INTERNATIONAL STANDARD

ISO 10432

Third edition
2004-12-15

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

Reference number
ISO 10432:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10432 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

This third edition cancels and replaces the second edition (ISO 10432:1999), which has been technically revised.

Introduction

This International Standard has been developed by users/purchasers and suppliers/manufacturers of subsurface safety valves 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 valves. Furthermore, this International Standard addresses the minimum requirements with which the supplier/manufacturer is to comply so as to claim conformity with this International Standard.

Users of this International Standard should be aware that requirements above those outlined in this International Standard may 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.

The requirements for lock mandrels and landing nipples previously contained in this International Standard are now included in ISO 16070.

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

1 Scope

This International Standard provides the minimum acceptable requirements for subsurface safety valves (SSSVs). It covers subsurface safety valves including all components that establish tolerances and/or clearances which may affect performance or interchangeability of the SSSVs. It includes repair operations and the interface connections to the flow control or other equipment, but does not cover the connections to the well conduit.

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.

Redress activities are beyond the scope of this International Standard, see Clause 8.

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 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

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

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

ISO 3601-3, *Fluid systems — Sealing devices — O-rings — Part 3: Quality acceptance criteria*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 9000:2000, *Quality management systems — Fundamentals and vocabulary*

ISO 9712, *Non-destructive testing — Qualification and certification of personnel*

ISO 10414-1, *Petroleum and natural gas industries — Field testing of drilling fluids — Par 1: Water-based fluids*

ISO 10417, *Petroleum and natural gas industries — Subsurface safety valve systems — Design, installation, operation and redress*

ISO 13628-3, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 3: Through flowline (TFL) systems*

ISO 13665, *Seamless and welded steel tubes for pressure purposes — Magnetic particle inspection of the tube body for the detection of surface imperfections*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production*

ISO 16070, *Petroleum and natural gas industries — Downhole equipment — Lock mandrels and landing nipples*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

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

API Manual of Petroleum Measurement Standards, Chapter 10.4, *Determination of sediment and water in crude oil by the centrifuge method (field procedure)*[2)]

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

API Spec 14A, *Specification for subsurface safety valve equipment*

ASME Boiler and Pressure Vessel Code, Section II, *Materials specification*[3)]

ASME Boiler and Pressure Vessel Code, Section V, *Nondestructive examination*

ASME Boiler and Pressure Vessel Code, Section VIII:2001, *Pressure vessels*

ASME Boiler and Pressure Vessel Code, Section IX, *Welding and brazing qualifications*

ASTM A 388/A 388M, *Standard practice for ultrasonic examination of heavy steel forgings*[4)]

ASTM A 609/A 609M, *Standard practice for castings, carbon, low-alloy, and martensitic stainless steel, ultrasonic examination thereof*

ASTM D 395, *Standard test methods for rubber property — Compression set*

ASTM D 412, *Standard test methods for vulcanized rubber and thermoplastic elastomers — Tension*

ASTM D 1414, *Standard test methods for rubber O-rings*

ASTM D 2240, *Standard test methods for rubber propert — Durometer hardness*

ASTM E 94, *Standard guide for radiographic examination*

ASTM E 140, *Standard hardness conversion tables for metals. (Relationship among Brinell hardness, Vickers hardness, Rockwell hardness, superficial hardness, Knoop hardness, and scleroscope hardness)*

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1) NCSL International, 2995 Wilderness Place, Suite 107, Boulder, Colorado 80301-5404, USA.

2) American Petroleum Institute, 1220 L Street NW, Washington, DC 20005-4070, USA.

3) American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, USA.

4) American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

ASTM E 165, *Standard test method for liquid penetrant examination*

ASTM E 186, *Standard reference radiographs for heavy-walled [2 to 4 1/2-in. (51 to 114-mm)] steel castings*

ASTM E 280, *Standard reference radiographs for heavy-walled [4 1/2 to 12-in. (114 to 305-mm)] steel castings*

ASTM E 428, *Standard practice for fabrication and control of steel reference blocks used in ultrasonic inspection*

ASTM E 446, *Standard reference radiographs for steel castings up to 2 in. (51 mm) in thickness*

ASTM E 709, *Standard guide for magnetic particle examination*

BS 2M 54:1991, *Temperature control in the heat treatment of metals*[5)]

SAE-AMS-H-6875:1998, *Heat treatment of steel raw materials*[6)]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000:2000 and the following apply.

3.1
bean
orifice
designed restriction causing the pressure drop in velocity-type SSCSVs

3.2
design acceptance criteria
defined limits placed on characteristics of materials, products, or services established by the organization, customer, and/or applicable specifications to achieve conformity to the product design

[ISO/TS 29001:2003]

3.3
design validation
process of proving a design by testing to demonstrate conformity of the product to design requirements

[ISO/TS 29001:2003]

3.4
design verification
process of examining the result of a given design or development activity to determine conformity with specified requirements

[ISO/TS 29001:2003]

3.5
end connection
thread or other mechanism providing equipment-to-tubular interface

3.6
environment
set of conditions to which the product is exposed

5) BSI, Customer Services, 389 Chiswick High Road, London W4 4AL, UK.

6) SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA.

3.7
failure
any equipment condition that prevents it from performing to the requirements of the functional specification

3.8
fit
geometric relationship between parts

NOTE This includes the tolerance criteria used during the design of a part and its mating parts, including seals.

3.9
form
essential shape of a product including all its component parts

3.10
function
operation of a product during service

3.11
functional test
test performed to confirm proper operation of equipment

3.12
heat treatment
heat treating
alternate steps of controlled heating and cooling of materials for the purpose of changing mechanical properties

3.13
interchangeable
conforming in every detail, within specified tolerances, to both fit and function of a safe design but not necessarily to the form

3.14
manufacturer
principal agent in the design, fabrication and furnishing of equipment, who chooses to comply with this International Standard

3.15
manufacturing
process and action performed by an equipment supplier/manufacturer that are necessary to provide finished component(s), assembly(ies) and related documentation, that fulfil the requests of the user/purchaser and meet the standards of the supplier/manufacturer

NOTE Manufacturing begins when the supplier/manufacturer receives the order and is completed at the moment the component(s), assembly(ies) and related documentation are surrendered to a transportation provider.

[ISO 16070]

3.16
mass loss corrosion
weight loss corrosion (deprecated term)
loss of metal in areas exposed to fluids which contain water or brine and carbon dioxide (CO_2), oxygen (O_2) or other corrosive agents

NOTE The term “weight” is commonly incorrectly used to mean mass, but this practice is deprecated.

3.17
model
SSSV equipment with unique components and operating characteristics which differentiate it from other SSSV equipment of the same type

NOTE The same model can have any of a variety of end connections.

3.18
operating manual
publication issued by the manufacturer which contains detailed data and instructions related to the design, installation, operation and maintenance of equipment

3.19
profile
feature that is designed for the reception of a locking mechanism

3.20
proof test
test specified by the manufacturer which is performed to verify that the SSSV meets those requirements of the technical specification which are relevant to the validation testing performance

3.21
qualified part
part manufactured under a recognized quality assurance programme and, in the case of replacement, produced to meet or exceed the performance of the original part produced by the original equipment manufacturer (OEM)

NOTE ISO 9001 is an example of a recognized quality assurance programme.

[ISO 10417]

3.22
redress
any activity involving the replacement of qualified parts

cf. **repair** (3.23)

NOTE See Clause 8 for more information.

3.23
repair
any activity beyond the scope of redress that includes disassembly, re-assembly, and testing with or without the replacement of parts and may include machining, welding, heat treating or other manufacturing operations, that restores the equipment to its original performance

cf. **redress** (3.22)

[ISO 10417]

NOTE See Clause 8 for more information.

3.24
sealing device
device preventing contact of liquid and/or gas across the interface between the lock mandrel and the landing nipple

3.25
size
relevant dimensional characteristics of the equipment as defined by the manufacturer

3.26
sour service
exposure to oilfield environments that contain H_2S and can cause cracking of materials by the mechanisms addressed in ISO 15156

NOTE Adapted from ISO 15156-1:2001.

3.27
special feature
specific component or sub-assembly that provides a functional capability that is not validated during the validation test conducted in accordance with 6.5

3.28
subsurface safety valve
SSSV
device whose design function is to prevent uncontrolled well flow when closed

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

3.29
subsurface safety valve equipment
SSSV equipment
subsurface safety valve, and all components that establish tolerances and/or clearances which can affect its performance or interchangeability

3.30
stress corrosion cracking
SCC
cracking of metal involving anodic processes of localized corrosion and tensile stress (residual and/or applied) in the presence of water and H_2S

NOTE Chlorides and/or oxidants and elevated temperature can increase the susceptibility of metals to this mechanism of attack.

[ISO 15156-1]

3.31
stress cracking
stress corrosion cracking, or sulfide stress cracking, or both

NOTE Adapted from NACE MR0175: Jan 2003.

3.32
stress relief
controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses

3.33
sulfide stress cracking
SSC
cracking of metal involving corrosion and tensile stress (residual and/or applied) in the presence of water and H_2S

NOTE SSC is a form of hydrogen stress cracking (HSC) and involves embrittlement of the metal by atomic hydrogen that is produced by acid corrosion on the metal surface. Hydrogen uptake is promoted in the presence of sulfides. The atomic hydrogen can diffuse into the metal, reduce ductility and increase susceptibility to cracking. High strength metallic materials and hard weld zones are prone to SSC.

[ISO 15156-1]

3.34
test agency
organization which provides a test facility and administers a test program that meets the validation test requirements of this International Standard

NOTE See Annex A for test agency requirements.

3.35
test pressure
pressure at which the equipment is tested based upon all relevant design criteria

3.36
test section
test apparatus which contains the SSSV and provides for connection to a test facility's validation test apparatus

3.37
type
SSSV equipment with unique characteristics which differentiate it from other functionally similar SSSV equipment

EXAMPLES SCSSV, velocity-type SSCSV and low-tubing-pressure-type SSCSV are types of SSSV.

3.38
validation test
test performed to qualify a particular size, type and model of equipment for a specific class of service

NOTE See Annex B for details.

3.39
working pressure
SSSV internal pressure rating, including the differential rating with the valve closed

4 Abbreviated terms

AQL	acceptance quality limit
NDE	non-destructive examination
TFL	through flowline
SCSSV	surface-controlled subsurface safety valve
SSCSV	subsurface controlled subsurface safety valve
SSSV	subsurface safety valve
TRSV	tubing-retrievable safety valve
WRSV	wireline-retrievable safety valve

5 Functional specification

5.1 General

5.1.1 Functional requirements

The user/purchaser shall prepare a functional specification for ordering products which conform with this International Standard and specify the following requirements and operating conditions, as appropriate, and/or identify the supplier's/manufacturer's specific product. These requirements and operating conditions may be conveyed by means of a dimensional drawing, data sheet or other suitable documentation.

5.1.2 Classes of service

SSSV equipment manufactured in accordance with this International Standard shall conform to one or more of the following classes of service. The user/purchaser shall specify the class(s), as applicable.

— **Class 1: standard service.** This class of SSSV equipment is intended for use in wells which are not expected to exhibit the detrimental effects defined by Classes 2, 3, or 4.

— **Class 2: sandy service.** This class of SSSV equipment is intended for use in wells where particulates such as sand could be expected to cause SSSV equipment failure.

— **Class 3: stress cracking service.** This class of SSSV equipment is intended for use in wells where water containing corrosive agents can cause stress cracking. Class 3 equipment shall meet the requirements for Class 1 or Class 2 service and be manufactured from metallic materials that are demonstrated as resistant to sulfide stress cracking and stress corrosion cracking.

  The supplier/manufacturer shall ensure that the metallic materials used in Class 3 equipment meet the metallurgical requirements of ISO 15156 (all parts) for sour service and/or shall be suitable for service in non-sour-containing environments where stress corrosion cracking can occur.

  The user/purchaser shall ensure that the specific metallic materials contained within Class 3 equipment are suitable for the intended application.

  Within Class 3, there are two sub-classes, as follows:

  1) 3S for sulfide stress cracking service and stress corrosion cracking service in which chlorides are present in a sour environment. Metallic materials suitable for a 3S environment shall be in accordance with ISO 15156 (all parts).

  2) 3C for stress corrosion cracking service in a non-sour environment. Metallic materials suitable for Class 3C non-sour service are dependent on specific well conditions; no national or international standards exist for the application of metallic materials for this class of service.

NOTE For the purposes of these provisions, NACE MR0175/ISO 15156-1-2-3, is equivalent to ISO 15156 (all parts).

— **Class 4: mass loss corrosion service** (see 3.16). This class of SSSV equipment is intended for use in wells where corrosive agents could be expected to cause mass loss corrosion. Class 4 equipment shall meet the requirements for Class 1 or Class 2 and be manufactured from materials which are resistant to mass loss corrosion. 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.

5.2 SSSV functional characteristics

The SSSV functional characteristics should include but are not limited to the following:

a) type of SSSV control (surface-controlled, subsurface-controlled);

b) type of SSSV retrieval (tubing-retrievable, WL-retrievable, coil-tubing-retrievable, TFL-retrievable, etc.);

c) type of SSSV closing mechanism (ball, flapper, etc.);

d) requirement for internal self-equalizing capability;

e) requirement, if any, for holding the SCSSV open without the use of the primary operating source (temporary or permanent lock-open system);

f) requirement, if any, for providing control fluid communication from the SCSSV to any other subsurface device (e.g. a through-tubing retrievable secondary valve);

g) requirement, if any, for providing pump-through capability;

h) requirement, if any, for a redundant/independent back-up operating system;

i) requirements, if any, for minimal leakage (in accordance with 6.7.2) during functional testing.

5.3 Well parameters

The following characteristics shall be specified as applicable:

a) well location (land, platform, subsea);

b) size, mass, grade and material of the casing and tubing;

c) setting depth (maximum required for application) and control system parameters (control fluid type/properties, supply pressure, supply line(s) and connection rating(s), etc.);

d) casing and/or tubing architecture, trajectory, deviations, maximum dog leg severity;

e) restrictions through which the SSSV shall pass and restrictions/profiles through which the SSSV service tools/accessories shall pass;

f) requirement, if any, for passage of additional lines (electrical, hydraulic), between the valve OD and the casing ID, if applicable.

5.4 Operational parameters

5.4.1 SSSVs

The following operational parameters, as applicable, shall be specified for the SSSV:

a) rated working pressure;

b) rated temperature range;

c) if applicable, maximum allowable pressure drop at maximum flow rate through SSSV;

d) loading conditions, including combined loading (pressures, tension/compression, torque, bending) and the corresponding temperature extremes anticipated to be applied to the valve;

e) well stimulation operations, including its parameters, such as acidizing (give the composition of the acid), the pressure, the temperature, the acid flow rate and the exposure time, as well as any other chemicals used during the stimulation;

f) sand consolidation and fracturing operations, including sand/proppant description, fluid flow rate, proppant/fluid ratio or sand/fluid ratio, chemical composition, pressure and temperature;

g) well-servicing activities through the safety valve: size, type and configuration of other devices to be run through the valve, if applicable.

5.4.2 SSCSVs

The conditions under which the SSCSV will operate (flow conditions) and the conditions under which the valve should close (see ISO 10417) shall be specified, such as

a) at valve setting depth, the minimum, maximum and normal values of the production/injection pressures and temperatures at the anticipated flow rates;

b) composition of the production fluid (gas/oil/water) and density of each component.

5.5 Environmental compatibility

The following shall be identified for the SSSV to ensure environmental compatibility:

a) production/injection/annulus fluid chemical and physical composition, including solids (sand production, scale, etc.), to which the SSSV is exposed during its full life cycle;

b) in cases where the user/purchaser has access to corrosion-property historical data and/or research which is applicable to the functional specification, the user/purchaser should state to the manufacturer which material(s) has the ability to perform as required within a similar corrosion environment.

5.6 Compatibility with related well equipment

The following information, as applicable, shall additionally be specified to ensure the compatibility of the SSSV with the related well equipment:

a) SSSV size, type, material, the configuration of the interface connections (these connections are not included in the evaluation of combined loading);

b) internal receptacle profile(s), sealing bore dimension(s), outside diameter, inside diameter and their respective locations;

c) requirement(s) for passage of conduits (electrical/hydraulic) between valve OD and casing ID.

6 Technical specification

6.1 Technical requirements

The supplier/manufacturer shall prepare and provide to the user/purchaser the technical specification that responds to the requirements defined in the functional specification.

6.2 Technical characteristics of SSSV

The following criteria shall be met:

a) the SSSV shall be located and/or seal at the specified location and remain so until intentional intervention defines otherwise;

b) while installed, the SSSV shall perform in accordance with the functional specification;

c) where applicable, the SSSV shall not compromise well-intervention operations as specified in 5.4;

d) while in service, the SSSV shall meet the requirements of the functional specification.

6.3 Design criteria

6.3.1 General

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

6.3.2 Design requirements

6.3.2.1 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, working and operating pressures, materials, environment (temperature limits, service class, chemicals) and other pertinent requirements upon which the design is based. Design documentation shall be reviewed and verified by a qualified individual other than the individual who created the original design.

6.3.2.2 SSSV equipment conforming to this International Standard shall be manufactured to drawings and specifications that are substantially the same as those of the size, type, and model SSSV equipment that has passed the validation test.

6.3.2.3 The manufacturer shall establish verified internal yield pressure, collapse pressure and minimum tensile strength, temperature limits, and rated working pressure, excluding end connections. The manufacturer shall identify the critically stressed components of the product and the mode of stress. The manufacturer shall calculate the critical stress level in the identified component(s) based upon the maximum loads in the design input requirements. The minimum acceptable material condition and minimum acceptable material yield shall be used in the calculations and the calculations shall include consideration of temperature limit effects and thermal cycles. Metal mechanical properties de-rating shall be in accordance with ASME Boiler and Pressure Vessel Code, Section II, Part D.

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.

6.3.2.4 Component and subassembly identification and interchangeability shall be required within each manufacturer's service class, size, type and model, including working pressure rating of SSSV equipment. Additive dimensional tolerances of components shall be such that proper operation of the SSSV equipment is assured. This requirement applies to manufacturer-assembled equipment and to replacement components or sub-assemblies.

6.3.2.5 TRSV profiles that interface with locks and sealing devices covered by ISO 16070 shall comply with the requirements of that International Standard.

6.3.3 Working pressure de-rating

6.3.3.1 Working pressure de-rating of SSSVs of the same nominal size, type and model is permitted by reference to a successfully validation-tested product (base design) when the requirements of this subclause and this International Standard are satisfied. The rated working pressure of a de-rated design may be less than that of the base design by a maximum of 50 %.

6.3.3.2 In establishing a de-rated design, the manufacturer shall identify the critically stressed components of the base design, establish the maximum stress factors within those components at the maximum rated conditions and the specific mode of that stress. All design considerations and stress factors applied to the base design and its components shall be applied to the de-rated design evaluation.

The manufacturer shall establish the maximum stress factors in the equivalent components within the de-rated design. The minimum acceptable material condition, minimum acceptable material yield strengths, and maximum and minimum temperature effects on material properties shall be used.

6.3.3.3 Evaluation of the de-rated design shall include comparison of the calculated maximum stress factors stated as a percentage of material yields of the components of the base design; these shall not exceed

the maximum stress factors of the components of the base design. The mode of stress and same method of calculation(s)/evaluation(s) shall be applied to the identified components of both product designs.

Adjustments to material thickness or yield strengths shall not negatively impact maximum stress factors. The de-rated product shall be evaluated by the manufacturer to ensure that it will meet the requirements of the validation test.

6.3.3.4 Each de-rated product requires evaluation, justification and design documentation of the changes. Documentation shall be included in the product's design records.

6.3.4 Materials

6.3.4.1 General

a) Materials, and/or the service, shall be stated by the supplier/manufacturer and shall be suitable for the class of service and the environment specified in the functional specification. The manufacturer shall have written specifications for all materials. All materials used shall comply with the manufacturer's written specifications.

b) The user/purchaser may specify materials for the specific corrosion environment in the functional specification. Should the manufacturer propose to use another material, the manufacturer shall state that this material has performance characteristics suitable for all parameters specified in the well and production/injection parameters. This applies to metallic and non-metallic components.

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

6.3.4.2 Metals

6.3.4.2.1 The manufacturer's specifications shall define the following:

a) chemical-composition limits;

b) heat treatment conditions;

c) mechanical-property limits:

   1) tensile strength,

   2) yield strength,

   3) elongation,

   4) hardness.

6.3.4.2.2 The mechanical properties specified in 6.3.4.2.1 c) 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 6.3.4.2.1.c). 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.

6.3.4.2.3 Each welded component shall be stress-relieved as specified in 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 3S SSSV equipment shall be stress-relieved in accordance with ISO 15156 (all parts).

NOTE For the purposes of these provisions, NACE MR0175/ISO 15156-1-2-3, is equivalent to ISO 15156 (all parts).

6.3.4.3 Non-metals

6.3.4.3.1 The manufacturer shall have documented procedures, including acceptance criteria, for evaluations or testing of sealing materials or other non-metals to the limits for which the equipment is rated.

6.3.4.3.2 Evaluations (or tests) shall verify the material used is suitable for use in the specific configuration, environment and application. These evaluations shall include the combination of: pressure, temperature, geometric seal design and its application, and the fluids compatible with the intended application.

6.3.4.3.3 Sealing devices and materials previously qualified in accordance with prior editions of ISO 10432 or API Spec 14A for the relevant range of application shall be considered as meeting the design validation requirements of this International Standard.

6.3.4.3.4 The manufacturer's written specifications for non-metallic compounds shall include handling, storage and labelling requirements, including the cure date, batch number, compound identification and shelf life appropriate to each compound and shall define those characteristics critical to the performance of the material, such as the following:

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.

6.3.5 Performance data

6.3.5.1 Performance rating-SCSSV

The supplier/manufacturer shall state the pressure, temperature and axial load rating, as applicable for the specific product. This information may be provided in an operating performance envelope; an example is given in Annex E.

6.3.5.2 Performance rating-SSCSV

The supplier/manufacturer shall provide the following information, as applicable, to establish the closing conditions for the specific product:

a) orifice size;

b) setting spring;

c) number of spacers to be used;

d) pressure charge.

6.3.6 TFL equipment

For additional requirements for these products in TFL applications, see ISO 13628-3.

6.4 Design verification

Design verification shall be performed to ensure that each SSSV design meets the supplier's/manufacturer's technical specifications. Design verification includes activities such as design reviews, design calculations, physical tests, comparison with similar designs and historical records of defined operating conditions.

6.5 Design validation

6.5.1 General

The SSSVs produced in accordance with this International Standard shall pass the validation test required by this subclause.

a) SSSVs shall pass the applicable validation test specified in Annex B and shall be performed by a test agency.

b) Seals shall meet the requirements of 6.3.4.3.

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

The objectives of the validation testing requirements of this subclause are to qualify SSSV equipment for specific classes of service, either Class 1 or Class 2. SSSV equipment furnished to this International Standard requires validation testing to qualify each size, type and model of SSSV. Qualification for Class 2 service shall include testing for Class 1 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.

Successful completion of the validation testing process shall qualify SSSVs of the same size, type and model as the tested SSSV.

Substantive changes to the validation test (specified herein) shall require requalification of a previously qualified SSSV within three years of the effective date of the change.

With mutual consent between the test agency and the manufacturer, higher flow rates than those stipulated in Annex B may be applied and used for all flow tests.

6.5.2 Manufacturer requirements

a) The SSSV shall be proof tested to ensure the valve meets the requirements of the technical specification with the manufacturer's specified safety factors. The manufacturer shall provide the test agency with an SSSV of most recent manufacture, one operating manual, records of proof testing, and associated documentation for each size, type and model for the class of service and working pressure desired in the validation test.

b) The manufacturer shall maintain a validation test file on each validation 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.

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 validation test.

d) The manufacturer shall submit a validation test application for each SSSV to be validation tested to the test agency that shall contain the manufacturer's test application as required in A.1.

e) 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.

f) In the case of validation test non-conformance, the manufacturer shall be responsible for determining the cause of the non-conformance. The test agency shall cooperate with the manufacturer to determine whether the non-conformance was product or test agency related. If the nonconformance is determined to be valve-related, the nonconformance becomes a test failure; if the nonconformance is determined to be test agency related, the manufacturer and test agency shall determine a course of action on the validation test process for the specific valve that is not less stringent than the validation testing requirements of this International Standard. The test agency shall document the testing non-conformance on the test data forms.

g) If a particular size, type and model of SSSV fails the validation 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.

h) Pre-test and post-test dimensional verification of functionally critical dimensions defined by the manufacturer shall be conducted and documented by the manufacturer. Dimensions shall be within established criteria.

6.5.3 Test agency requirements

Test agency requirements are provided in Annex A.

6.5.4 Special feature validation

The manufacturer shall identify, in design documentation, all special features included in the product design that are not validated by design validation testing per this International Standard. Special features shall be validated by test to their rated limits. Special feature validation testing may be performed by the manufacturer.

The manufacturer shall identify those special features that shall be included in the functional testing.

The manufacturer's design validation documentation shall include the design requirements, test procedures and test results of special features.

6.6 Design changes

Changes to the design acceptance criteria of the SSSV design which may affect validation test performance or interchangeability shall require requalification of the SSSV design. Seals that meet the requirements of 6.3.4.3 shall be considered interchangeable among the SSSV equipment of any one manufacturer.

The manufacturer/supplier shall, as a minimum, consider the following when making design changes: stress levels of the modified or changed components; material changes; and functional changes. All design changes and modifications shall be identified, documented, reviewed and approved before their implementation. Design changes and changes to design documents shall require the same control features as the design which has passed the applicable validation test requirements of this International Standard.

6.7 Functional test

6.7.1 Each SSSV shall be tested in accordance with Annex C.

6.7.2 Optional minimal leakage requirements are given in Annex D.

7 Supplier/manufacturer requirements

7.1 General

Clause 7 contains the detailed requirements to verify that each product manufactured under this International Standard meets the requirements of the functional and technical specifications.

7.2 Raw material

7.2.1 Certification

Raw material used in the manufacture of components shall require the following:

a) certificate of conformance stating that the raw material meets the manufacturer's documented specifications;

b) material test report so that the manufacturer can verify that the raw material meets their documented specifications.

7.2.2 Mechanical and physical properties

7.2.2.1 Metals

Tensile testing shall be in accordance with ISO 6892 for the metallic materials used for traceable components. Hardness testing shall be in accordance with ISO 6506-1 or ISO 6508-1; ISO 6507-1 may be used if ISO 6506-1 or ISO 6508-1 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 ISO 15156 (all parts) for materials that are intended for use in wells where corrosive agents can possibly be expected to cause stress-corrosion cracking.

NOTE For the purposes of these provisions, NACE MR0175/ISO 15156-1-2-3 is equivalent to ISO 15156 (all parts).

7.2.2.2 Non-metals

Non-metals shall be tested to determine their mechanical properties as follows:

a) tensile, elongation, modulus:

   1) O-rings in accordance with ASTM D 1414,

   2) other elastomers in accordance with ASTM D 412 (alternative ISO or ASTM methods may be used, where applicable),

   3) non-elastomers in accordance with ISO 527-1;

   NOTE For the purposes of these provisions, ASTM D 638 is equivalent to ISO 527-1.

b) compression set (homogeneous elastomeric compounds only):

   1) O-rings in accordance with ASTM D 1414,

   2) all others in accordance with ASTM D 395;

c) durometer hardness:

   1) O-rings in accordance with ISO 48 or ASTM D 2240 with Shore M,

   NOTE For the purposes of these provisions, ASTM D 1415 is equivalent to ISO 48.

2) other elastomers in accordance with ASTM D 2240 (plastics and other materials may be tested using the Rockwell method, where applicable).

7.3 Heat-treating-equipment qualification

7.3.1 Furnace calibration

Furnaces for heat treatment of production parts shall require the following.

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

b) Each furnace shall have been surveyed within one year prior to heat treating operations. When a furnace is repaired or rebuilt, a new inspection shall be required before heat treating.

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

1) procedures specified in SAE-AMS-H-6875:1998, Section 5;

2) procedures specified in BS 2M 54:1991, Section 7;

3) manufacturer's written specifications including acceptance criteria which are not less stringent than the procedures identified above.

7.3.2 Furnace instrumentation

The requirements for furnace instrumentation are as follows.

a) Automatic controlling and recording instruments shall be used.

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

c) Controlling and recording instruments used for the heat treatment processes shall possess an accuracy of ± 1 % of their full-scale range.

d) 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.

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

7.4 Traceability

7.4.1 All components, weldments, subassemblies and assemblies of SSSV equipment shall be traceable except the following:

a) setting springs used to establish closure parameters for SSCSVs;

b) beans for SSCSVs;

c) common hardware items such as nuts, bolts, set screws and spacers.

7.4.2 Traceability shall be in accordance with the manufacturer's documented procedures. All assemblies, components (including seals), weldments and subassemblies of equipment supplied shall be traceable to a job lot and a material test report. Components and weldments shall also have their included heat(s) or batch

lot(s) identified. All components and weldments in a multi-heat or multi-batch lot shall be rejected if any heat or batch does not comply with the manufacturer's specified requirements.

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

7.5 Components undergoing special processes

7.5.1 Coatings and overlays

Application of coatings and overlays shall be controlled using documented procedures and instructions that include acceptance criteria.

7.5.2 Welding and brazing

Welding and brazing shall require the following.

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

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

7.6 Quality control

7.6.1 General

Subclause 7.6 provides minimum quality control requirements to meet this International Standard. All quality control work shall be controlled by documented instructions that include acceptance criteria.

7.6.2 Component dimensional inspection

All traceable components, except non-metallic seals, shall be dimensionally inspected to assure proper function and compliance with design criteria and specifications. Inspection shall be performed during or after the manufacture of the components but prior to assembly, unless assembly is required for proper measurement.

7.6.3 Non-metals inspection

a) 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 sealing elements until a documented variation history can be established. Sampling procedures shall then be established based on the documented variation history.

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

NOTE For the purposes of this provision, MIL STD 413 is equivalent to ISO 3601-3.

c) Dimensional tolerances of O-rings shall be in accordance with ISO 3601-1. Other sealing elements shall meet dimensional tolerances of the manufacturer's written specifications.

NOTE For the purposes of this provision, SAE AS568B is equivalent to ISO 3601-1.

d) The durometer hardness of O-rings or other elastomeric sealing elements shall be determined in accordance with ISO 48 or ASTM D 2240. A test specimen manufactured from each batch may be used.

NOTE For the purposes of these provisions, ASTM D 1415 is equivalent to ISO 48.

7.6.4 Surface inspection(s)

The supplier/manufacturer shall have documented procedures, including acceptance criteria, for inspection of all accessible surfaces for defects and damage before assembly of the SSSV.

7.6.5 Thread inspection

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

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

7.6.6 Measuring/testing equipment calibration

7.6.6.1 Measuring and testing equipment used for acceptance shall be identified, inspected, calibrated and adjusted at specific intervals in accordance with documented specifications, ANSI/NCSL Z540-1, and this International Standard.

7.6.6.2 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.

7.6.6.3 Pressure measuring devices shall be used only within the calibrated range.

7.6.6.4 Pressure measuring devices shall be calibrated with a master pressure measuring device or a dead-weight tester. 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, degree of usage and documented calibration history.

7.6.7 NDE

7.6.7.1 Requirements

7.6.7.1.1 All NDE instructions shall be approved by a Level III examiner qualified in accordance with ISO 9712.

NOTE For the purposes of these provisions, SNT-TC-1A is equivalent to ISO 9712.

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

7.6.7.1.3 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.

7.6.7.1.4 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.

7.6.7.2 Methods and acceptance criteria

7.6.7.2.1 Liquid penetrant

Liquid-penetrant inspection shall be carried out as follows:

a) method: in accordance with ASTM E 165;

b) acceptance criteria: in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix 8.

7.6.7.2.2 Wet magnetic particle examination

Wet magnetic particle examination shall be carried out as follows:

a) method: in accordance with ISO 13665 or ASTM E 709;

b) indications shall be described as one of the following:

   1) relevant indication: only those indications with major dimensions greater than 1,6 mm (1/16 in) shall be considered relevant whereas inherent indications not associated with a surface rupture (i.e., magnetic permeability variations, non-metallic stringers etc.) shall be 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 in which the length is less than three times its width;

c) acceptance criteria:

   1) any relevant indication greater than or equal to 4,8 mm (3/16 in) shall be considered unacceptable;

   2) no relevant linear indications shall be allowed for weldments;

   3) no more than ten relevant indications shall be present in any 39 cm^2 (6 in^2) area;

   4) four or more rounded relevant indications in a line separated by less than 1,6 mm (1/16 in) shall be considered unacceptable.

7.6.7.2.3 Ultrasonic inspection of weldments

Ultrasonic inspection of weldments shall be carried out as follows:

a) method: in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 5;

b) acceptance criteria: in accordance with ASME Boiler and Pressure Code, Section VIII, Division 1, Appendix 12.

7.6.7.2.4 Ultrasonic inspection of castings

Ultrasonic inspection of castings shall be carried out as follows:

a) method: in accordance with ASTM E 428 and ASTM A 609;

b) acceptance criteria: in accordance with ASTM A 609 at an ultrasonic testing quality level 1, minimum.

7.6.7.2.5 Ultrasonic inspection of forgings and wrought products

Ultrasonic inspection of forgings and wrought products shall be carried out as follows:

a) method: in accordance with 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 the 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 for thicknesses up to and including 101,6 mm (4 in) and a 6,4 mm (1/4 in) flat bottom hole for thicknesses greater than 101,6 mm (4 in),

   3) angle beam technique: the distance amplitude curve (DAC) shall be based on a notch of a 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 no greater than twice its depth;

c) acceptance criteria: any of the following forging or wrought product defects shall be basis for rejection:

   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 those of the reference notch.

7.6.7.2.6 Radiographic inspection of weldments

Radiographic inspection of weldments shall be carried out as follows:

a) method: in accordance with ASTM E 94;

b) acceptance criteria: in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, UW-51.

7.6.7.2.7 Radiographic inspection of castings

Radiographic inspection of castings shall be carried out as follows:

a) method: in accordance with ASTM E 94;

b) acceptance criteria:

   1) in accordance with ASTM E 186;

   2) in accordance with ASTM E 280;

   3) in accordance with ASTM E 446.

   The maximum defect severity levels for 1), 2) and 3) are given in Table 1.

Table 1 — Maximum defect severity levels for castings

Defect category	Maximum defect severity level
A	3
B	2
C (all types)	2
D	None acceptable
E	None acceptable
F	None acceptable
G	None acceptable
NOTE The defect categories, types and severity levels are defined in ASTM E 186, ASTM E 280 and ASTM E 446, as applicable.	

7.6.7.2.8 Radiographic inspection of forgings

Radiographic inspection of forgings shall be carried out as follows:

a) method: in accordance with ASTM E 94;

b) acceptance criteria of which any of the following defects shall be basis for rejection:

1) any type of crack or lap;

2) any other elongated indication with length, L, and wall thickness, t, as follows:

— $L > 6{,}4$ mm (1/4 in) for $t \leqslant 19$ mm (3/4 in)

— $L > 1/3\ t$ for 19 mm $< t \leqslant$ 57,2 mm (3/4 in $< t \leqslant$ 21/4 in)

— $L >$ 19 mm (3/4 in) for $t >$ 57,2 mm (21/4 in)

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

7.6.8 Personnel qualifications

7.6.8.1 Personnel performing NDE evaluations and interpretations shall be qualified in accordance with ISO 9712, to at least Level II, or equivalent.

NOTE For the purposes of these provisions, SNT-TC-1A is equivalent to ISO 9712.

7.6.8.2 Personnel performing visual examinations shall have an annual eye examination, as applicable to the discipline to be performed, in accordance with ISO 9712.

NOTE For the purposes of these provisions, SNT-TC-1A is equivalent to ISO 9712.

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

7.6.9 Certifications

Components undergoing external processes at a subcontractor, such as heat treatment, welding or coating shall require the following:

a) a certificate of conformance stating the materials and/or processes meet the manufacturer's documented specifications;

b) a material test report, where applicable, to verify the materials and/or processes meet the supplier's documented specifications.

7.6.10 Manufacturing non-conformities

Processing of non-conformities shall be controlled in accordance with the manufacturer's documented procedures. Weld repair shall be restricted to the weld only.

7.7 SSSV functional testing

7.7.1 SSSV functional testing shall be performed by the manufacturer on each new SSSV manufactured in accordance with this International Standard.

7.7.2 Results of the functional test shall be traceable to the valve tested and retained in accordance with 7.9.1.1.

7.7.3 Functional-test data shall be recorded, dated and signed by the personnel performing the tests. The required data is indicated in F.1.20 or F.1.21, as applicable.

7.7.4 If the user/purchaser specifies if the optional functional test for minimal leakage the requirements given in annex D shall be applied.

7.8 Product identification

SSSV equipment furnished to this International Standard shall be permanently identified in accordance with the manufacturer's written specifications. Identification shall include the following:

a) manufacturer's name or trademark;

b) manufacturer's size and model;

c) manufacturer's part number;

d) unique identifying serial number;

e) rated working pressure;

f) minimum ID (TRSV only);

g) class(es) of service designation.

Class of service designations listed below may be combined to indicate the complete class of service. For example, 2,4 indicates sandy and mass loss corrosion service.

1 — Standard service

2 — Sandy service

3S — Stress corrosion cracking service—sour environment

3C — Stress corrosion cracking service—non-sour environment

4 — Mass loss corrosion service.

h) Orifice beans for velocity-type SSCSVs shall be identified by the orifice diameter.

7.9 Documentation and data control

7.9.1 Retained documentation

7.9.1.1 General

The supplier/manufacturer shall establish and maintain documented procedures to control all documents and data that relate to the requirements of this International Standard. These documents and data shall be legible and maintained to demonstrate conformance to specified requirements. All documents and data shall be retained in facilities that provide an environment that prevents damage, deterioration, or loss. Documents and data may be in the form of any type of media, such as hard copy or electronic media. All documents and data shall be available and auditable by the user/purchaser; they shall be available within one week of request. Documentation shall be retained for a minimum of five years from the date of manufacture.

7.9.1.2 Design documentation

Design criteria, verification, and validation documents for each size, type and model, and the information listed below, shall be maintained for ten years after date of last manufacture:

a) functional and technical specifications;

b) one complete set of drawings, written specifications and standards;

c) instructions providing methods for the safe assembly and disassembly of the SSSV and stating the operations which are permitted and preclude failure and/or non-compliance with the functional and performance requirements;

d) material type, yield strength and connection identification for the actual end connection(s) provided with the SSSV;

e) operating manual;

f) contents of F.1.20 or F.1.21, as applicable, and F.1.22 are a minimum data requirement for the documentation specified in this subclause;

g) validation test files 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 validation 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 validation test,

   4) all test data specified in this subclause.

7.9.2 Supplied documentation

7.9.2.1 General

SSSVs shall be delivered with a manufacturer's shipping report and an operating manual. F.1.22 contains shipping-report requirements for SSSVs.

7.9.2.2 Operating manual contents

a) size, type and model;

b) class(s) of service;

c) operating data as follows:

— working pressure,

— temperature range,

— internal yield pressure,

— collapse pressure (applies to tubing-retrievable SSSV equipment at maximum rated temperature),

— tensile load strength (applies to tubing-retrievable SSSV equipment at maximum rated temperature),

— operating envelope, if specified by the user/purchaser (see example in Annex E);

d) dimensional data, including dimensions of drift bar and drift sleeve, if applicable;

e) calculations as follows:

— SCSSVs — Calculation procedures used to determine maximum fail-safe setting depths, where applicable,

— SSCSVs — Orifice coefficients, spring force, optimum operating range of pressure differential for velocity-type valves, etc.;

f) drawings and illustrations;

g) parts list with all necessary information for reordering, including manufacturer's contact information;

h) specific details of functional testing should be included if the test apparatus or procedures are significantly different than those included in this International Standard;

i) running instructions;

j) pulling instructions;

k) inspection and testing procedures;

l) installation and operating procedures;

m) troubleshooting and maintenance procedures;

n) repair limitations;

o) redress disassembling and reassembling requirements;

p) operating requirements as follows:

— SCSSVs:

1) opening and closing procedures with opening and closing pressures,

2) equalizing procedure, including maximum recommended unequalized opening pressure,

— SSCSVs:

3) opening or equalization procedures,

4) optimum conditions to avoid nuisance closures and throttling;

q) Storage recommendations.

7.10 Failure reporting and analysis

7.10.1 This subclause provides the requirements for processing the user/purchaser provided failure reports as defined in ISO 10417. The supplier/manufacturer shall have documented procedures that define the actions required.

7.10.2 Notification of the receipt of a failure report shall be provided to the submitting user/purchaser contact within 30 calendar days of the documented receipt at the manufacturer. This notification shall include any data collection requests that the manufacturer needs to perform an effective evaluation and a projected completion date of the evaluation. Should the requested data or equipment not be provided as requested, the failure report becomes inactive 30 calendar days after the notification has been provided to the user/purchaser.

7.10.3 Following receipt of the requested data and equipment to be analyzed, reasonable efforts shall be implemented to complete the evaluations in a timely manner that meets the prevailing business need. The evaluation report shall be provided to the user/purchaser within 15 calendar days after completion of the evaluation. This evaluation shall include the actions required of the user/purchaser to mitigate reoccurrence of the identified problem and suggested measures to extend the product's operational life, when appropriate. The manufacturer shall make necessary design changes that result from the failure analysis on all affected SSSV equipment. If the required or suggested actions apply to similar products, they shall be referenced in the evaluation.

7.10.4 Evaluations and any subsequent notifications prepared in response to a failure report shall be documented and available for three years after the date of preparation.

8 Repair/redress

8.1 Repair

Repair operations for SSSVs shall include the return of the product to a condition meeting all requirements stated in this International Standard or the edition of this International Standard in effect at the time of original manufacture.

8.2 Redress

Redress operations are beyond the scope of this International Standard. ISO 10417 provides requirements for SSSV equipment redress.

9 Storage and preparation for transport

9.1 SSSV equipment shall be stored per the written specifications of the equipment manufacturer to prevent deterioration (for example, caused by atmospheric conditions, debris, radiation, etc.) prior to transport.

9.2 SSSV equipment shall be packaged for transport per the written specifications of the equipment manufacturer to prevent normal handling loads and contamination from harming the equipment. These specifications shall address the protection of: external sealing elements, sealing surfaces, exposed threaded connections, access port(s) sealing and contamination from fluids and debris.

9.3 All material provided as protection for transport shall be clearly identified for removal prior to equipment use.

9.4 For storage after transport, see operating manual.

Annex A
(normative)

Test agency requirements

A.1 General

The test agency shall meet the requirements of Annex A and have the ability to perform the tests of Annex B in order to conduct validation tests. Any variation from the validation test requirements of this International Standard shall be noted on the test application and recorded on the validation test data summary (see F.1.13) by the test agency.

The test agency shall conduct validation tests as specified on the manufacturer's test application in F.1.1 and record the results of the validation test as specified in F.1.13. The content of Annex F, as applicable, is a minimum data requirement for the documentation specified in this subclause. The test agency shall supply a copy of the validation test report to the manufacturer within thirty days of the completion of the test. This report shall be retained by the manufacturer and by the test agency, and shall be available to the user/purchaser upon request to the manufacturer.

Test agencies performing validation testing shall conform to ISO/IEC 17025.

The test agency shall provide, on written request, current documentation to manufacturer or user/purchaser. This shall include the following, as a minimum:

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;

b) test procedures and forms actually used at the facility for each type and service class of SSSV;

c) procedures for maintenance and calibration of measuring equipment used for test acceptance, and calibration records;

d) procedures for making applications for tests, the delivery of SSSVs, the initial installation and checkout of SSSVs and other pertinent information;

e) any limitations on the accessibility of the facility (such limitations shall not preclude reasonable access to the facility for inspection by manufacturers or user/purchasers);

f) any limitations on the receipt of proprietary information.

The test agency shall promptly provide a response to the test application requestor, stating acceptance or rejection of the requirements therein. A test application may be declined if the data are incomplete, inaccurate or self-conflicting. Any declined applications shall detail the specific provisions causing rejection.

A.2 Test facility requirements

A.2.1 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 Figures F.1, F.2, and F.4.

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

a) hydraulic-fluid reservoir with a filtered vent;

b) accumulator;

c) hydraulic pump;

d) control system to operate the pump;

e) pressure relief facility to protect the system.

A.2.2 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.

A gas reservoir with a gas release device and instrumentation to measure the test parameters shall be provided.

The test facility shall, as a minimum, consist of the items listed below:

a) test facility piping, which shall be at least 50,8 mm (2 in) nominal diameter;

b) fresh-water tank;

c) sand slurry tank;

d) Marsh funnel viscometer in accordance with ISO 10414-1 with required timer and graduated beaker;

NOTE For the purposes of these provisions, API RP 13B1 is equivalent to ISO 10414-1.

e) centrifuge with basic sediment and water (BS&W) sample flasks in accordance with API Manual of Petroleum Measurement, Chapter 10.4;

f) circulation pumps;

g) flow meter;

h) pressure measurement systems;

i) time-based recorder to simultaneously record the required pressure and flow data;

j) back-pressure regulator;

k) propane system as shown in Figure F.5;

l) high-pressure water pump and accumulator system.

A.3 Validation test reports

Test reports completed by a test agency conforming to this International Standard shall be traceable to the equipment tested and shall include the following:

a) general information (date, location, manufacturer, model, serial number, size, rating, etc.);

b) summary of test results;

c) description of the characteristics of equipment under test;

d) observed data (including calculations and details of test personnel);

e) test conditions (limits required by the standard);

f) identification of test methods and procedures;

g) supporting data (log sheets, etc.);

h) graphical presentation of operating pressure traces;

i) identification of instruments involved in the testing;

j) copy of validation test application from F.1.1;

k) the content of the data requirements of F.1, as applicable;

l) certificate of compliance in accordance with a national or internationally recognized standard such as ISO/IEC Guide 22;

m) time-based testing data, as requested.

A.4 Test agency records

Unless otherwise specified in the appropriate referenced standard(s), the test agency shall keep the following records for ten years from completion of all tests on all equipment tested:

a) test data and test reports, Annex F, as applicable;

b) measuring and test equipment calibration data;

c) non-conformance reports;

d) audit and corrective-action records;

e) personnel qualification records;

f) test procedures;

g) data on any special testing.

Annex B
(normative)

Validation testing requirements

B.1 General

To pass the validation test, the SSSV shall successfully complete all steps of the validation-testing procedure within the limits specified and in the order shown.

Validation 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 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.

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

Prior to any liquid pressure test, purge with test liquid to remove air.

Gas pressure-relieving (bleed-down) operations shall be performed per the manufacturer's requirements.

During validation testing of hydraulically operated SSSVs, control line fluid metering may be used to provide a readable hydraulic control line pressure trace. Refer to Figure F.6 for a characteristic pressure versus time plot for opening and closing hydraulic control pressures with hydraulic fluid being applied at a metered rate.

When validation testing of SSSV sizes not covered in Tables F.1, F.2, and F.3, the flow rate values may be interpolated or extrapolated by a ratio of the square of the diameter versus the parameter involved.

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.

The test section ends, length and hydraulic control connections shall be compatible with the test agency's facility.

Each data form shall be signed and dated by the person(s) conducting the test. The form containing the data specified in F.1.13 shall be signed and dated by the test agency's designated approval authority.

B.2 Validation test procedure — SCSSV

B.2.1 General

Verify that the model and serial numbers appearing on the test valve are in agreement with the manufacturer's application.

B.2.2 Class 1 test

B.2.2.1 Perform the SCSSV gas flow test (see B.3).

B.2.2.2 Open the test valve. Record the full-open hydraulic control pressure as shown in F.1.4.

B.2.2.3 Fill the test valve with water and circulate water to displace gas out of the test section. Once gas has been displaced from the test section, discontinue water circulation.

B.2.2.4 Close the test valve. Record the full-closed hydraulic control pressure as shown in F.1.4.

B.2.2.5 Perform the liquid leakage test (see B.5).

B.2.2.6 Perform the unequalized opening test (see B.6).

B.2.2.7 Perform the operating-pressure test (see B.7).

B.2.2.8 Perform the propane test (see B.8).

B.2.2.9 Perform the nitrogen leakage test (see B.9).

B.2.2.10 Repeat the operating-pressure test (see B.7).

B.2.2.11 Perform the SCSSV Class 1 flow test (see B.10).

B.2.2.12 Repeat B.2.2.9 to B.2.2.11 four additional times.

B.2.2.13 Perform the liquid leakage test (see B.5).

B.2.2.14 Perform the controlled-temperature test (see B.11).

B.2.2.15 If the test valve is being qualified for Class 1 service only, proceed to B.2.3.6.

B.2.3 Class 2 test

B.2.3.1 Perform the nitrogen leakage test (see B.9).

B.2.3.2 Perform the operating-pressure test (see B.7).

B.2.3.3 Perform the Class 2 flow test (see B.12). Class 2 flow testing shall be performed in a continuous manner with no interruptions longer than 2 h.

B.2.3.4 Repeat B.2.3.1 to B.2.3.3 six additional times.

B.2.3.5 Perform the liquid leakage test (see B.5).

B.2.3.6 Perform the drift test (see B.4).

NOTE If at any point in the Class 2 test the valve fails and it is desired to have Class 1 qualification, perform the Class 1 drift test to confirm Class 1qualification.

B.2.3.7 If the test valve has performed within the limits specified, it has passed the validation test.

B.2.3.8 Summarize the validation test data as specified in F.1.13.

B.3 Gas flow test — SCSSV

B.3.1 Record test data as specified in F.1.2.

B.3.2 Install the test valve in the gas flow test stand. The test medium shall be air, nitrogen or any other suitable gas.

B.3.3 Set the control line resistance to the appropriate setting shown in Table F.1.

— The test flow rates specified in Table F.1 are based on a pressure of 13,8 MPa (2 000 psi) and a velocity of 6,10 m/s (20 ft/s) in the tubing for valve closure test 1 and test 4, a velocity of 9,15 m/s (30 ft/s) for test 2, and a velocity of 3,05 m/s (10 ft/s) for test 3.

— The test flow rates shall be maintained within -5 % and $+15$ % of the nominal value given in Table F.1 or between $-(0{,}01 \times 10^6)$ m^3 and $+(0{,}04 \times 10^6)$ m^3/d [$-(0{,}5 \times 10^6)$ scf and $+(1{,}5 \times 10^6)$ scf per day], whichever is greater. The low control line resistance test shall be performed with a hydraulic control line having an inside diameter of at least 9,6 mm (0,38 in) and a maximum total length of 7,6 m (25 ft).

— The configuration for the high control line resistance test shall consist of the control line used for the low-resistance configuration plus a square-edge orifice having an inside diameter of 0,5 mm $\pm$ 0,05 mm (0,020 in $\pm$ 0,002 in) and a length of 25,4 mm $\pm$ 2,5 mm (1,0 in $\pm$ 0,1 in).

B.3.4 Open and close the test valve. Record the full-open and full-closed control pressures.

B.3.5 Close the flow control valve and bleed valve (see Figure F.1). Set the flow control valve to provide a gas flow at a test rate in accordance with Table F.3.

B.3.6 Increase the gas pressure in the system to between 13,8 MPa (2 000 psi) and 17,3 MPa (2 500 psi).

B.3.7 Open the test valve. Record the full-open control pressure.

B.3.8 Establish and maintain the gas flow rate indicated in Table F.1, and then close the test valve while recording the control line pressure and gas flow rate.

B.3.9 The test valve shall shut off a minimum of 95 % of the specified flow in 5,0 s or less after the hydraulic control pressure reaches zero, or the test valve fails the test. Record the time required by the test valve to shut off the specified flow. If the test valve fails, discontinue testing.

B.3.10 Bleed the valve bore downstream pressure to zero. Adjust the test valve upstream bore pressure to 8,3 MPa $\pm$ 0,4 MPa (1 200 psi $\pm$ 60 psi). Record the test valve bore upstream pressure and gas leakage rate. If leakage exceeds 0,14 m^3/min (5 scf/min) of gas, the test valve fails. If the test valve fails, discontinue testing.

B.3.11 Bleed all pressure to zero. Repeat step B.3.3 to step B.3.10 until all four closure tests specified in Table F.1 are successfully completed or until the test valve fails.

B.4 Drift test — SCSSV

B.4.1 General

The manufacturer shall provide the test agency with a drift sleeve (for WRSVs) and/or drift bar (for TRSVs and WRSVs) that is appropriate for detecting changes in the valve's dimensions. Each drift bar/sleeve shall be permanently marked with a unique identifier. Drift bar dimensions (measured) and unique identifier shall be recorded along with the minimum specified ID of the test valve (TRSVs and WRSVs) or maximum specified OD of the test valve (WRSVs).

Drift bars shall be of no smaller OD than the valve's specified minimum ID, less 0,75 mm (0,030 in); drift sleeves shall be no larger on the ID than the valve's specified maximum OD plus 0,75 mm (0,030 in), and shall be a full round at the recorded drift dimensions.

Each drift bar shall be of a length designated as appropriate to verify that the product provides no restriction to the passage of tools for the full length of the product and shall be a minimum length of four times the specified inside diameter of the product, or 610 mm (24 in), whichever is greater.

Each drift sleeve shall be of a length designated as appropriate to verify that the product can be received into its intended receptacle and shall be a minimum length of two times the specified outside diameter of the product.

B.4.2 Drift test — TRSV

B.4.2.1 Record test data as specified in F.1.3.

B.4.2.2 Open and close the test valve, recording the full-open hydraulic control pressure.

B.4.2.3 Orient the test valve so that the valve is vertical, upside down, and in the normal open position. The test valve may be opened prior to repositioning.

B.4.2.4 Pass the drift bar completely through the test valve in a manner that does not cause the test valve's closure mechanism to be opened. The drift bar shall be aided by a force no greater than that of gravity while being passed down and back through the test valve. If the drift bar does not pass freely completely through the test valve, the test valve fails.

B.4.3 Drift test — WRSV

B.4.3.1 Record test data as specified in F.1.3.

B.4.3.2 Open the test valve, recording the full-open hydraulic control pressure. Orient the test valve so that the valve is vertical, upside down, and in the normal open position.

B.4.3.3 Pass the drift bar completely through the test valve in a manner that does not cause the test valve's closure mechanism to be opened. The drift bar shall be aided by a force no greater than that of gravity while being passed down and back through the test valve. If the drift bar does not pass freely completely through the test valve, the test valve fails.

B.4.3.4 Pass the drift sleeve over the entire length, except for the packing stack/sealing device, of the test valve in a manner that does not cause the test valve's closure mechanism to be moved.

NOTE If control line or control sleeve is in place, a partial drift of the lower valve can be accomplished here.

Close the test valve and record the closing pressures. If a partial OD drift has been accomplished, pass the drift sleeve over the remaining length of the test valve. The drift sleeve shall be aided by a force no greater than that of gravity while being passed down and back over the test valve. If the drift sleeve does not freely pass completely over the test valve, except for the packing stack/sealing device, the test valve fails.

B.5 Liquid leakage test — SSSV

B.5.1 Record test data as specified in F.1.5.

B.5.2 Make certain that the test valve is in the closed position with only liquid above and below the valve.

B.5.3 Apply water pressure upstream of the test valve closure mechanism at 100 % of the rated working pressure (allowable range of 95 % to 100 %) of the valve. Record the test valve bore pressure and the time at which pressure was applied to the valve.

B.5.4 Wait for a minimum of 3 min after applying water pressure upstream of the test valve closure mechanism before beginning collection of water leakage from the downstream bleed valve.

Continuously collect water leakage for a period of 5 min. Record the times at which water leakage collection began and ended and the amount of water collected. Calculate and record the average leakage rate. If the average leakage rate during the collection period exceeds 10 cm^3/min of water, or if external body leakage is detected (tubing-retrievable only), the test valve fails. If the test valve fails, discontinue testing.

B.6 Unequalized opening test — SCSSV

B.6.1 Record test data as specified in F.1.6.

B.6.2 Establish water pressure upstream of the test valve closure mechanism at the maximum manufacturer-specified opening-pressure differential.

B.6.3 Open the test valve closure mechanism against pressure as recommended in the test valve-operating manual. Record the equalizing pressure and the full-open hydraulic control pressure.

B.7 Operating-pressure test — SCSSV

B.7.1 Record test data as specified in F.1.7.

B.7.2 Apply pressure of 25 % of the rated working pressure (allowable range of 20 % to 30 % of rated working pressure) of the test valve to the entire test section. Record the test valve bore pressure (base pressure).

B.7.3 Close and open test valve five times while maintaining the test section pressure recorded in B.7.2 within the specified range.

NOTE The test section pressure can increase as the valve is opened, and then can decrease as the valve is closed due to the differential volume of the hydraulic operating piston.

The full-open/full-closed hydraulic control pressures shall be adjusted based on the change in test section pressure at the time of control pressure measurement. The adjusted control pressure is determined by adding/subtracting the actual control pressure with the difference between the base pressure and the actual test section pressure recorded at the time of each opening/closing pressure measurement. If the five adjusted hydraulic control pressures do not repeat within ± 10 % of their average, or ± 0,7 MPa (± 100 psi), whichever is greater, or if any body joint leakage (tubing-retrievable only) is detected, the test valve fails.

B.7.4 Repeat B.7.2 and B.7.3 at 75 % of the rated working pressure (allowable range of 70 % to 80 % of rated working pressure).

B.8 Propane test — SCSSV (SSCSV as noted)

B.8.1 Record test data as specified in F.1.8.

B.8.2 Open the test valve. Displace liquid out of the test section with nitrogen at a downstream location and bleed the nitrogen pressure to zero.

B.8.3 Cycle the test valve closed and open three times. Leave the test valve open. Record the full-closed and full-open hydraulic control pressures. If the three hydraulic control pressures do not repeat within ± 10 % of their averages or ± 0,7 MPa (100 psi), whichever is greater, the test valve fails.

B.8.4 Transfer propane to the test section until the test section pressure reaches 2,8 MPa ± 0,14 MPa (400 psi ± 20 psi).

B.8.5 Open the downstream vent valve until liquid propane is expelled, close the propane vent valve, and adjust the pressure to 2,8 MPa ± 0,14 MPa (400 psi ± 20 psi). Record the test valve bore pressure.

B.8.6 Close and open the test valve three times, leaving the test valve in each position (opened or closed) for a minimum of 15 min. Record the full-open and full-closed hydraulic control pressures.

NOTE The test section pressure can increase as the valve is opened, and then can decrease as the valve is closed due to the differential volume of the hydraulic operating piston.

The full-open/full-closed hydraulic control pressures shall be adjusted based on the change in test section pressure at the time of control pressure measurement. The adjusted control pressure is determined by adding/subtracting the actual control pressure with the difference between the base pressure and the actual test section pressure recorded at the time of each opening/closing pressure measurement. If the three adjusted hydraulic control pressures do not repeat within ± 10 % of their average, or ± 0,7 MPa (± 100 psi), whichever is greater, or if any body joint leakage (tubing-retrievable only) is detected, the test valve fails

B.8.7 Leave the test valve in the open position in propane for an additional 2 h, minimum. Record the start and completion times and the valve bore pressure at the end of the 2 h interval.

B.8.8 Bleed the section pressure to zero.

B.8.9 Purge the test section with nitrogen.

B.8.10 Close the test valve and record the full-closed hydraulic control pressure.

B.9 Nitrogen leakage test — SCSSV (SSCSV as noted)

B.9.1 Record test data as specified in F.1.9.

B.9.2 Apply 1,4 MPa ± 0,07 MPa (200 psi ± 10 psi) nitrogen pressure upstream of the test valve. Wait a minimum of 1 min, then measure any nitrogen leakage through the closure mechanism. Record the test valve bore pressure, the leakage rate and the start and completion times of the waiting period. If the leakage rate is greater than 0,14 m^3/min (5 scf/min), or if any body joint leakage (tubing-retrievable only) is detected, the test valve fails.

B.9.3 Repeat B.9.2 at 25 % of the rated working pressure (allowable range of 20 % to 30 % of rated working pressure) of the test valve.

B.9.4 Bleed the pressure upstream of the test valve to zero.

B.9.5 Open the test valve. Record the full-open hydraulic control pressure.

B.10 Class 1 flow test — SCSSV

B.10.1 Record test data as specified in F.1.10.

B.10.2 Circulate fresh water through the system while bypassing the test valve until gas has been displaced from the system.

B.10.3 Adjust the water flow rate through the test valve to obtain a stable flow at the value specified in Table F.2. Record the time at which flow is directed through the test valve. Pass water through the test valve at the specified rate for a minimum of 5 min.

B.10.4 Close the test valve against the flow. Record the full-closed hydraulic control pressure and the water flow rate through the test valve at the time closure was initiated. The test valve shall shut off a minimum of 95 % of the specified flow at the first closure attempt in 15,0 s or less after the hydraulic control pressure reaches zero, or the test valve fails. Record the time required by the test valve to shut off the specified flow.

B.10.5 Open the test valve. Record the full-open hydraulic control pressure.

B.10.6 Repeat B.10.2 to B.10.4 until the three fresh-water closure rates have been completed or the test valve fails.

B.11 Controlled-temperature test — SCSSV

B.11.1 Record test data as specified in F.1.11.

B.11.2 Install the test valve in the controlled-temperature test stand. Temperature measurements shall be taken in the area of the control line entry port of the test valve.

B.11.3 Allow the test valve to reach a stable temperature of 38 °C ± 3 °C (100 °F ± 5 °F).

B.11.4 Apply nitrogen gas pressure of 25 % of the rated working pressure (allowable range of 20 % to 30 % of rated working pressure) of the test valve. Allow the temperature at the test valve to stabilize. Record the test valve temperature and the test valve bore pressure (base pressure).

B.11.5 Cycle the test valve ten times while maintaining the specified test valve temperature and pressure recorded in B.11.4 within the specified ranges.

NOTE The test section pressure can increase as the valve is opened, and then can decrease as the valve is closed due to the differential volume of the hydraulic operating piston.

The full-open/full-closed hydraulic control pressures shall be adjusted based on the change in test section pressure at the time of control pressure measurement. The adjusted control pressure is determined by adding/subtracting the actual control pressure with the difference between the base pressure and the actual test section pressure recorded at the time of each opening/closing pressure measurement. If the ten adjusted hydraulic control pressures do not repeat within ± 10 % of their average, or ± 0,7 MPa (± 100 psi), whichever is greater, or if any body joint leakage (tubing-retrievable only) is detected, the test valve fails.

B.11.6 Connect a tube from the test valve hydraulic control line port to a container filled with water. Position the tube so any gas bubbles from the hydraulic control line port can be observed.

B.11.7 With the test valve bore filled with nitrogen gas at the specified temperature and pressure, wait a minimum of 3 min and then observe for gas bubble leakage continuously for a minimum of 5 min. Record the times at which the 3 min waiting period, preceding the leakage test, begins and ends and the times at which the 5 min gas bubble leakage observation period begins and ends. If continuous leakage from the control line is observed for at least 1 min during the observation period, or if body joint leakage (tubing-retrievable only) is detected, the test valve fails.

B.11.8 Repeat B.11.3 to B.11.7 using a test valve bore pressure of 75 % of the rated working pressure (allowable range of 70 % to 80 % of rated working pressure) of the test valve.

B.11.9 Bleed nitrogen pressure above the closure mechanism to zero. Adjust and stabilize the pressure below the closure mechanism to 75 % of the rated working pressure (allowable range of 70 % to 80 % of rated working pressure) of the test valve. Wait a minimum of 1 min, then measure any nitrogen leakage across the closure mechanism. Record the test valve bore pressure below the closure mechanism, any leakage, and the start and completion times of the waiting period. If the leakage rate is greater than 0,14 m^3/min (5 scf/min), or if any body joint leakage (tubing-retrievable only) is detected, the test valve fails.

B.11.10 Repeat B.11.3 to B.11.8 using a stabilized temperature of 82 °C ± 3 °C (180 °F ± 5 °F).

B.11.11 Bleed all pressure to zero. Allow the test valve to cool. Remove the test valve from the controlled-temperature test stand.

B.12 Class 2 flow test — SCSSV

B.12.1 Record test data as specified in F.1.12.

B.12.2 Prepare a slurry consisting of sand and viscosified water.

B.12.3 Determine the sand content of the slurry in accordance with the API Manual of Petroleum Measurement Standards, Chapter 10.4. Adjust the sand content to 2 % ± 0,5 % by adding 150 µm to 180 µm (100 U.S. mesh to 80 U.S. mesh) sand or by diluting the slurry with fresh water.

B.12.4 Determine the viscosity of the slurry sample with a Marsh funnel viscometer in accordance with ISO 10414-1. Adjust the viscosity to 70 s ± 5 s by adding a viscosifier or diluting the slurry with fresh water.

NOTE For the purposes of these provisions, API RP 13B1 is equivalent to ISO 10414-1.

B.12.5 The viscosity and sand content requirements specified above shall be met before proceeding.

B.12.6 Adjust the slurry circulation rate to the value specified in Table F.2. Record the slurry circulation rate, sand content and slurry viscosity. Record the time at which the slurry circulation begins.

B.12.7 Circulate the slurry through the test valve at the specified rate for a minimum of 1 h, and then close the test valve against the specified rate.

B.12.8 Record the full-closed hydraulic control pressure and the slurry flow rate through the test valve at the time closure is initiated. The test valve shall shut off a minimum of 95 % of the specified flow at the first closure attempt in 15,0 s or less after the hydraulic control pressure reaches zero or the test valve fails. Record the time required for the test valve to shut off the specified flow. If the test valve fails, discontinue testing.

B.12.9 At the completion of the flow period, measure and record the sand content of the slurry and the slurry viscosity.

B.13 Validation test procedure — SSCSV

B.13.1 Verify that the model and serial numbers appearing on the test valve assembly are in agreement with the manufacturer's application.

B.13.2 Perform the SSCSV gas closure test (B.14). For velocity-type SSCSVs, use the gas flow test stand to conduct the test.

B.13.3 Perform the initial liquid closure test (B.15) using water as the test medium.

B.13.4 Perform the liquid leakage test (B.5).

B.13.5 Perform the propane test (B.8), omitting B.8.2 and B.8.5. Replace B.8.9 with: “Conduct the liquid closure test (B.15), using water as the test medium.” Record the results as specified in F.1.16. The closing flow rate for a velocity-type SSCSV or the closing pressure for a tubing-pressure-type SSCSV shall repeat within ±15 % of the closing flow rate or pressure of B.13.3 or the test valve fails the test. If the test valve fails, discontinue testing.

B.13.6 Perform the nitrogen leakage test (B.9), omitting B.9.4. Record the results as specified in F.1.17.

B.13.7 Perform the SSCSV Class 1 flow test (B.16).

B.13.8 Repeat B.13.6 and B.13.7 fourteen additional times. The closing flow rate for velocity-type SSCSVs or the closing pressure for tubing-pressure-type SSCSVs shall repeat within ±15 % of the closing flow rate or pressure of B.13.3 above, or the valve fails the test. If the test valve fails, discontinue testing.

B.13.9 Perform the liquid leakage test (see B.5). If the test valve is being qualified for Class 1 service only, proceed to B.13.14.

B.13.10 Perform the nitrogen leakage test (see B.9), omitting B.9.4.

B.13.11 Perform the Class 2 flow test (see B.17). Class 2 flow testing shall be performed in a continuous manner with no interruptions longer than 2 h.

B.13.12 Repeat B.13.10 and B.13.11 six additional times. The closing flow rate for a velocity-type SSCSV or the closing pressure for a tubing-pressure-type SSCSV shall repeat within ± 15 % of the closing flow rate or pressure of B.13.3, or the test valve fails the test.

B.13.13 Perform the liquid leakage test (see B.5).

B.13.14 If the test valve has performed within the limits specified, it has passed the validation test.

B.13.15 Summarize the validation test data as specified in F.1.13.

B.14 Gas closure test — SSCSV

B.14.1 Record test data as specified in F.1.14.

B.14.2 Increase gas pressure in the system to between 13,8 MPa (2 000 psi) and 17,3 MPa (2 500 psi).

B.14.3 Close the test valve as follows.

a) Velocity-type SSCSVs — Increase the gas flow rate through the test valve until the test valve closes. The test valve shall close at a flow rate of at least ± 25 % of the design closing flow rate indicated in F.1.1 in 30 s or less from the time this flow rate is achieved, or the test valve fails the test. If the test valve fails, discontinue testing. Record the initial pressure upstream of the test valve, the differential pressure across the test valve closure mechanism, and the gas flow rate through the test valve at closure.

b) Tubing-pressure-type SSCSVs — Adjust the gas pressure downstream of the test valve to ensure the test valve is open. Decrease the downstream pressure until the test valve closes. The test valve shall close at a downstream pressure of at least 75 % of the design closing pressure indicated in F.1.1. The minimum allowable downstream pressure is 0,35 MPa (50 psi). The test valve shall close in 30 s or less from the time this minimum pressure is achieved, or the test valve fails the test. Record the initial pressure downstream of the test valve and the pressure downstream of the test valve at closure. If the test valve fails, discontinue testing.

B.14.4 Bleed the valve bore downstream pressure to zero. Adjust the test valve bore upstream pressure to 8,3 MPa (1 200 psi) ± 5 %. Wait a minimum of 1 min, then measure any gas leakage through the closure mechanism. Record the test valve bore pressure, the leakage rate and the start and completion times of the waiting period. If the leakage rate is greater than 0,14 m^3/min (5 scf/min), the test valve fails. If the test valve fails, discontinue testing.

B.14.5 Bleed all pressure to zero.

B.15 Liquid closure test — SSCSV

B.15.1 Record test data as specified in F.1.15.

B.15.2 Circulate liquid through the system while bypassing the test valve until gas has been displaced from the system.

B.15.3 Adjust the circulation rate through the test valve to obtain a flow at the rate specified in Table F.3.

B.15.4 Close the test valve as follows.

a) Velocity-type SSCSVs — Adjust the pressure downstream of the test valve to between 0,35 MPa and 0,38 MPa (50 psi and 55 psi). Increase the circulation rate through the valve until the valve closes. The

circulation rate shall be increased such that the pressure downstream of the test valve can be maintained between 0,35 MPa and 0,38 MPa (50 psi and 55 psi). The test valve shall close at a flow rate of at least ±25 % of the design closing flow rate indicated in F.1.1 in 30 s or less from the time this flow rate is achieved, or the test valve fails the test. If the test valve fails, discontinue testing. Record the initial pressure upstream of the test valve, the differential pressure across the valve closure mechanism and the flow rate through the valve at closure.

b) Tubing-pressure-type SSCSVs — Decrease the downstream pressure until the test valve closes. The test valve shall close at a downstream pressure of at least 75 % of the design closing pressure indicated in F.1.1. The minimum allowable downstream pressure shall be 0,35 MPa (50 psi). The valve shall close in 30 s or less from the time this pressure minimum is achieved, or the valve fails the test. Record the initial pressure downstream of the test valve and the pressure downstream of the test valve at closure. If the test valve fails, discontinue testing.

B.16 Class 1 flow test — SSCSV

B.16.1 Record test data as specified in F.1.18.

B.16.2 Circulate water through the system while bypassing the test valve until gas has been displaced from the system.

B.16.3 Adjust the water circulation rate through the test valve to obtain a flow rate at the value specified in Table F.3. Record the time at which flow is directed through the test valve and the circulation rate. Circulate water through the test valve at the specified rate for a minimum of 1 h.

B.16.4 Close the test valve using the liquid closure test procedure (B.15), using water as the test medium and omitting B.15.1 and B.15.2.

B.17 Class 2 flow test — SSCSV

B.17.1 Record test data as specified in F.1.19.

B.17.2 Prepare a slurry consisting of 150 µm to 180 µm (100 U.S. mesh to 80 U.S. mesh) sand and viscosified water.

B.17.3 Determine the sand content of the slurry in accordance with the API Manual of Petroleum Measurement Standards, Chapter 10.4. Adjust the sand content to 2 % ± 0,5 % by adding 150 µm to 180 µm (100 U.S. mesh to 80 U.S. mesh) sand or by diluting the slurry with water.

B.17.4 Determine the viscosity of the slurry sample with a Marsh funnel viscometer in accordance with ISO 10414-1. Adjust the viscosity to 70 s ± 5 s by adding a viscosifier or diluting the slurry with water.

NOTE For the purposes of these provisions, API RP 13B1 is equivalent to ISO 10414-1.

B.17.5 The viscosity and sand content requirements specified above shall be met before proceeding.

B.17.6 Adjust the slurry circulation rate to the value specified in Table F.3. Record the slurry circulation rate, sand content and slurry viscosity. Also, record the time at which the slurry circulation begins.

B.17.7 Circulate slurry through the test valve at the specified rate for a minimum of 1 h, and then close the test valve using the liquid closure test procedure (see B.15), using slurry as the test medium and omitting B.15.1 and B.15.2.

B.17.8 At the completion of the circulation period, measure and record the sand content and the slurry viscosity.

Annex C
(normative)

Functional testing requirements

C.1 General

To pass the functional test, the SSSV shall successfully complete all steps of the functional-testing procedure within the limits specified and in the order shown. The manufacturer's test facility shall be equipped with instrumentation to display and record information required by the test procedure.

Functional testing shall be discontinued if the valve fails to perform within the limits specified for any step. 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.

Testing may be resumed from the last successfully completed step when it is determined the cause of the failure is the result of a failure within the test facility.

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

Prior to any liquid pressure test, purge with test liquid to remove air.

Gas pressure relieving (bleed-down) operations shall be performed per the manufacturer's requirements.

During functional testing of hydraulically operated SSSVs, control line fluid metering may be used to provide a readable hydraulic control line pressure trace. Refer to Figure F.6 for a characteristic pressure versus time plot for opening and closing hydraulic control pressures with hydraulic fluid being applied at a metered rate.

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.

C.2 Functional test — SCSSV

C.2.1 Test facility

A typical test facility is shown in Figure F.7 and includes:

a) test section installed vertically;

b) test section and hydraulic control section pressure measurement devices;

c) pressurized-gas source;

d) hydraulic control pressure system;

e) flow meters;

f) pressurized-water system;

g) time-based recorder to simultaneously record the required data;

h) internal and external drifts.

C.2.2 Functional test procedure — SCSSV

All test section pressures shall be measured with calibrated devices and recorded. The procedure shall be as follows.

a) Record test data as specified in F.1.20.

b) Record the serial number.

c) Place the SCSSV in a fixture capable of retaining and sealing the valve in a vertical position.

d) Open the SCSSV with zero pressure in the test section. Adjust and stabilize the hydraulic control pressure to the manufacturer's recommended hold-open pressure. Isolate the hydraulic control pressure from the source. Monitor for a minimum of 5 min. If a loss greater than 5 % of the applied pressure is detected after stabilization, the SCSSV fails the functional test.

e) Close and open the SCSSV five times with zero pressure in the test section. Record the full-closed and full-open hydraulic control pressures. Each control pressure shall repeat within ± 5 % of the average pressure of the five valve cycles as well as falling within the manufacturer's specified control pressure tolerance. If each pressure is not within these the limits, the SCSSV fails the functional test.

f) Fill the test section with water or another suitable liquid to displace air from the test section, and proceed as follows.

   1) Wireline-retrievable SCSSVs:

      Close the SCSSV. Adjust and stabilize the pressure across the entire test section to 150 % of the rated working pressure (allowable range of 145 % to 155 % of the rated working pressure) for SCSSVs up to 69 MPa (10 000 psi) rated working pressure. For SCSSVs with rating working pressures in excess of 69 MPa (10 000 psi), the test pressure shall be the rated working pressure plus a minimum of 34,5 MPa (5 000 psi). Hold the pressure for a minimum of 5 min. Reduce the pressure in the test section to zero. Repeat the test once. The SCSSV fails the functional test if leakage is detected through the hydraulic control port(s).

   2) Tubing-retrievable SCSSVs:

      Close the SCSSV. Thoroughly dry the test valve exterior. Adjust and stabilize the pressure in the entire test section to 150 % of the rated working pressure (allowable range of 145 % to 155 % of the rated working pressure) for SCSSVs up to 69 MPa (10 000 psi) rated working pressure of the SCSSV. For SCSSVs with rating working pressures in excess of 69 MPa (10 000 psi), the test pressure shall be the rated working pressure plus a minimum of 34,5 MPa (5 000 psi). Hold the pressure a minimum of 5 min. Reduce the pressure in the test section to zero. Repeat the test once. The SCSSV fails the functional test if leakage is detected on the exterior or through the hydraulic control line port(s).

g) Open and close the SCSSV with zero pressure in the test section and record the full-open and full-closed hydraulic control pressures. Open the SCSSV.

h) Apply pressure of 50 % of the SCSSV's rated working pressure (allowable range of 45 % to 55 % of rated working pressure) of the test valve to the entire test section. Record the test valve bore pressure (base pressure).

i) Close and open test valve five times while maintaining the test section pressure recorded in C.2.2 h) within the specified range.

   NOTE The test section pressure can increase as the valve is opened, and then can decrease as the valve is closed due to the differential volume of the hydraulic operating piston.

   The full-open/full-closed hydraulic control pressures shall be adjusted based on the change in test section pressure at the time of control pressure measurement. The adjusted control pressure is

determined by adding/subtracting the actual control pressure with the difference between the base pressure and the actual test section pressure recorded at the time of each opening/closing pressure measurement. If the five adjusted hydraulic control pressures do not repeat within ± 10% of their average, or ± 0,7 MPa (± 100 psi), whichever is greater, or if any body joint leakage (tubing-retrievable only) is detected, the test valve fails.

j) Adjust and stabilize the test section pressure to 100 % of the rated working pressure (allowable range of 95 % to 105 % of rated working pressure) of the SCSSV. Close the SCSSV. Record the full-closed hydraulic control pressure. Bleed the hydraulic control pressure to zero.

k) Adjust and stabilize the test section pressure to 100 % of the rated working pressure (allowable range of 95 % to 105 % of rated working pressure) of the SCSSV. Monitor for leakage at hydraulic control line ports(s) for a minimum of 5 min. If any leakage is detected, the SCSSV fails the functional test.

l) Bleed the pressure above the SCSSV closure mechanism to zero. Adjust and stabilize the pressure below the closure mechanism to 100 % of the rated working pressure (allowable range of 95 % to 105 % of rated working pressure) of the SCSSV. Measure liquid leakage for a minimum of 5 min. If the leakage rate exceeds 10 cm^3/min, the SCSSV fails the functional test.

m) Remove the liquid from the test section.

n) Open the SCSSV. Record the full-open hydraulic control pressure.

o) Adjust and stabilize the pressure in the entire test section with gas to 1,4 MPa ± 0,07 MPa (200 psi ± 10 psi). Close the SCSSV. Record the full-closed hydraulic control pressure. Bleed the hydraulic control pressure to zero.

p) Adjust and stabilize the test section pressure with gas to 1,4 MPa ± 0,07 MPa (200 psi ± 10 psi). Monitor for gas leakage at the hydraulic control port(s) for a minimum of 5 min. If any leakage is detected, the SCSSV fails the functional test.

q) Bleed the pressure above the SCSSV's closure mechanism to zero. Adjust and stabilize the pressure below the SCSSV's closure mechanism to 1,4 MPa ± 0,07 MPa (200 psi ± 10 psi) with gas. Measure the leakage rate for a minimum of 5 min. If the leakage rate exceeds 0,14 m^3/min (5 scf/min), the SCSSV fails the functional test.

r) Repeat o) and p) with 8,3 MPa ± 0,41 MPa (1 200 psi ± 60 psi).

s) Bleed all pressures to zero.

t) Open and close the SCSSV two times. Record the full-open and full-closed hydraulic control pressures.

u) Prepare the SCSSV for drift tests. Open the SCSSV, then, proceed as follows.

   1) Drift the interior of the SCSSV assembly with the manufacturer's specified drift bar. Pass the drift bar completely through the test valve.

   2) Drift the exterior of wireline-retrievable SCSSVs with the manufacturer's specified drift sleeve. If the SCSSV fails the drift test, it fails the functional test.

   3) Record the drift's unique identifiers and the nominal drift sizes.

v) Special features unique to a manufacturer's SCSSV shall be tested in accordance with the manufacturer's operating manual. Failure to meet the requirements of these tests fails the SCSSV. These tests can be incorporated in the existing sequence of functional tests. Such special-feature test procedures, the sequence and the results shall be fully described in the test report.

w) If the SCSSV performs within the limits of the functional test, it passes the functional test. Attach all recorded data to the manufacturer's test form. Certify the test with the appropriate manufacturer's approval signatures and dates.

C.3 Functional testing — SSCSV

C.3.1 Test facility

A typical test facility is shown in Figure F.8 and includes the following:

a) test section installed vertically;

b) test section pressure measurement devices;

c) pressurized-gas source;

d) flow meters;

e) pressurized-water system;

f) time-based recorder to record the required data simultaneously;

g) drift sleeve.

C.3.2 Functional test procedure — velocity-type SSCSVs

Proceed as follows.

a) Record test data as specified in F.1.21.

b) Record the serial number.

c) Place the SSCSV in a fixture capable of retaining and sealing the valve in a vertical position.

d) Initiate a flow against a minimum back-pressure of 0,35 MPa (50 psi).

e) Check the operation of the recorders for the flow rate, upstream pressure and downstream pressure.

f) Increase flow rate until the SSCSV closes.

g) Record the flow rate and the upstream and downstream pressures at the time of valve closure. If the closing rate and pressure differential are not within ± 5 % of the manufacturer's specified values, the SSCSV fails the functional test.

h) Adjust and stabilize the pressure upstream of the SSCSV to 100 % ± 5 % of the rated working pressure.

i) Hold the upstream pressure for a minimum of 5 min and measure the leakage rate. If the leakage rate exceeds 10 cm^3/min, the SSCSV fails the functional test.

j) Bleed the pressure from below the SSCSV to a value 0,7 MPa (100 psi) greater than the differential closing pressure.

k) Adjust the gas pressure to a value 1,4 MPa ± 0,07 MPa (200 psi ± 10 psi) greater than the differential closing pressure.

l) Measure the gas leakage rate for 5 min. If the leakage rate exceeds 0,14 m^3/min (5 scf/min), the SSCSV fails the functional test.

m) Bleed all pressures to zero.

n) Prepare the SSCSV for a drift test. Drift the exterior of a wireline-type SSCSV with the drift sleeve. If the SSCSV does not pass through the drift sleeve, it fails the functional test. Record the nominal size of the drift sleeve and the unique identifier.

o) If the SSCSV performs within the limits of the functional test, it has passed the functional test. Attach all recorded data to the manufacturer's test form. Certify the test with the appropriate manufacturer's approval signatures and dates.

C.3.3 Functional test procedure — tubing-pressure-type SSCSVs

Proceed as follows:

a) Record test data as specified in F.1.21.

b) Record the serial number.

c) Place the SSCSV in a fixture capable of retaining and sealing the valve in a vertical position.

d) Adjust the flow rate in accordance with Table F.3.

e) Reduce the downstream pressure until the SSCSV closes.

f) Record the flow rate and downstream pressure at the time of valve closure. If the downstream pressure at closure is not within ±5 % of the manufacturer's specified pressure or 0,7 MPa (100 psi), whichever is larger, the SSCSV fails the functional test.

g) Bleed the downstream pressure to zero.

h) Adjust and stabilize the pressure upstream of the SSCSV to 100 % ± 5 % of the rated working pressure of the SSCSV.

i) Hold the upstream pressure for a minimum of 5 min and measure the leakage rate. If the leakage rate exceeds 10 cm^3/min, the SSCSV fails the functional test.

j) Bleed the upstream pressure from the SSCSV to a value 0,7 MPa (100 psi) greater than the closing pressure.

k) Adjust the upstream pressure with gas to a value 1,4 MPa ± 0,07 MPa (200 psi ± 10 psi) greater than the closing pressure.

l) Measure the gas leakage rate for 5 min. If the leakage rate exceeds 0,14 m^3/min (5 scf/min), the SSCSV fails the functional test.

m) Bleed all pressures to zero.

n) Prepare the SSCSV for a drift test. Drift the exterior of wireline-type SSCSVs with a drift sleeve. If the SSCSV does not pass through the drift sleeve, it fails the functional test.

o) If the SSCSV performs within the limits of the functional test, it has passed the test. Attach all recorded data to the manufacturer's test form. Certify the test with the appropriate manufacturer's approval signatures and dates.

C.4 Functional testing — Other types of SSSV

The following shall apply:

a) The manufacturer shall document the functional-test procedure and record test data.

b) The apparatus and test procedure for a specific SSSV not included in previous subclauses shall be as specified by the manufacturer.

c) The manufacturer shall be responsible for assuring that the test procedures are not less stringent than those in this International Standard.

Annex D
(informative)

Optional requirement for closure mechanism minimal leakage

D.1 General

Minimal leakage rate applies only to the functional test. If a minimal leakage requirement is specifically requested by user/purchaser, the supplier shall adhere to D.2 and D.3.

NOTE These test requirements are optional and do not mandate minimal leakage requirements for all SSSVs.

D.2 Gas leakage test requirements

If the leakage rate exceeds 14,2 dm^3/min (0,5 scfm), the SSSV fails the functional test.

D.3 Liquid leakage test requirements

If the leakage rate exceeds 1 cm^3/min (0,034 fl oz/min), the SSSV fails the functional test.

Annex E
(informative)

Operating envelope

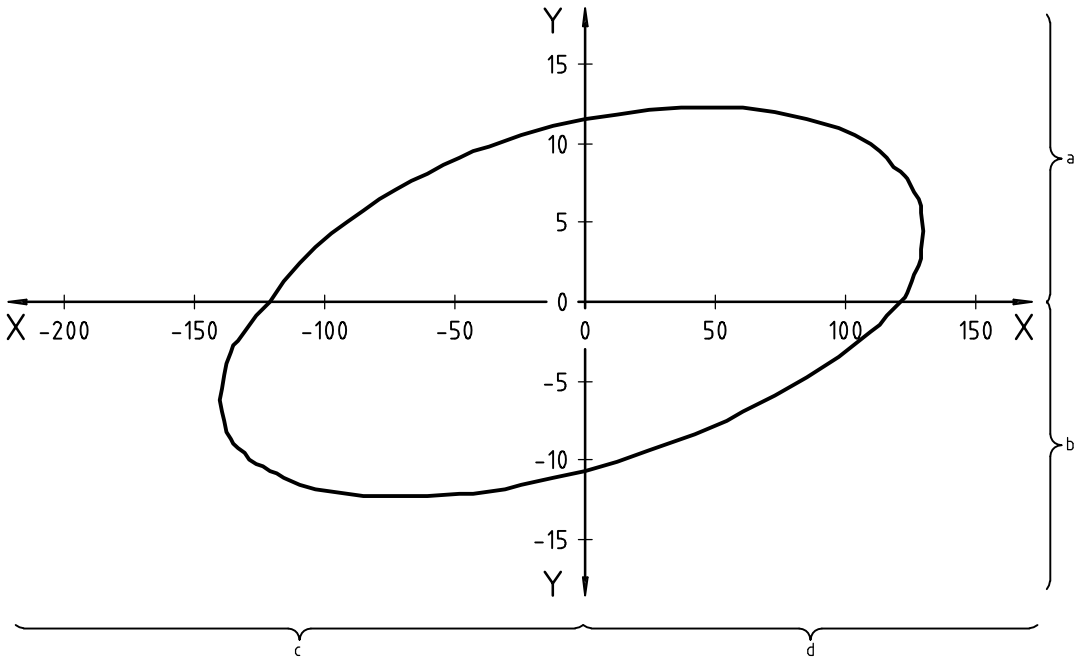
E.1 General

Reference ISO 13679 or API Bull 5C3, API Bull 5C5 or other nationally or internationally accepted reference standards. Specifically note ISO 13679 or API Bull 5C5 procedures and test requirements for combined load testing.

E.2 Envelope documentation

If specified by the user/purchaser, an operating envelope shall be supplied for tubing-retrievable subsurface safety valves to illustrate the combined effects of pressure, temperature, and axial loads, as various well completion schemes dictate that information be available to an user/purchaser during completion/production operations. The operating envelope may be based upon test data and/or calculated data.

An example envelope is illustrated below. The area within the boundaries defines the operating envelope. The lines forming the boundary of the envelope are defined by the various failure modes of the SCSSV.



Key

X axial load

Y pressure

a Burst only (+VME).

b Collapse only (–VME).

c Compression (–VME).

d Tension (+VME).

Figure E.1 — Operating envelope example

E.3 Envelope requirements

Operating envelopes shall meet the criteria below.

— The boundary lines of the envelope represent the manufacturer's maximum ratings.

— More than one graph may be displayed on the envelope if a legend is included for explanation. For example, calculated versus tested operating envelope data.

— The product(s) covered by the envelope shall be specified on the envelope.

Annex F
(normative)

Data requirements, figures/schematics, and tables

F.1 Data requirements

F.1.1 Validation test application — SSSV (reference 6.5.2)

a) General requirements are as follows:

   1) identification of test agency (company/facility name, location/address, pertinent department, etc.);

   2) identification of product manufacturer (company name, location/address, pertinent department, contact name & phone numbers, etc.);

   3) date of validation test and date of report;

   4) validation test number (provided by test facility);

   5) if retest, reference to previous test number;

   6) the test application shall include a statement verifying a successful proof test to the anticipated test loads of the SSSV and all hardware supplied for the test.

b) The equipment to be tested shall be identified as follows:

   1) equipment type: SCSSV, SSCSV (surface controlled vs. subsurface controlled, etc.);

   2) model designation or other identification by manufacturer;

   3) product number with unique serial number;

   4) nominal tubing size;

   5) rated working pressure rating;

   6) test section length;

   7) for SCSSV equipment:

      i) minimum specified ID,

      ii) maximum hydraulic control line pressure (greater than valve bore pressure),

      iii) maximum unequalized opening pressure;

   8) for SSCSV equipment:

      i) closing parameters (fluid velocity, pressure, design closing flow rate, etc. as appropriate),

      ii) tubing pressure: design closing pressure.

c) The following procedures and special requirements shall be stated:

1) Class 1 or 2 service designation;

2) Non-specified equipment or procedures required for testing;

3) All requested variation(s) to the test agency's testing procedures shall be accurately defined, as well as the specific point in the testing procedure where the testing variation(s) are to be implemented. The specific procedures of the requested variation(s) and a document that verifies that variations to the requirements are not less stringent than those of the referenced standard are required as a component of the application.

4) If new equipment, specific details of methods and/or practices that may be required.

d) Space shall be provided for the following information from the test agency:

1) testing schedule (month/day/year);

2) test location;

3) applicant notified (month/day/year).

F.1.2 Gas flow test — SCSSV (reference B.3)

The following shall be recorded:

a) validation test number;

b) date (month/day/year);

c) test start time; test stop time;

d) data to be collected/recorded for each flow test shall be as follows:

1) hydraulic opening pressure at zero bore pressure,

2) hydraulic closing pressure at zero bore pressure,

3) hydraulic opening pressure at 13,8 MPa to 17,2 MPa (2 000 psi to 2 500 psi) bore pressure,

4) closure data:

i) gas flow rate,

ii) full-closed hydraulic control pressure,

iii) time to close,

5) nitrogen leakage data:

i) test pressure,

ii) leakage rate,

iii) body joint leakage detected? (yes or no);

e) test passed? (yes or no);

f) conducted by: (printed name and signature), date: (month/day/year).

F.1.3 Drift test — SCSSV (reference B.4)

The following shall be recorded:

a) validation test number;

b) drift information:

   1) minimum inside diameter or maximum outside diameter of test valve (specify ID or OD),

   2) drift bar outside diameter or drift sleeve inside diameter (specify ID or OD),

   3) drift length,

   4) unique identifier of drift bar or sleeve;

c) for each drift test, record the following:

   1) date of test (month/day/year),

   2) full-open hydraulic control pressure (five times),

   3) full-closed hydraulic control pressure (five times),

   4) drift pass? (yes or no);

d) conducted by: (printed name and signature), date: (month/day/year).

F.1.4 Initial opening and closing test — SCSSV (references B.2.2.2 and B.2.2.4)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) date (month/day/year);

d) test start time; test stop time;

e) open and close at zero valve bore pressure:

   1) full-open hydraulic control pressure (measured),

   2) full-closed hydraulic control pressure (measured);

f) conducted by: (printed name and signature), date: (month/day/year).

F.1.5 Liquid leakage test — SSSV (reference B.5)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) for each iteration (B.2.2.5, B.2.2.13, and B.2.3.5) of the liquid leakage test, record the following:

1) identification of the applicable test step being performed (note class of service as well),
2) date of test (month/day/year),
3) valve bore test pressure (nominal 100 % of rated working pressure),
4) time at which test pressure is applied,
5) time at start of leakage test,
6) time at end of leakage test,
7) average leakage rate at test pressure (100 % of rated working pressure),
8) body leakage detected (TRSV only)? (yes or no),
9) test step passed? (yes or no);

d) conducted by: (printed name and signature), date: (month/day/year).

F.1.6 Unequalized opening test — SCSSV (reference B.6)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) date (month/day/year);

d) rated working pressure of SCSSV being tested;

e) manufacturer's maximum recommended unequalized opening pressure (from operating manual);

f) for each unequalized opening test, record the following:
1) test start time; test completion time,
2) valve bore upstream test pressure (measured),
3) equalizing test pressure (measured),
4) full-open hydraulic control pressure (measured);

g) Test passed? (yes or no);

h) conducted by: (printed name and signature), date: (month/day/year).

F.1.7 Operating pressure test — SCSSV (reference B.7)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) for each iteration (B.2.2.7, B.2.2.10, B.2.2.12, B.2.3.2, and B.2.3.4) of the operating pressure test, record the following:

1) date (month/day/year),

2) initial SCSSV valve bore pressure (base pressure) at 25 % of working pressure,

3) full-open hydraulic control pressure (and actual test section pressure),

4) full-closed hydraulic control pressure (and actual test section pressure),

5) record repeated cycle results as specified by the requirement in B.7,

6) repeat above at 75 % of working pressure;

d) calculate the following values:

1) adjusted hydraulic control pressure — full-closed,

2) average of adjusted hydraulic control pressure — full-closed,

3) adjusted hydraulic control pressure — full-open,

4) average of adjusted hydraulic control pressure — full-open;

e) body leakage detected (TRSV only)? (yes or no);

f) test passed? (yes or no);

g) conducted by: (printed name and signature), date: (month/day/year).

F.1.8 Propane test — SSSV (reference B.8)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) date (month/day/year);

d) for each of the open/close cycles at zero test valve bore pressure, record the following:

1) full-closed hydraulic control pressure,

2) full-open hydraulic control pressure;

e) calculate the following values for the set of cycles just completed:

1) average adjusted hydraulic control pressure — full-closed; same plus 10 %; same minus 10 %,

2) average adjusted hydraulic control pressure — full-open; same plus 10 %; same minus 10 %;

f) for each of the open/close cycles at 2,8 MPa (400 psi) test valve nominal bore pressure, record the following:

1) time at valve closure,

2) full-closed hydraulic control pressure,

3) time at valve opening,

4) full-open hydraulic control pressure;

g) calculate the following values for the set of cycles just completed:

   1) average adjusted hydraulic control pressure — full-closed; same plus 10 %; same minus 10 %;

   2) average adjusted hydraulic control pressure — full-open; same plus 10 %; same minus 10 %.

h) for (each) propane soak period. record the following:

   1) time at start of soak period,

   2) time at end of soak period,

   3) valve bore pressure at end of soak period;

i) record the last full-closed hydraulic control pressure at the end of the propane test.

j) Test passed? (yes or no);

k) conducted by: (printed name and signature), date: (month/day/year).

F.1.9 Nitrogen leakage test — SSSV (reference B.9)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) for each iteration (B.2.2.9, B.2.2.12, B.2.3.1, and B.2.3.4) of the nitrogen leakage test, record the following:

   1) date (month/day/year),

   2) SCSSV bore pressure [1,33 MPa to 1,47 MPa (190 psi to 210 psi)],

   3) time at start of waiting period,

   4) time at completion of waiting period,

   5) measured gas leakage rate,

   6) body leakage detected (TRSV only)? (yes or no),

   7) SCSSV bore pressure [20 % to 30 % of rated working pressure (RWP)],

   8) full-open hydraulic control pressure,

   9) time at start of waiting period,

   10) time at completion of waiting period,

   11) measured gas leakage rate,

   12) body leakage detected (TRSV only)? (yes or no),

   13) test passed? (yes or no);

d) conducted by: (printed name and signature), date: (month/day/year).

F.1.10 Class 1 flow test — SCSSV (reference B.10)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) for each iteration (B.2.2.11 and B.2.2.12) of the Class 1 flow test, record the following:

   1) date of test (month/day/year),

   2) for each circulation flow rate record the following:

      i) time at start of circulation through test valve,

      ii) time at valve closure,

      iii) water flow rate immediately before valve closure,

      iv) full-closed hydraulic control pressure,

      v) flow 15 s after hydraulic control pressure reaches zero,

      vi) time to close,

      vii) full-open hydraulic control pressure;

d) test passed? (yes or no);

e) conducted by: (printed name and signature), date (month/day/year).

F.1.11 Controlled temperature test — SCSSV (reference B.11)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) SCSSV stabilized test temperature;

d) For each iteration (B.11.4, B.11.7, and B.11.9) of the controlled temperature test, record the following:

   1) date (month/day/year),

   2) initial SCSSV valve bore pressure (base pressure) at 25 % of working pressure at 38 °C (100 °F) and 82 °C (180 °F),

   3) full-open hydraulic control pressure (and actual test section pressure),

   4) full-closed hydraulic control pressure (and actual test section pressure),

   5) record repeated cycle results as specified by the requirements in B.11.4,

   6) repeat above at 75 % of working pressure;

e) Calculate the following values:

   1) adjusted hydraulic control pressure — fully-closed,

   2) average of adjusted hydraulic control pressure — fully-closed,

   3) adjusted hydraulic control pressure — fully-open,

   4) average of adjusted hydraulic control pressure — fully-open;

f) For each control line leakage test (at specified valve temperature and pressure), record the following:

   1) time at start of waiting period,

   2) time at completion of waiting period,

   3) leak detected? (yes or no),

   4) body leakage detected (TRSV only)? (yes or no);

g) For each closure mechanism leakage test (at specified valve temperature and pressure below the closure mechanism), record the following:

   1) test temperature,

   2) time at which the bore pressure above the closure mechanism is reduced to zero,

   3) valve bore pressure below the closure mechanism,

   4) time at start of waiting period,

   5) time at completion of waiting period,

   6) leakage rate,

h) Test passed? (yes or no);

i) conducted by: (printed name and signature), date: (month/day/year).

F.1.12 Class 2 flow test — SCSSV (reference B.12)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) For each iteration (B.2.3.3 and B.2.3.4) of the Class 2 flow test, record the following:

   1) date of test (month/day/year),

   2) time at start of slurry circulation through valve,

   3) flow rate at start of circulation period,

   4) sand concentration (%) at start of circulation period,

   5) slurry viscosity at start of circulation period,

   6) time at valve closure (against slurry flow),

7) slurry flow rate,

8) full-closed hydraulic control pressure,

9) flow 15 s after hydraulic control pressure reaches zero,

10) time to close,

11) sand concentration (%)at completion of circulation period,

12) slurry viscosity at completion of circulation period,

13) test passed? (yes or no);

d) conducted by: (printed name and signature), date: (month/day/year).

F.1.13 Validation test summary — SSSV (references A.1, B.2.3.8 and B.13.15)

The following shall be recorded:

a) identification of test agency (company/facility name, location/address, pertinent department, etc.);

b) identification of product manufacturer (company name, location/address, pertinent department, contact name & phone numbers, etc.);

c) date of validation test and date of report;

d) validation test number (provided by test facility);

e) equipment type: SCSSV, SSCSV (surface controlled vs. subsurface controlled, etc.);

f) model designation or other identification by manufacturer;

g) product number with unique serial number;

h) nominal tubing size;

i) rated working pressure;

j) service class tested (1 or 2);

k) service class passed (1 or 2);

l) if valve failed the test, step at which the failure occurred and the reason for failure;

m) remarks (describing any non-specified equipment or procedures requested by valve manufacturer, unusual conditions observed during test, etc.);

n) test approved by: (test agency approval authority), date: (month/day/year).

F.1.14 Gas closure test — SSCSV (reference B.14)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) test start time;

d) test completion time;

e) date (month/day/year);

f) for velocity-type SSCSVs:

   1) initial test valve upstream pressure,

   2) closing flow rate (gas),

   3) differential closing pressure,

   4) calculate maximum closing rate,

   5) calculate minimum closing rate;

g) for tubing-pressure-type SSCSVs:

   1) initial test valve downstream pressure,

   2) downstream closing pressure,

   3) design closing pressure,

   4) calculate maximum closing rate,

   5) calculate minimum closing rate;

h) nitrogen leakage data:

   1) test valve bore pressure,

   2) leakage rate;

i) test passed? (yes or no);

j) conducted by: (printed name and signature), date: (month/day/year).

F.1.15 Liquid closure test — SSCSV (reference B.15)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) number;

c) test start time;

d) test completion time;

e) date (month/day/year);

f) for velocity-type SSCSVs:

   1) initial test valve downstream pressure,

   2) closing flow rate (water),

3) differential closing pressure,

4) design closing flow rate (liquid),

5) maximum closing rate: 125 % × design closing rate (liquid),

6) minimum closing rate: 75 % × design closing rate (liquid);

g) for tubing-pressure-type SSCSVs:

1) initial test valve downstream pressure,

2) downstream closing pressure,

3) maximum closing rate: 125 % × design closing rate (liquid),

4) minimum closing rate: 75 % × design closing rate (liquid);

h) test passed? (yes or no);

i) conducted by: (printed name and signature), date: (month/day/year).

F.1.16 Propane test — SSCSV (reference B.13.5)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) propane soak period:

1) date,

2) 2 h soak period:

i) start,

ii) stop;

3) valve bore pressure at end of 2 h soak period;

d) closure after propane soak:

1) test start time,

2) test completion time,

3) date (month/day/year);

e) for velocity-type SSCSVs:

1) initial test valve downstream pressure,

2) closing flow rate (water):

i) + 15 % of the closing flow rate recorded in F.1.15 f) 2),

ii) − 15 % of the closing flow rate recorded in F.1.15 f) 2);

3) differential closing pressure;

f) for tubing-pressure-type SSCSVs:

1) initial test valve downstream pressure,

2) downstream closing pressure:

i) + 15 % of the downstream closing pressure recorded in F.1.15 g) 2),

ii) − 15 % of the downstream closing pressure recorded in F.1.15 g) 2);

g) test passed? (yes or no);

h) conducted by: (printed name and signature), date: (month/day/year).

F.1.17 Nitrogen leakage — SSCSV (reference B.13.6)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) for each iteration of the SSCSV nitrogen leakage test (reference B.13.6 and B.13.8):

1) date (month/day/year),

2) valve bore test pressure [1,33 MPa to 1,47 MPa (190 psi to 210 psi)],

3) time at start of waiting period,

4) time at completion of waiting period,

5) measured gas leakage rate,

6) valve bore test pressure (20 % to 30 % RWP),

7) time at start of waiting period,

8) time at completion of waiting period,

9) measured gas leakage rate,

10) test passed? (yes or no);

d) conducted by: (printed name and signature), date: (month/day/year).

F.1.18 Class 1 flow test — SSCSV (reference B.16)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) identification;

c) for velocity-type SSCSVs:

1) + 15 % of closing flow rate recorded in F.1.15 f) 2),

2) − 15 % of closing flow rate recorded in F.1.15 f) 2);

d) For tubing-pressure-type SSCSVs:

1) + 15 % of downstream closing pressure recorded in F.1.15 g) 2),

2) − 15 % of downstream closing pressure recorded in F.1.15 g) 2);

e) For each iteration of the SSCSV Class 1 flow test (reference B.13.7 and B.13.8), record the following:

1) date of test (month/day/year),

2) for each circulation flow rate record the following:

i) time at start of circulation through test valve,

ii) flow rate at start of circulation period,

iii) time at valve closure;

3) for velocity-type SSCSVs:

i) initial downstream pressure,

ii) water flow rate at closure,

iii) differential pressure across valve at closure;

4) for tubing-pressure-type SSCSVs:

i) initial downstream pressure,

ii) downstream pressure at closure;

5) test passed? (yes or no).

f) conducted by: (printed name and signature), date: (month/day/year).

F.1.19 Class 2 flow test — SSCSV (reference B.17)

The following shall be recorded:

a) validation test number;

b) test stand (or apparatus) number;

c) for velocity-type SSCSVs:

1) + 15 % of closing flow rate recorded in F.1.15 f) 2),

2) − 15 % of closing flow rate recorded inF.1.15 f) 2);

d) for tubing-pressure-type SSCSVs:

1) + 15 % of downstream closing pressure recorded in F.1.15 g) 2),

2) − 15 % of downstream closing pressure recorded in F.1.15 g) 2);

e) For each iteration of the SSCSV Class 1 flow test (reference B.13.11 and B.13.12), record the following:

1) date of test (month/day/year),

2) For each circulation flow rate record the following:

i) time at start of circulation through test valve,

ii) flow rate at start of circulation period,

iii) sand concentration (%) at start of circulation period,

iv) slurry viscosity at start of circulation period (Marsh seconds),

v) time at valve closure (against slurry flow);

3) for velocity-type SSCSVs:

i) initial downstream pressure,

ii) slurry flow rate at closure,

iii) differential pressure across valve at closure;

4) for tubing-pressure-type SSCSVs:

i) initial downstream pressure,

ii) downstream pressure at closure,

iii) sand concentration (%) at completion,

iv) slurry viscosity at completion of circulation period;

5) test passed? (yes or no);

f) conducted by: (printed name and signature), date: (month/day/year).

F.1.20 Functional test documentation — SCSSV (reference C.2)

The following shall be recorded:

a) valve manufacturer;

b) equipment name;

c) SSSV type and size;

d) product/material number and unique serial number;

e) working pressure rating;

f) hydrostatic control pressure test:

1) start time at pressure,

2) end time at pressure,

3) beginning control pressure,

4) ending control pressure,

5) calculate pressure loss over minimum of 5 min,

6) test passed? (yes or no);

g) control pressure repeatability:

1) at zero valve bore pressure,

2) full-open hydraulic control pressure,

3) full-closed hydraulic control pressure,

4) repeat cycle five times,

5) calculate average of five cycles;

6) test passed? (yes or no);

h) hydrostatic test (for each iteration):

1) start time at pressure,

2) end time at pressure,

3) beginning section pressure,

4) ending section pressure,

5) leakage within 5 min? (yes or no),

6) test passed? (yes or no);

i) record full-open/full-closed pressures;

j) SCSSV operating pressure test:

1) for each iteration of the operating pressure test, record the following:

i) initial SCSSV valve bore pressure (base pressure) at 50 % of working pressure,

ii) full open hydraulic control pressure (and actual test section pressure),

iii) full-closed hydraulic control pressure (and actual test section pressure),

iv) record repeated cycle results as specified by the requirements of C.2.2 h);

2) calculate the following values:

i) adjusted hydraulic control pressure — fully-closed,

ii) average of adjusted hydraulic control pressure — fully-closed,

iii) adjusted hydraulic control pressure — fully-open,

iv) average of adjusted hydraulic control pressure — fully-open;

3) body joint leakage detected (TRSV only)? (yes or no);

k) record full-open/full-closed hydraulic control pressure at 100 % test section pressure;

l) with 100 % test section pressure and zero hydraulic control pressure:

1) control port leakage within 5 min? (yes or no),

2) test passed? (yes or no);

m) closure mechanism leakage test at 100 % pressure below closure mechanism:

1) measured leakage in cm^3/minute within 5 min? (yes or no),

2) test passed? (yes or no);

n) record full-open hydraulic control pressure;

o) with 1,4 MPa (200 psi) gas pressure in test section:

1) record full-closed hydraulic pressure,

2) control port leakage within 5 min? (yes or no),

3) test passed? (yes or no);

p) with zero test section pressure and 1,4 MPa (200 psi) gas pressure below closure mechanism:

1) measured leakage in m^3/min within 5 min? (yes or no),

2) test passed? (yes or no);

q) results of repeat of o) and p) at 8,3 MPa (1 200 psi);

r) record full-open/full-closed hydraulic control pressures two times;

s) internal/external drift test. test passed? (yes or no);

t) special features test results. test passed? (yes or no);

u) test date;

v) performed by: (printed name and signature), date: (month/day/year).

F.1.21 Functional test documentation — SSCSV (reference C.3)

The following shall be recorded:

a) valve manufacturer;

b) equipment name;

c) SSSV type and size;

d) SSSV catalogue/material number and unique serial number;

e) safety valve lock, serial number, and size (as applicable);

f) working pressure rating;

g) for velocity-type SSCSVs:

1) initial flow rate,

2) initial upstream pressure,

3) initial downstream pressure,

4) flow rate at moment of SSCSV closing,

5) upstream pressure at moment of SSCSV closing,

6) downstream pressure at moment of SSCSV closing,

7) liquid leakage rate over period of 5 min with upstream liquid pressure equal to 100 % SSCSV rated working pressure,

8) gas leakage rate over period of 5 min with upstream gas pressure equal to 1,4 MPa (200 psi),

9) drift test results (reference B.4),

10) test passed? (yes or no);

h) for tubing-pressure-type SSCSVs:

1) liquid flow rate as specified in Table F.3,

2) flow rate at moment of SSCSV closing,

3) downstream pressure at moment of SSCSV closing,

4) liquid leakage rate over period of 5 min with upstream liquid pressure equal to 100 % SSCSV rated working pressure,

5) gas leakage rate over period of 5 min with upstream gas pressure equal to 1,4 MPa (200 psi),

6) drift test results (reference B.4),

7) test passed? (yes or no);

i) conducted by: (printed name and signature), date: (month/day/year).

F.1.22 Shipping report — SSSV (reference 7.9.2.1)

The following shall be recorded:

a) manufacturer's data:

1) manufacturer's name and manufacturing address,

2) product/material number,

3) equipment name,

4) serial number,

5) size,

6) class of service;

b) SSSV data:

1) pressure rating,

2) temperature rating, maximum,

3) temperature rating, minimum,

4) validation test agency,

5) validation test number,

6) date of report (month/day/year),

7) tested to International Standard ISO 10432:2004;

c) SSSV function test summary:

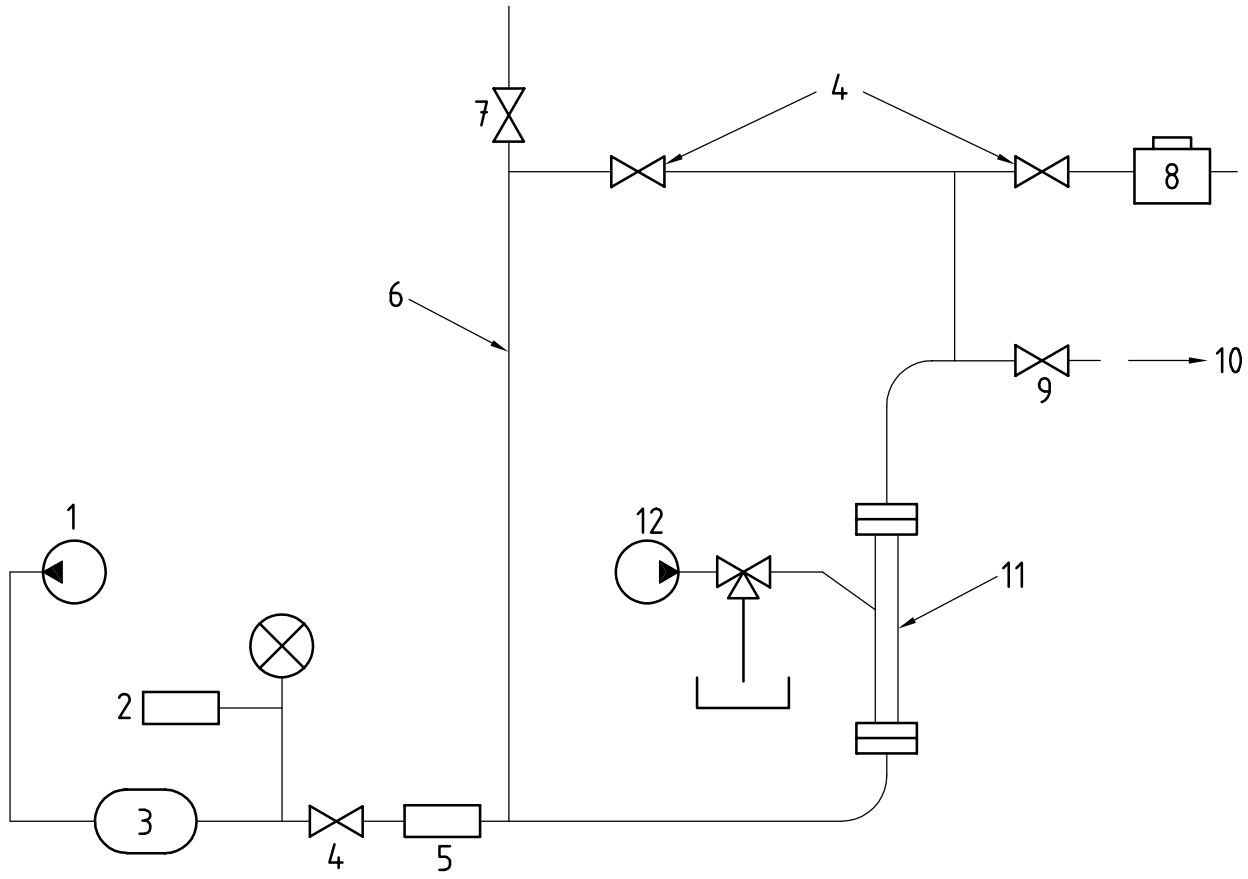
1) opening pressure with zero pressure in test section: maximum and minimum,

2) closing pressure with zero pressure in test section: maximum and minimum,

3) performed by: (printed name and signature), date: (month/day/year);

d) inspected by: (printed name and signature), date: (month/day/year).

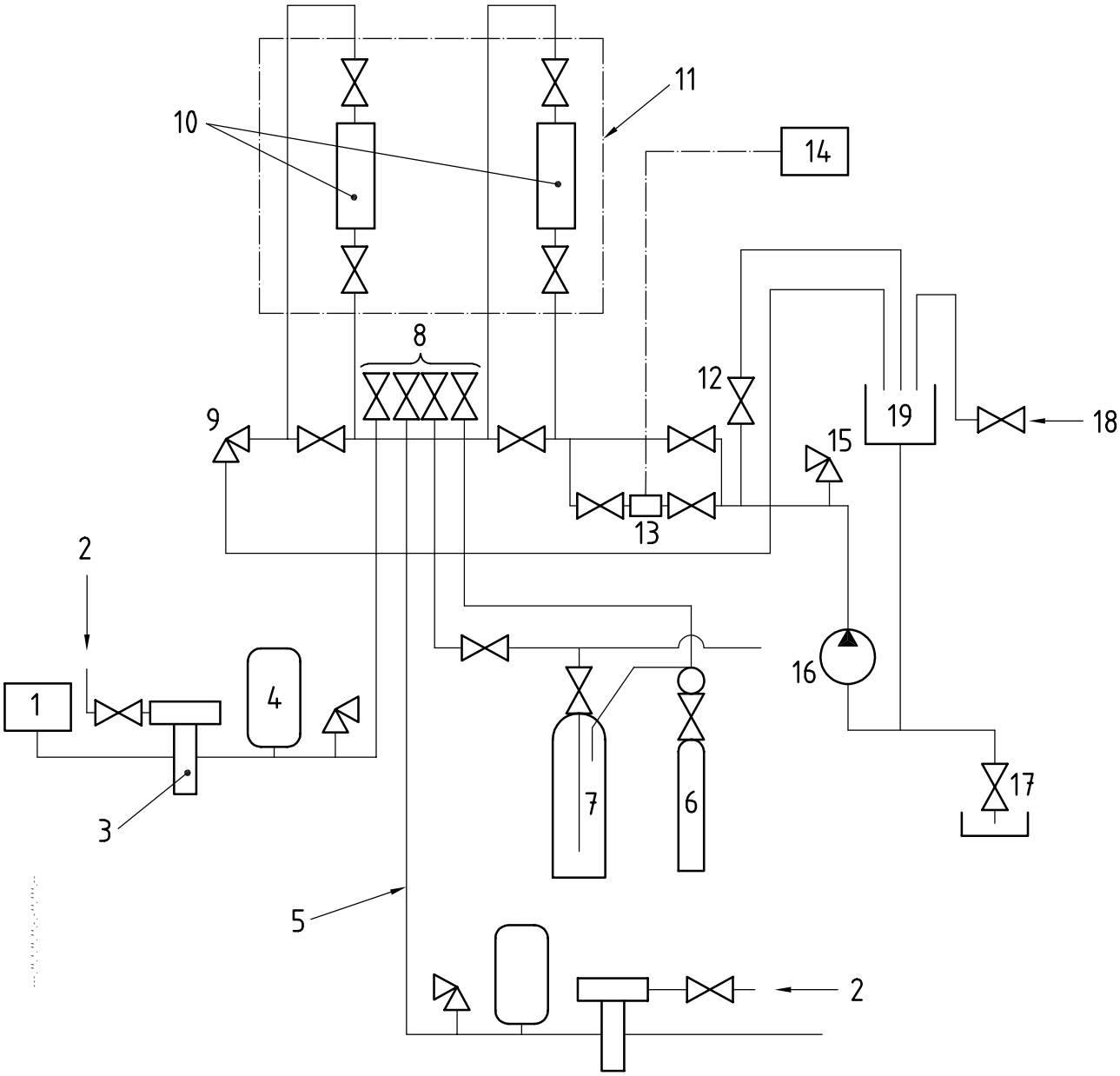
F.2 Figures/schematics



Key

1 gas supply
2 pressure measurement device
3 gas reservoir
4 shut-off valve
5 flow meter
6 equalizing line
7 bleed valve
8 leakage flow meter
9 flow control valve
10 vent
11 SSSV test section
12 hydraulic pressure source (for SCSSVs only)

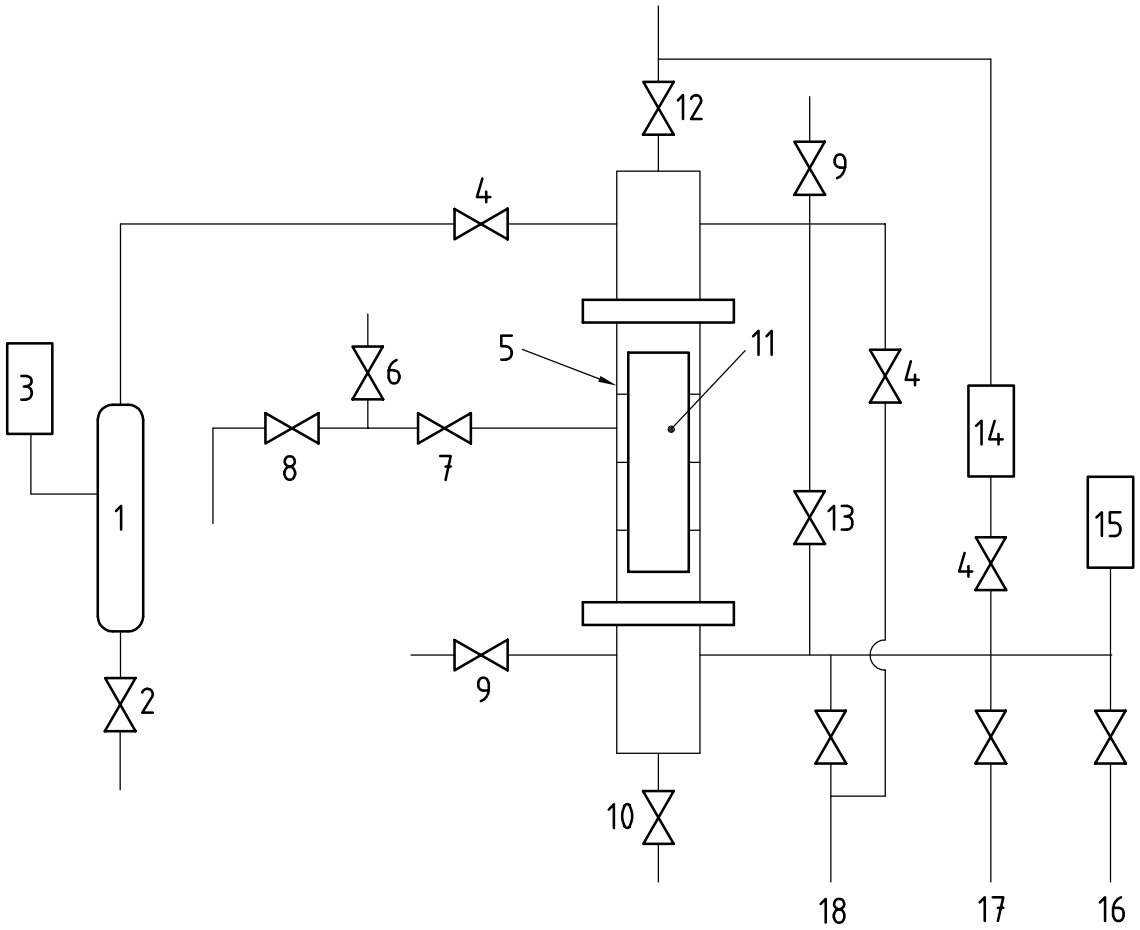
Figure F.1 — Example schematic of gas flow facility



Key

1 hydraulic oil
2 air supply
3 hydraulic pressure source
4 hydraulic control system
5 high-pressure water system
6 nitrogen supply
7 propane supply
8 manifold valves
9 choke valve
10 test section
11 see Figure F.3
12 by-pass valve
13 flow meter
14 recorder
15 relief valve
16 pump
17 drain valve
18 water supply
19 liquid supply tank

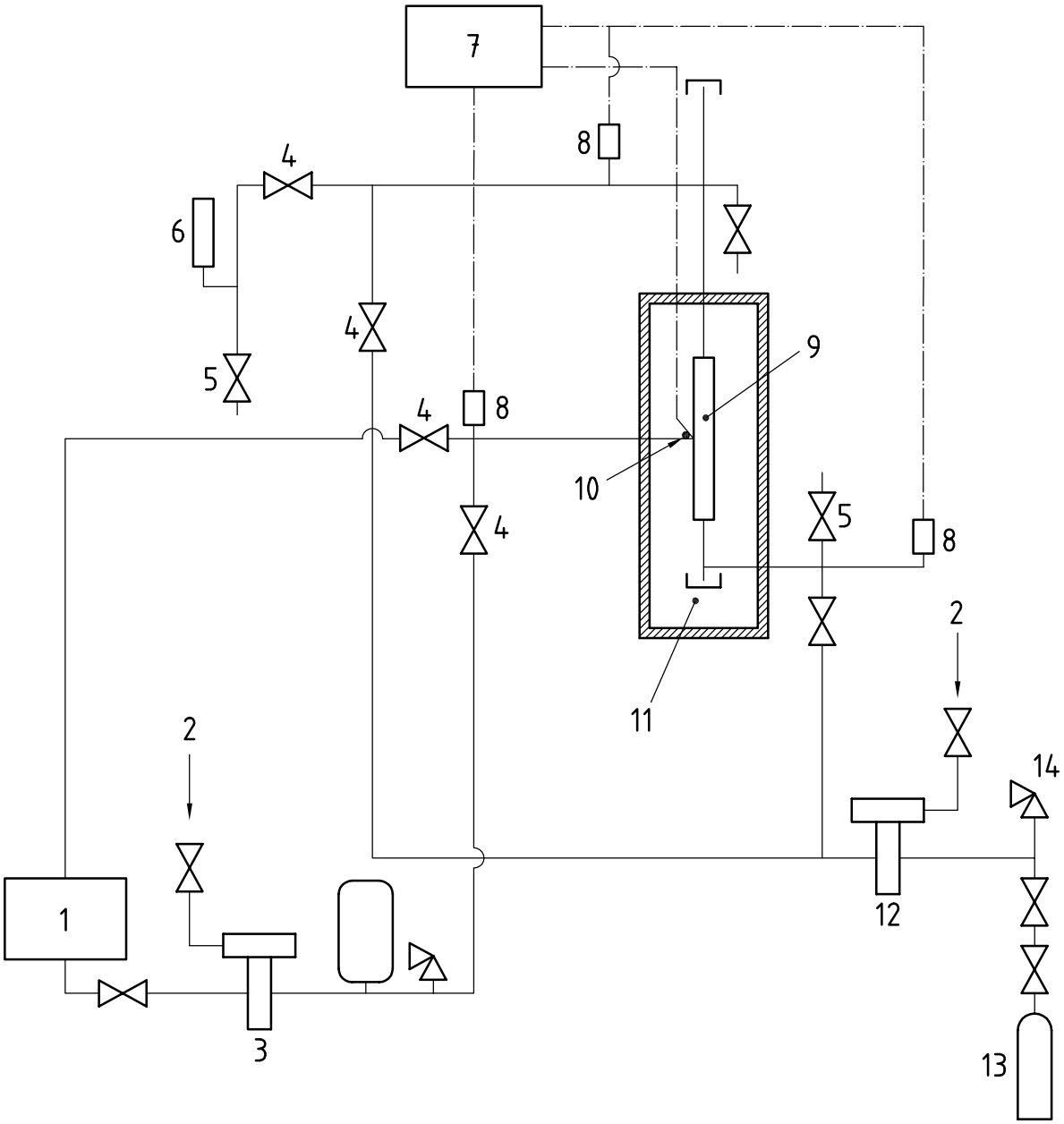
Figure F.2 — Example schematic of liquid test facility



Key

1 gas/liquid separator
2 drain
3 nitrogen flow meter
4 shut-off valve
5 test section
6 hydraulic control line bleed valve
7 metering valve
8 hydraulic control valve
9 bleed valve
10 upstream isolation valve
11 SSSV
12 downstream isolation valve
13 balance valve
14 differential pressure measuring device
15 pressure-measuring device
16 high-pressure water manifold valve
17 propane manifold valve
18 nitrogen manifold valve

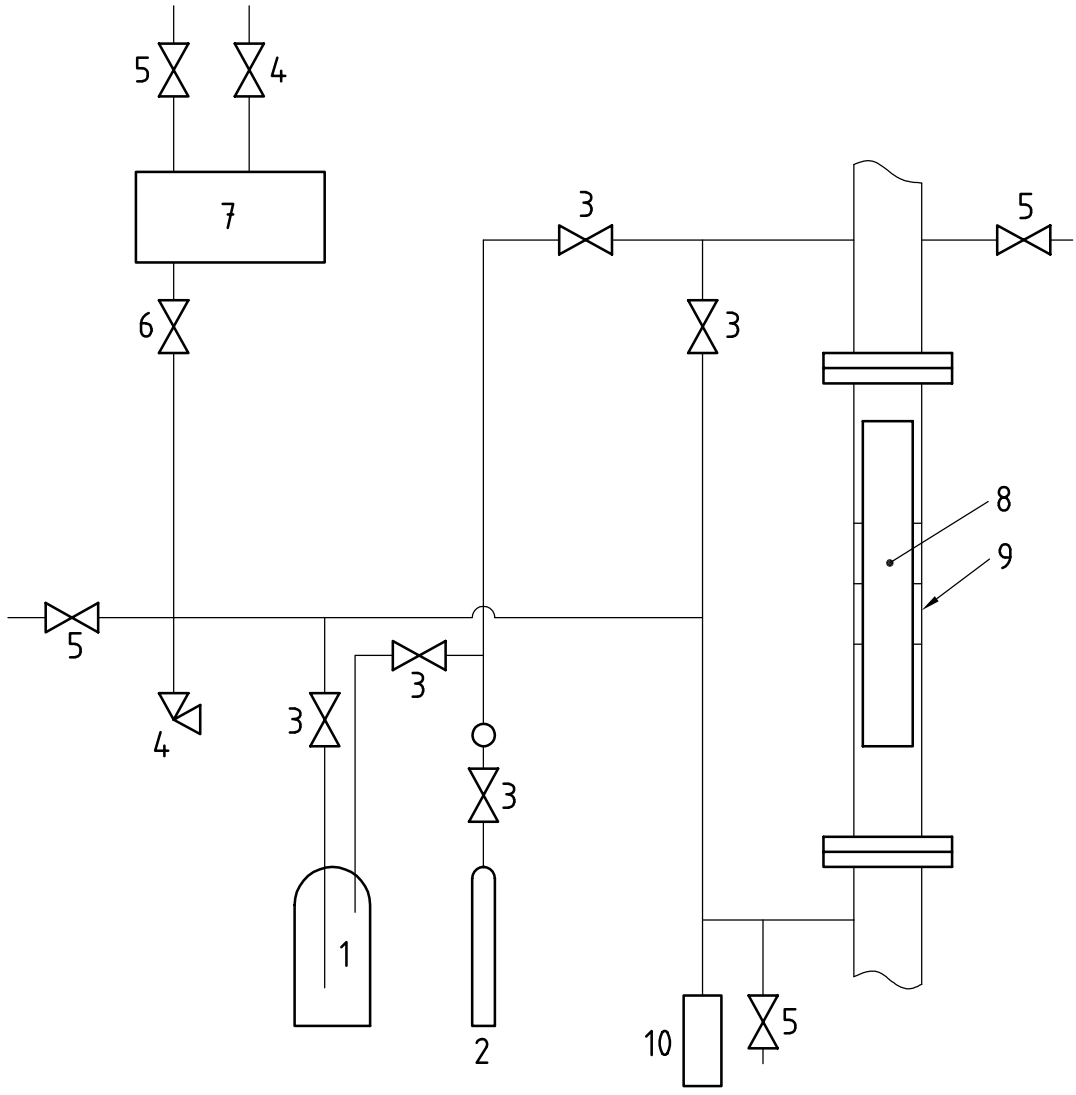
Figure F.3 — Example detail of liquid test facility



Key

1 hydraulic oil
2 air supply
3 hydraulic pressure source (for SCSSVs only)
4 shut-off valve
5 vent valve
6 nitrogen flow meter
7 recorder
8 pressure-measuring device
9 test section
10 thermocouple
11 heating chamber
12 nitrogen pressure intensifier
13 nitrogen pressure source
14 relief valve

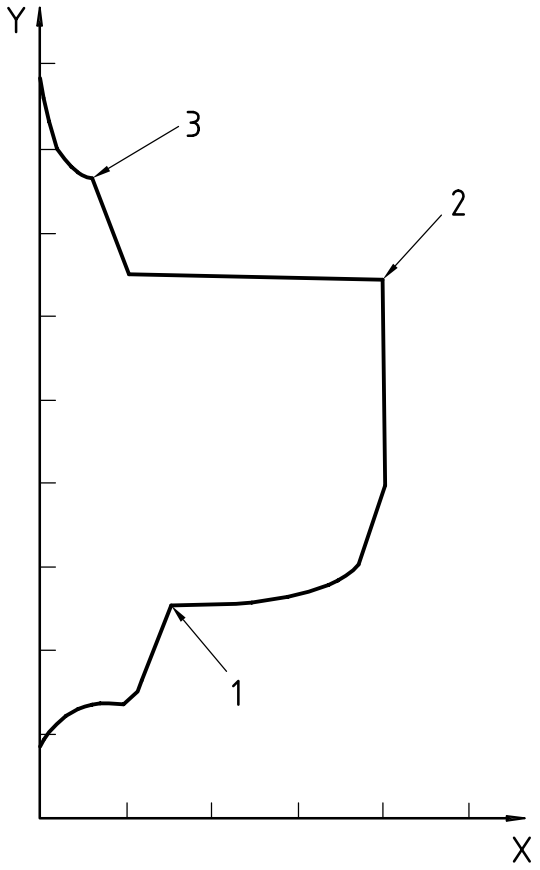
Figure F.4 — Example schematic of controlled-temperature test facility



Key

1 high-pressure propane tank
2 nitrogen tank
3 shut-off valve
4 relief valve
5 vent valve
6 liquid shut-off valve
7 low-pressure propane storage tank
8 SSSV
9 test section
10 pressure-measuring device

Figure F.5 — Example schematic of propane test facility



Key

X hydraulic pressure, increasing to the right

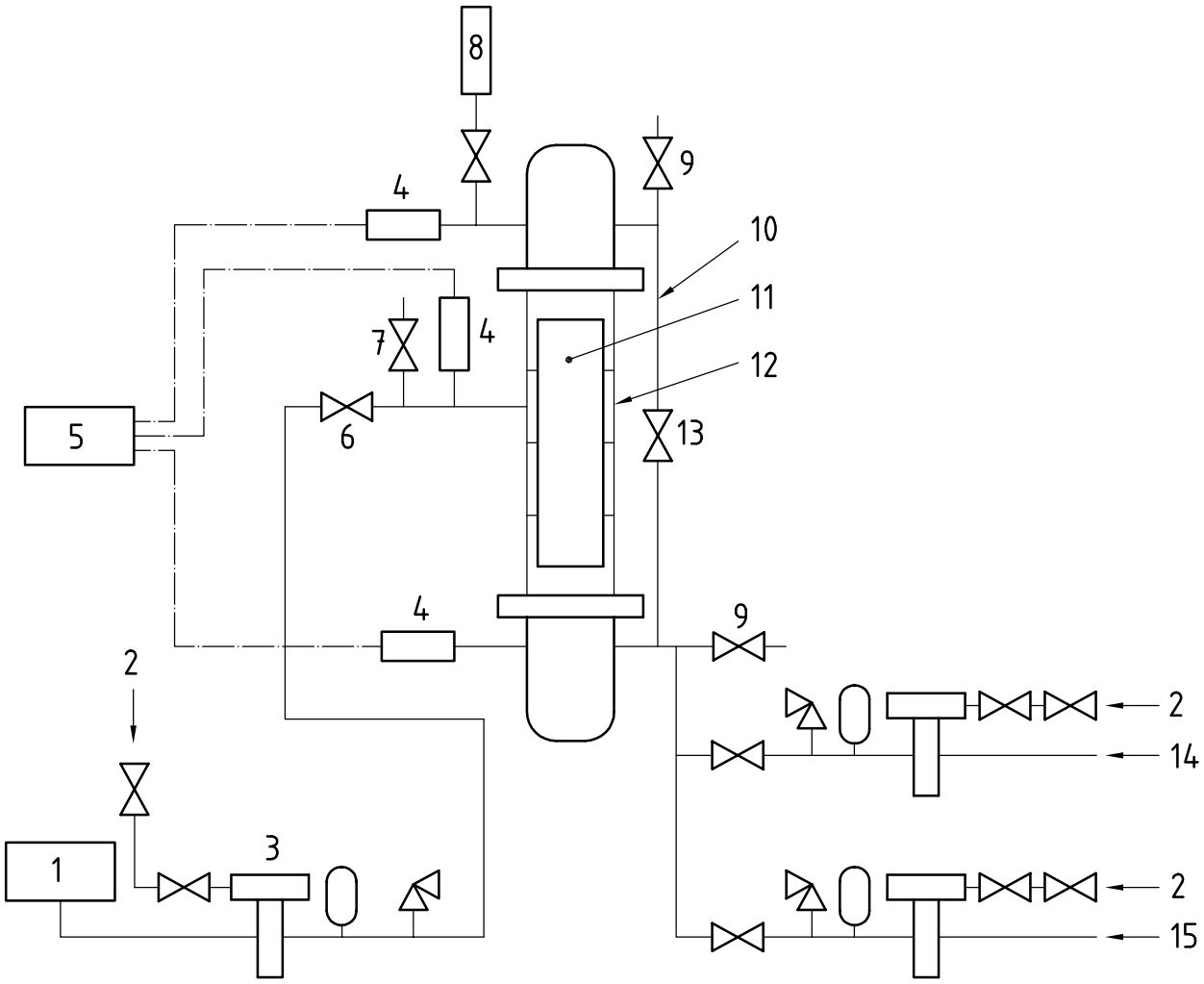
Y time, with hydraulic control pressure applied or released at a metered rate, increasing upwards

1 SCSSV becomes fully open

2 hydraulic system pressure

3 SCSSV becomes fully closed

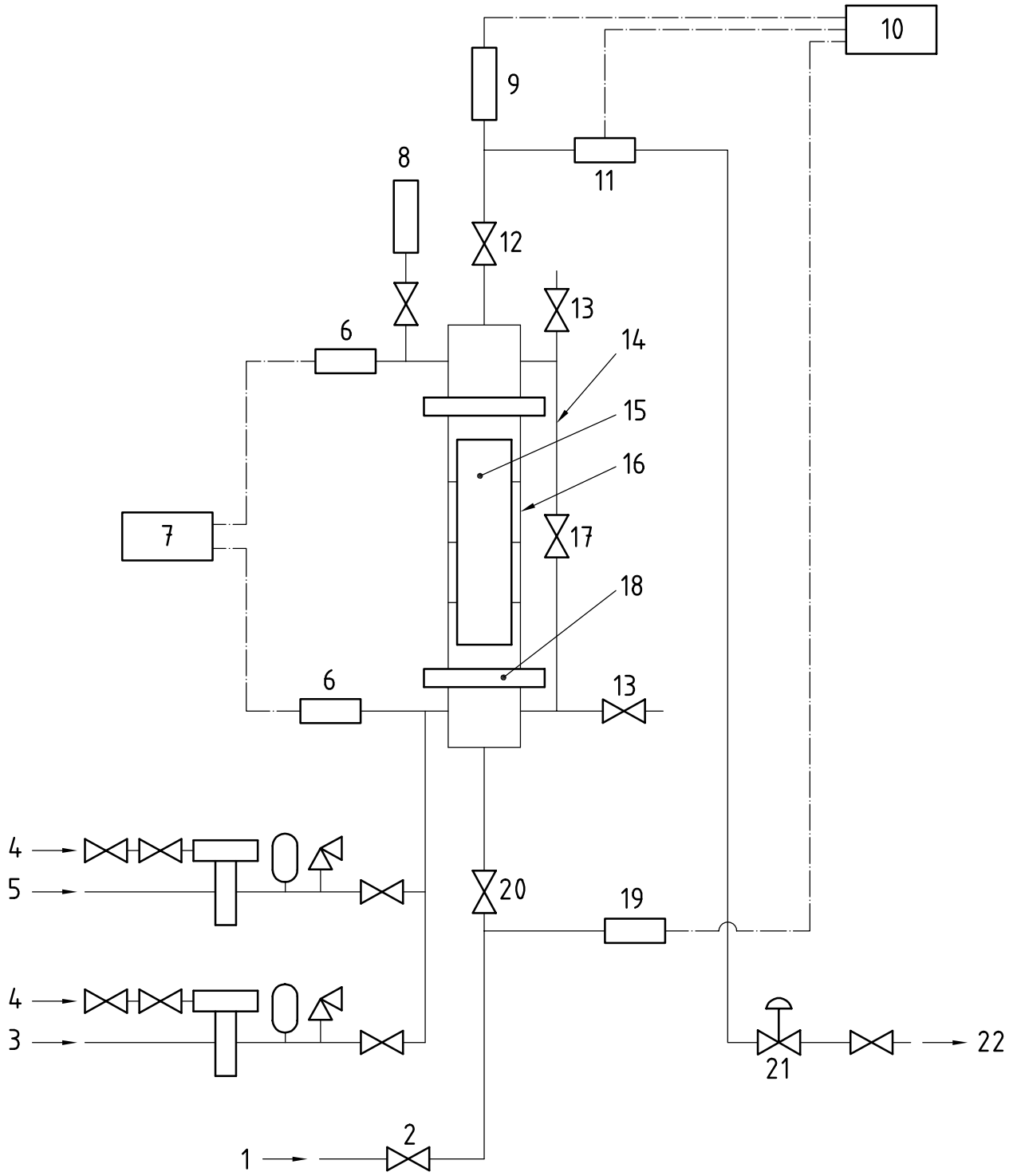
Figure F.6 — Example of characteristic hydraulic control pressure curve for SCSSVs



Key

1 hydraulic oil
2 air supply
3 hydraulic control system
4 pressure-measuring device
5 recorder
6 hydraulic control valve
7 hydraulic control line bleed valve
8 nitrogen flow meter
9 bleed valve
10 equalizing line
11 SSSV
12 test section
13 balance valve
14 test liquid source
15 test gas source

Figure F.7 — Example schematic of functional-test facility for hydraulically actuated SSSVs



Key

1 water or high-pressure gas source
2 flow control valve
3 test gas source
4 air supply
5 test liquid source
6 pressure-measuring device
7 recorder
8 nitrogen flow meter
9 downstream pressure-measuring device
10 strip-chart recorder
11 flow meter
12 downstream isolation valve
13 bleed valve
14 equalizing line
15 SSSV
16 test section
17 balance valve
18 connector
19 upstream pressure-measuring device
20 upstream isolation valve
21 downstream pressure regulator
22 water or gas return

Figure F.8 — Example schematic of functional-test facility for velocity- and tubing-pressure-activated SSSVs

F.3 Tables

Table F.1 — SCSSV gas flow rates (see B.3) [a]

Nominal tubing or casing size mm (in)	Gas flow rate and control line resistances for each valve closure test			
	Low resistance		High resistance	
	Test No. 1 Flow rate $m^3/d \times 10^6$ ($scf/d \times 10^6$)	Test No. 2 Flow rate $m^3/d \times 10^6$ ($scf/d \times 10^6$)	Test No. 3 Flow rate $m^3/d \times 10^6$ ($scf/d \times 10^6$)	Test No. 4 Flow rate $m^3/d \times 10^6$ ($scf/d \times 10^6$)
60,3 (2 3/8)	0,14 (5,1)	0,22 (7,7)	0,07 (2,6)	0,14 (5,1)
73,0 (2 7/8)	0,23 (8,0)	0,34 (12,0)	0,11 (4,0)	0,23 (8,0)
88,9 (3 1/2)	0,33 (11,5)	0,49 (17,3)	0,16 (5,8)	0,33 (11,5)
101,6 (4)	0,44 (15,7)	0,67 (23,6)	0,22 (7,9)	0,44 (15,7)
114,3 (4 1/2)	0,58 (20,5)	0,87 (30,8)	0,29 (10,3)	0,58 (20,5)
127,0 (5)	0,73 (25,9)	1,10 (38,9)	0,37 (13,0)	0,73 (25,9)
139,7 (5 1/2)	0,91 (32,0)	1,36 (48,0)	0,45 (16,0)	0,91 (32,0)
165,1 (6 1/2)	1,30 (46,1)	1,96 (69,2)	0,65 (23,1)	1,30 (46,1)
177,8 (7)	1,79 (63,1)	2,68 (94,7)	0,89 (31,6)	1,79 (63,1)

[a] See B.3.1 and B.3.2 for information on the basis of this table, and requirements for its application.

Table F.2 — SCSSV liquid flow rates (see B.10 and B.12)

Nominal tubing or casing size mm (in)	Circulation rate m^3/d (B/D) (± 10 %)			
	Class 1			Class 2
	Test rate No. 1	Test rate No. 2	Test rate No. 3	
60,3 (2 3/8)	79 (500)	159 (1 000)	238 (1 500)	79 (500)
73,0 (2 7/8)	124 (780)	248 (1 560)	372 (2 340)	124 (780)
88,9 (3 1/2)	178 (1 120)	356 (2 240)	534 (3 360)	178 (1 120)
101,6 (4)	238 (1 500)	477 (3 000)	715 (4 500)	238 (1 500)
114,3 (4 1/2)	305 (1 920)	610 (3 840)	915 (5 760)	305 (1 920)
127,0 (5)	386 (2 430)	772 (4 860)	1 159 (7 290)	386 (2 430)
139,7 (5 1/2)	477 (3 000)	954 (6 000)	1 431 (9 000)	477 (3 000)
165,1 (6 1/2)	686 (4 320)	1 373 (8 640)	2 060 (12 960)	686 (4 320)
177,8 (7)	935 (5 880)	1 869 (11 760)	2 804 (17 640)	935 (5 880)

The manufacturer establishing sizes not covered by this table may interpolate or extrapolate, assuming the circulation rate depends on the square of the nominal size.

Table F.3 — SSCSV liquid flow rates (see B.15, B.16 and B.17)

Nominal tubing or casing size mm (in)	**Circulation rate** m^3/d (B/d) (± 10 %) **Class 1 and Class 2**
60,3 (2 3/8)	79 (500)
73,0 (2 7/8)	124 (780)
88,9 (3 1/2)	178 (1 120)
101,6 (4)	238 (1 500)
114,3 (4 1/2)	305 (1 920)
127,0 (5)	386 (2 430)
139,7 (5 1/2)	477 (3 000)
165,1 (6 1/2)	687 (4 320)
177,8 (7)	935 (5 880)
The manufacturer establishing sizes not covered by this specification may interpolate or extrapolate, assuming the circulation rate depends on the square of the nominal size.	

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