NOTE These devices may be installed and retrieved by wireline or pump-down methods (wireline-retrievable) or be an integral part of the tubing string (tubing retrievable).

3.21

SSSV equipment

the subsurface safety valve, safety valve lock, safety valve landing nipple and all components that establish tolerances and/or clearances which may affect performance or interchangeability of the SSSV equipment

3.22

stress corrosion cracking

cracking which results from a combination of corrosion and stress when susceptible materials are exposed to specific corrosive media

3.23

stress relief

controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses

3.24

sulfide stress cracking

cracking under the combined action of tensile stress and corrosion in the presence of water and hydrogen sulfide

3.25**SV lock**

a device attached to or a part of the SSSV that holds the SSSV in place

3.26**SVLN**

a receptacle with internal sealing surfaces in which an SSSV may be installed

NOTE It may include recesses for locking devices to hold the SSSV in place and may be ported for communication to an outside source for SSSV operation.

3.27**test agency**

any party which provides a test facility and administers a test programme that meets the verification test requirements of this International Standard

3.28**type**

SSSV equipment with unique characteristics which differentiate it from other SSSV equipment

NOTE The SCSSV, the velocity-type SSCSV and the low-tubing-pressure-type SSCSV are examples of SSSV types.

3.29**verification test**

test performed to qualify a particular size, type and model of SSSV equipment for a specific class of service

3.30**weight loss corrosion**

loss of metal in areas exposed to fluids which contain water or brine and carbon dioxide (CO₂), oxygen (O₂) or other corrosive agents

4 Requirements**4.1 General**

The user shall provide to the manufacturer the information required to define the appropriate product. Annex F contains a checklist of suggested ordering information.

4.2 Design requirements

4.2.1 Drawings, manufacturing specifications and the verification test results shall be retained by the manufacturer for a period of ten years after SSSVs of that size, model and type are discontinued from the manufacturer's product line. SSSV equipment conforming to this International Standard shall be manufactured to drawings and specifications that are substantially the same as those of the SSSV equipment that has passed the verification test.

4.2.2 Documentation of designs shall include methods, assumptions, calculations and design requirements. Design requirements shall include but not be limited to those criteria for size, test and operating pressures, material, environmental and other pertinent requirements upon which the design is based. Design documentation shall be clear, legible, reproducible and retrievable.

4.2.3 Design documentation shall be reviewed and verified by a qualified individual other than the individual who created the original design.

4.2.4 Changes to the design acceptance criteria which may affect verification test performance or interchangeability of SSSV equipment shall require requalification, except that seals which have passed the applicable verification test requirements of clause 7 shall be considered interchangeable among the SSSV equipment of any one manufacturer for a particular class of service.

4.2.5 SSSV equipment manufactured in accordance with this International Standard shall conform to one or more of the following classes of service:

- ³/₄ **Class 1: standard service.** This class of SSSV equipment is intended for use in wells which do not exhibit the detrimental effects caused by sand or corrosive agents.
- ³/₄ **Class 2: sandy service.** This class of SSSV equipment is intended for use in wells where a substance such as sand could be expected to cause SSSV equipment failure. Class 2 SSSV equipment shall also meet the requirements for Class 1 service.
- ³/₄ **Class 3: stress corrosion cracking service.** This class of SSSV equipment is intended for use in wells where corrosive agents could be expected to cause stress corrosion cracking. Class 3 equipment shall meet the requirements for Class 1 or Class 2 and be manufactured from materials which are resistant to stress corrosion cracking. Within this service class, there are two divisions, 3S for sulfide stress cracking service and 3C (see note) for chloride stress cracking service. Metallic materials, suitable for a 3S environment, shall be in accordance with NACE MR0175.

NOTE Metallic materials suitable for Class 3C service are dependent on specific well conditions. No national or international standards exist for the application of metallic materials for this class of service.

- ³/₄ **Class 4: weight loss corrosion service.** This class of SSSV equipment is intended for use in wells where corrosive agents could be expected to cause weight loss corrosion. Class 4 equipment shall meet the requirements for Class 1 or Class 2 and be manufactured from materials which are resistant to weight loss corrosion (see note).

NOTE Metallic materials suitable for Class 4 service are dependent on specific well conditions. No national or international standards exist for the application of metallic materials for this class of service.

4.3 Functional considerations

SSSV design shall permit prediction and repeatability of rates, pressures or other conditions required for closure.

4.4 Design considerations

4.4.1 The manufacturer shall establish rated working pressures of SSSV equipment within the requirements of this International Standard. These rated working pressures are commonly 20,7 MPa, 34,5 MPa, 41,4 MPa, 69,0 MPa and 103,5 MPa (3 000 psi, 5 000 psi, 6 000 psi, 10 000 psi and 15 000 psi). Temperature effects on all the materials used in the manufacture of SSSV equipment shall be considered in establishing the rated working pressure. The design shall take into account the effects of pressure containment and pressure-induced loads. Specialized conditions shall also be considered such as pressure testing with temporary test plugs.

4.4.2 The manufacturer shall establish internal yield pressure, collapse pressure and minimum tensile strength ratings, excluding end connections.

4.4.3 SSSV equipment design shall take into consideration the effects of temperature gradients and thermal cycles on all components. The upper temperature limit shall be the lowest high-temperature rating of any component of the SSSV. The lower temperature limit shall be the highest low-temperature rating of any component of the SSSV. Derating of metal mechanical properties shall be in accordance with ASME Boiler and Pressure Vessel Code Section II, Part D, *Material Properties*.

4.4.4 SSSV equipment design shall take into account the effects of retained fluid(s) on all components. SSSV equipment design shall consider the effects of sand, chlorides, corrosion inhibitors and other chemicals routinely encountered in oil and gas production.

4.4.5 Component and subassembly interchangeability shall be required within each manufacturer's service class, size, type and model, including pressure rating of SSSV equipment. This shall extend to all facilities of the manufacturer. Components shall be designed or identified to avoid the use of non-interchangeable parts.

4.4.6 Additive dimensional tolerance shall be such that proper operation of the SSSV equipment is assured. This requirement applies to factory-assembled equipment and to replacement components.

4.4.7 Internal diameters and tolerances for typical-size SVLNs are listed in Annex A, Table A.1. External diameters and tolerances for typical-size wireline-retrievable SSSVs are listed in Annex A, Table A.2. The manufacturer may establish other dimensions and tolerances.

4.5 Verification test

SSSVs, SV locks, SVLNs and seals shall pass the applicable verification test specified in clause 7.

5 Materials

5.1 General

The manufacturer shall have written specifications for all materials used in SSSV equipment. The manufacturer shall select all materials to be suitable for a particular class of service and shall document the selection criteria. All materials shall comply with the manufacturer's written specifications.

Material substitutions, except seals, in qualified SSSV equipment are allowed without verification testing provided that the manufacturer's selection criteria are documented and meet all other requirements of this International Standard.

Seals that have passed the verification test requirements of 7.25 are considered interchangeable among the SSSV equipment of any one manufacturer for a particular class of service.

5.2 Metals

5.2.1 The manufacturer's specifications shall define:

- a) chemical-composition limits;
- b) heat treatment conditions;
- c) mechanical-property limits:
 - 1) tensile strength,
 - 2) yield strength,
 - 3) elongation,
 - 4) hardness.

5.2.2 The mechanical properties specified in 5.2.1 for traceable metal components shall be verified by tests conducted on a material sample produced from the same heat of material. The material sample shall experience the same heat treatment process as the component it qualifies. Material subsequently heat-treated from the same heat of material shall be hardness-tested after processing to confirm compliance with the hardness requirements of the manufacturer's specifications. The hardness results shall verify through documented correlation that the mechanical properties of the material tested meet the properties specified in 5.2.1. The heat treatment process parameters shall be defined in the heat treatment procedure. Hardness testing is the only mechanical-property test required after stress relieving. Material test reports provided by the material supplier or the manufacturer are acceptable documentation.

5.2.3 Each welded component shall be stress-relieved as per the manufacturer's written specifications and, where applicable, in accordance with Paragraphs UCS-56 and UHA-32, Section VIII, Division 1, Subsection C, ASME Boiler and Pressure Vessel Code. In addition, carbon and low-alloy steel weldments on Class 3 SSSV equipment shall be stress-relieved in accordance with NACE MR0175.

5.3 Non-metals

5.3.1 The manufacturer shall have written procedures, and documentation of test results, for testing sealing materials to the limits for which the SSSV equipment is rated.

5.3.2 The manufacturer's written specifications for non-metallic compounds shall define those characteristics critical to the performance of the material, such as:

- a) compound type;
- b) mechanical properties, as a minimum:
 - 1) tensile strength (at break),
 - 2) elongation (at break),
 - 3) tensile modulus (at 50 % or 100 %, as applicable);
- c) compression set;
- d) durometer hardness.

5.3.3 The manufacturer's written specifications shall include handling, storage and labelling requirements, including the cure date, batch number, compound identification and shelf life appropriate to each compound.

5.4 Traceability

5.4.1 All components, weldments, subassemblies and assemblies of SSSV equipment shall be traceable except:

- a) setting springs used to establish closure parameters for SSCSVs;
- b) beans for SSCSVs;
- c) common hardware items such as nuts, bolts, set screws, shear pins, spacers, tube fittings, tubing and shear screws.

5.4.2 Component traceability is considered sufficient when it can be traced to a job lot, which identifies the included heat or batch lot(s) and a material test report. All components in a multiheat job lot are rejectable if any heat lot does not comply with the manufacturer's written specification.

5.4.3 Traceability identification shall be sufficient to identify significant problems and permit proper corrective action and shall include assembly, subassembly and component traceability to a heat or other appropriate batch lot.

5.4.4 Traceability for SSSV equipment is considered sufficient if the equipment meets the requirements of this International Standard when it leaves the manufacturer's inventory.

6 Quality control requirements

6.1 General

This clause provides minimum quality control requirements to meet this International Standard. All quality control work shall be controlled by documented instructions which include acceptance criteria.

6.2 Documentation retention

Required documentation for quality control work shall be retained for a minimum of five years from the date of origination.

6.3 Personnel qualifications

6.3.1 Personnel performing NDE shall be qualified in accordance with at least SNT TC-1A, Level II, for evaluation and interpretation.

6.3.2 Personnel performing visual examinations shall have an annual eye examination in accordance with SNT-TC-1A, as applicable to the discipline to be performed.

6.3.3 All other personnel performing inspection for acceptance shall be qualified in accordance with documented requirements.

6.4 Calibration systems

6.4.1 Measuring and testing equipment used for acceptance shall be identified, controlled, calibrated and adjusted at specified intervals in accordance with written specifications, ANSI/NCSL Z540-1 and this International Standard.

6.4.2 Pressure-measuring devices shall:

- a) be readable to at least 0,5 % of full-scale range;
- b) be calibrated to maintain 2 % accuracy of full-scale range.

6.4.3 If a pressure gauge is utilized, pressure measurements shall be made at not less than 25 % nor more than 75 % of the full span of the pressure gauge.

6.4.4 Pressure-measuring devices shall be periodically calibrated with a master pressure-measuring device or a dead-weight tester at 25 %, 50 % and 75 % of full scale.

6.4.5 Calibration intervals for pressure-measuring devices shall be a maximum of three months until documented calibration history can be established. Calibration intervals shall then be established based on repeatability, amount of usage and documented calibration history.

6.5 Inspection of elastomeric materials

6.5.1 Sampling procedures, and the basis for acceptance or rejection of a batch lot, shall be in accordance with ISO 2859-1 general inspection level II at a 2,5 AQL for O-rings and a 1,5 AQL for other packing elements until a documented variation history can be established. Sampling procedures shall then be established based on the documented variation history.

6.5.2 Visual inspection of O-rings shall be in accordance with ISO 3601-3. Other packing elements shall be visually inspected in accordance with the manufacturer's documented specifications.

6.5.3 Dimensional tolerances of O-rings shall be in accordance with ISO 3601-1 or equivalent. Other packing elements shall meet dimensional tolerances of the manufacturer's written specifications.

6.5.4 The durometer hardness of O-rings or other elastomeric packing elements shall be determined in accordance with ASTM D 2240 or D 1415. A test specimen manufactured from each batch may be used.

6.6 Dimensional inspection

All traceable components, except elastomeric seals, shall be dimensionally inspected to assure proper function and compliance with design specifications and drawings.

6.7 Thread inspection

6.7.1 All API tapered-thread tolerances, inspection requirements, gauging, gauging practice, gauge calibration and gauge certification shall be in accordance with API Spec 5B.

6.7.2 All other thread tolerances, inspection requirements, gauging, gauging practice, gauge calibration and gauge certification shall conform to the specified thread manufacturer's written specifications.

6.8 Welding and brazing

6.8.1 Welding and brazing procedure and personnel qualification shall be in accordance with ASME Boiler and Pressure Vessel Code Section IX.

6.8.2 Material and practices not listed in ASME Boiler and Pressure Vessel Code Section IX shall be applied using welding procedures qualified in accordance with the methods of ASME Boiler and Pressure Vessel Code Section IX.

6.9 Qualification of heat treatment equipment

6.9.1 Furnace calibration

Heat treatment of production parts shall be performed with heat treatment equipment that has been calibrated and surveyed.

Each furnace shall be surveyed within one year prior to heat treatment operations. When a furnace is repaired or rebuilt, a new survey shall be carried out before heat treatment.

Batch-type and continuous-type heat treatment furnaces shall be calibrated in accordance with one of the following procedures:

- a) the procedure specified in MIL-H-6875H, Section 5;
- b) the procedure specified in BS 2M 54:1991, Section 7;
- c) the manufacturer's written specifications, including acceptance criteria which are not less stringent than the procedures identified above.

6.9.2 Instruments

Automatic controlling and recording instruments shall be used.

Thermocouples shall be located in the furnace working zone(s) and protected from furnace atmospheres.

The controlling and recording instruments used for the heat treatment processes shall possess an accuracy of 1 % of their full-scale range.

Temperature-controlling and recording instruments shall be calibrated at least once every three months until a documented calibration history can be established. Calibration intervals shall then be established based on repeatability, degree of usage and documented calibration history.

Equipment used to calibrate the production equipment shall possess an accuracy of 0,25 % of full-scale range.

6.10 Coatings and overlays

Coatings and overlays shall be controlled by documented instructions which include acceptance criteria.

6.11 Mechanical and physical properties (where required by this International Standard)

6.11.1 Mechanical-property test procedures and practices shall be in accordance with ASTM A 370 for the metallic materials used for traceable components. Hardness testing shall be in accordance with ASTM E 10 or E 18 (ASTM E 92 may be used when E 10 or E 18 cannot be applied due to size, accessibility or other limitations). Hardness conversion to other measurement units shall be in accordance with ASTM E 140, with the exceptions noted in NACE MR0175 for Class 3 equipment.

6.11.2 Mechanical-property test procedures for elastomeric compound types shall be in accordance with:

- a) tensile-elongation modulus:

- 1) O-Rings — ASTM D 1414,
- 2) all others — ASTM D 412;
- b) compression set:
 - 1) O-Rings — ASTM D 1414,
 - 2) all others — ASTM D 395;
- c) durometer hardness:
 - 1) O-Rings — ASTM D 1415,
 - 2) all others — ASTM D 2240.

6.12 NDE requirements

6.12.1 All NDE instructions shall be approved by a Level III examiner.

6.12.2 All primary closure springs shall be magnetic-particle or liquid-penetrant inspected to verify conformance with the manufacturer's written specifications.

6.12.3 All pressure-containing welds shall be magnetic-particle or liquid-penetrant inspected for surface defects and shall be volumetrically inspected by radiographic or ultrasonic techniques to verify conformance with the manufacturer's written specifications.

6.12.4 All pressure-containing castings and forgings shall be magnetic-particle or liquid-penetrant inspected for surface defects and shall be volumetrically inspected by radiographic or ultrasonic techniques to verify conformance with the manufacturer's written specifications. The manufacturer may develop AQL inspection levels based on documented variation history.

6.12.5 NDE methods and acceptance criteria are as follows:

6.12.5.1 Liquid penetrant

- a) Method — ASTM E 165.
- b) Acceptance criteria — ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels, Division 1, Appendix 8.

6.12.5.2 Wet magnetic-particle examination

- a) Method — ASTM E 709.
- b) Definitions:
 - 1) Relevant indication — only those indications with major dimensions greater than 1,6 mm (1/16 in) shall be considered relevant. Inherent indications not associated with a surface rupture (i.e. magnetic-permeability variations, non-metallic stringers, etc.) are considered non-relevant.
 - 2) Linear indication — any indication in which the length is equal to or greater than three times its width.
 - 3) Rounded indication — any indication which is circular or elliptical with its length less than three times the width.
- c) Acceptance criteria:
 - 1) Any relevant indication 4,8 mm (3/16 in) or greater is unacceptable. No relevant linear indications are allowed for weldments.

- 2) No more than ten relevant indications in any 39 cm² (6 in²) area.
- 3) Four or more rounded relevant indications in a line separated by less than 1,6 mm (1/16 in) are unacceptable.

6.12.5.3 Ultrasonic inspection — weldments

- a) Method — ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination, Article 5.
- b) Acceptance criteria — ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessel, Division 1, Appendix 12.

6.12.5.4 Ultrasonic inspection — castings

- a) Method — ASTM E 428 and ASTM A 609.
- b) Acceptance criteria — ASTM A 609 ultrasonic-testing quality level 1, minimum.

6.12.5.5 Ultrasonic inspection — forgings and wrought products

- a) Method — ASTM E 428 and ASTM A 388.
- b) Calibration:
 - 1) Back-reflection technique — the instrument shall be set so that the first back-reflection is 75 % ± 5 % of screen height when the transducer is placed on an indication-free area of the forging or wrought product.
 - 2) Flat-bottom hole technique — the distance-amplitude curve (DAC) shall be based on a 3,2 mm (1/8 in) flat-bottom hole through 101,6 mm (4 in) of metal and a 6,4 mm (1/4 in) flat-bottom hole for metal distances exceeding 101,6 mm (4 in).
 - 3) Angle beam technique — the distance-amplitude curve (DAC) shall be based on a notch of depth equal to the lesser of 9,5 mm (3/8 in) or 3 % of the normal section thickness [9,5 mm (3/8 in) maximum], a length of approximately 25,4 mm (1 in) and a width not greater than twice its depth.
- c) Acceptance criteria — the following forging or wrought-product defects are rejectable:
 - 1) Back-reflection technique — indications greater than 50 % of the referenced back-reflection accompanied by a complete loss of back-reflection.
 - 2) Flat-bottom hole technique — indications equal to or larger than the indications observed from the calibration flat-bottom hole.
 - 3) Angle beam technique — amplitude of the discontinuities exceeding that of the reference notch.

6.12.5.6 Radiographic inspection — weldments

- a) Method — ASTM E 94.
- b) Acceptance criteria — ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessel, UW-51.

6.12.5.7 Radiographic inspection — castings

- a) Method — ASTM E 94.
- b) Acceptance criteria:
 - 1) ASTM E 186.

2) ASTM E 280.

3) ASTM E 446.

Maximum defect classification for 1), 2) and 3) above is as follows:

Type of defect	Maximum defect classification
A	3
B	2
C	2 (all types)
D	None acceptable
E	None acceptable
F	None acceptable
G	None acceptable

6.12.5.8 Radiographic inspection — forgings

a) Method — ASTM E 94.

b) Acceptance criteria — the following defects are rejectable:

- 1) Any type of crack or lap.
- 2) Any other elongated indication with length greater than:
 - 6,4 mm (1/4 in) for t up to 19 mm (3/4 in) inclusive;
 - $1/3t$ from $t = 19$ mm (3/4 in) up to $t = 57,2$ mm (2 1/4 in);
 - 19 mm (3/4 in) for t over 57,2 mm (2 1/4 in).

NOTE t is the wall thickness.

- 3) Any group of indications in a line that have an aggregate length greater than t in a length of $12t$.

7 Testing

7.1 General

7.1.1 The SSSVs, SV locks and SVLNs produced in accordance with this International Standard shall be constructed of materials in compliance with this International Standard and pass the verification and functional tests required by this clause.

7.1.2 The testing requirements in this International Standard are not represented as well conditions.

7.1.3 During verification testing of hydraulically operated SSSVs, control line fluid metering shall be used to provide a readable hydraulic control line pressure trace, unless otherwise specified. Refer to Annex C, Figure C.6 for a characteristic pressure versus time plot for opening and closing hydraulic control pressures with hydraulic fluid being applied at a metered rate.

7.1.4 All pressures are defined as gauge unless otherwise specified and shall be recorded on time-based equipment.

7.1.5 All test conditions without a specified tolerance shall be considered minimum values. The maximum value shall not exceed the minimum value by more than 10 %.

7.1.6 The drift bar used in the verification test shall be provided by the manufacturer. Drift bar dimensions and a unique identifier for the bar shall be provided by the manufacturer.

7.1.7 With mutual consent between the test agency and the manufacturer, higher flow rates may be applied and used for all flow tests.

7.1.8 The objectives of the testing requirements of this clause are to qualify SSSV equipment for specific classes of service and to verify proper operation of SSSV equipment. Testing required for SSSV equipment furnished to this International Standard is:

- a) verification testing to qualify each size, type and model of SSSV for a specific class of service, either Class 1 or combined Class 1 and Class 2;
- b) functional testing of each SSSV;
- c) functional and verification testing of SVLN(s);
- d) functional and verification testing of SV lock(s).

7.2 Verification testing

7.2.1 General

- a) Verification testing to qualify an SSSV for Class 1 or combined Class 1 and Class 2 service shall be performed by a test agency.
- b) Verification testing of SV locks, SVLNs and all seals shall be performed by a test agency.

7.2.2 Manufacturer requirements

The manufacturer shall submit an SSSV of most recent manufacture for verification testing. Such testing shall qualify SSSVs of the same size, type and model as the tested SSSV. Substantive changes to the verification test (specified herein) shall require requalification of a previously qualified SSSV within three years of the effective date of the change.

- a) The test section shall completely enclose a wireline-retrievable SSSV. Tubing-retrievable SSSVs shall be an integral part of the test section. The test section shall be rated to at least the rated working pressure of the SSSV.
- b) The test section ends, length and hydraulic control connections shall be compatible with the test agency's facility.
- c) The manufacturer shall furnish any equipment not normally furnished by the test agency to accommodate installation of a particular SSSV in the test facility or to accomplish the verification test.

7.2.3 Verification-testing requirements

- a) The manufacturer shall declare that an SSSV is being submitted for the class of service and working pressure desired in the verification test by submitting an application to the test agency. The application form shall contain the minimum information shown in Annex B, Table B.1.
 - 1) A manufacturer may submit an SSSV for Class 1 or for Class 1 and 2 testing. For combined testing, an SSSV passing both portions of the test shall be qualified for both Class 1 and Class 2 service. An SSSV passing the Class 1 portion, but failing the Class 2 portion of the combined test, shall be qualified for Class 1 service only.

- 2) In the event that a particular SSSV has design or operational features which are incompatible with the test facility and test procedures required by this International Standard, the manufacturer shall advise the test agency as to the nature of the incompatibility and shall request and fully describe on the test application, or attachments thereto, any equipment or procedures required to test the SSSV. Responsibility for furnishing, installing and testing this equipment shall be by agreement between the test agency and the manufacturer. The manufacturer shall be responsible for assuring that such equipment or procedures are not less stringent than this International Standard.
 - 3) The test agency shall conduct the test as specified on the manufacturer's test application. Any variation from the verification test requirements of this International Standard shall be recorded on the verification test data summary form (Table B.16) by the test agency.
- b) The manufacturer shall provide the test agency with a functionally tested SSSV, one operating manual and associated documentation for each size, type and model to be tested.
 - c) If a particular size, type and model of SSSV fails the verification test, that SSSV and any other SSSV of the same basic design and materials of construction shall not be submitted for retest until the manufacturer has determined and documented the justification for retest. The manufacturer shall conduct this analysis and document the results, including any corrective action taken. Such information need not be submitted to the test agency, but shall be placed in the manufacturer's test file for that SSSV before the SSSV is submitted for retest.
 - d) The test agency shall record the results of the verification test on documentation which as a minimum shall contain the data specified in the applicable example tables shown in Annex B. The content of the forms in Annex B is normative as a minimum data requirement for the documentation specified in this clause; however, the format of the forms is informative. This documentation shall be retained by the manufacturer and by the test agency, and shall be available to the operator upon request to the manufacturer.
 - e) To pass the verification test, the SSSV shall successfully complete all steps of the verification-testing procedure within the limits specified and in the order shown. The basis for discontinuing the test, and any unusual conditions observed at or prior to the time of discontinuance, shall be noted on the test data form by the test agency. Verification testing shall be discontinued if the valve fails to perform within the limits specified for any step except when such failures are determined to be a result of actions by the test agency or a failure within the test facility. The manufacturer, not the test agency, shall be responsible for determining the cause of failure of the valve.
 - f) Pre-test and post-test dimensional verification shall be conducted and documented by the manufacturer.
 - g) The manufacturer shall maintain a verification test file on each verification test including any retests that may have been required to qualify SSSV equipment and seals. This file shall be retained by the manufacturer for a period of ten years after such SSSV equipment and seals are discontinued from the manufacturer's product line. As a minimum, this file shall contain sufficient documentation to identify and permit retrieval of:
 - 1) all drawings and specifications applicable at the time of manufacture;
 - 2) all applications for verification tests or retests;
 - 3) all design and/or material modifications, or other justification for retest, of SSSV equipment and seals which did not pass any verification test;
 - 4) all test data specified in this clause;
 - 5) the documentation required in clause 8.

7.2.4 Test agency requirements

- a) The test agency reporting and records shall conform with Annex E and the applicable portions of clause 6.
- b) The test agency shall conduct verification tests in accordance with this clause.

- c) The test agency shall be responsible for assuring itself, the manufacturers and the operators that the test facility, procedures and forms comply with this International Standard.
- d) The test agency shall provide current documentation to manufacturers or operators on written request. This shall include, as a minimum:
 - 1) a description of the facility, including any limitations on the size, length, mass, type, pressure rating, temperature rating, and service class of SSSV that may be tested;
 - 2) the test procedures and forms actually used at the facility for each type and service class of SSSV;
 - 3) the procedures for maintenance and calibration of measuring equipment;
 - 4) the procedures for making applications for tests, the delivery of SSSVs, the initial installation and checkout of SSSVs and other pertinent information;
 - 5) any limitations on the accessibility of the facility (such limitations shall not preclude reasonable access to the facility for inspection by manufacturers or operators);
 - 6) any limitations on the receipt of proprietary information;
 - 7) any other information considered pertinent by the test agency.

7.3 Functional testing

7.3.1 SSSV functional testing shall be performed by the manufacturer on each new SSSV manufactured in accordance with this International Standard. The manufacturer's test facility shall be equipped with instrumentation to display and record information required by the test procedure.

7.3.2 Each SSSV shall be serialized, and results of functional tests delivered with the SSSV.

7.3.3 Results of functional tests shall be retained by the manufacturer for a period of five years after the date of sale of a specific SSSV.

7.3.4 Functional-test data shall be recorded, dated and signed by the personnel performing the tests. The required data is indicated in Annex B, Table B.24.

7.4 General requirements for an SSSV verification test facility

7.4.1 The components of the test facility systems shall have a capacity and working pressure as required by the size and/or working pressure of the SSSV to be tested. Typical test facility schematics, the SSSV gas flow facility, the liquid test facility and the controlled-temperature test facility are shown in Annex C, Figure C.1, Figure C.2 and Figure C.4, respectively.

7.4.2 The control pressure system components shall, as a minimum, consist of the items listed below:

- a) a hydraulic-fluid reservoir with a filtered vent;
- b) an accumulator;
- c) a hydraulic pump;
- d) a control system to operate the pump;
- e) a pressure relief facility to protect the system.

7.4.3 There shall be provision for the supply of nitrogen gas to conduct the required nitrogen leak test and a gas flow meter to indicate the leakage rate.