INTERNATIONAL STANDARD

ISO 28781

First edition
2010-08-15

Petroleum and natural gas industries — Drilling and production equipment — Subsurface barrier valves and related equipment

Industries du pétrole et du gaz naturel — Équipement de production et de forage — Vannes de barrage de subsurface et équipement associé

Reference number
ISO 28781:2010(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

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

Contents

Page

Foreword v

Introduction vi

1 Scope 1

2 Normative references 1

3 Terms and definitions 2

4 Abbreviated terms 7

5 Functional requirements 7
5.1 General 7
5.2 Functional characteristics 9
5.3 Well parameters 10
5.4 Operational parameters 10
5.5 Environmental compatibility 10
5.6 Compatibility with related well equipment 11
5.7 Optional requirements 11

6 Technical specification 11
6.1 General 11
6.2 Technical characteristics 12
6.3 Design criteria 12
6.4 Materials 13
6.5 Performance envelope 14
6.6 Design documentation 14
6.7 Design verification 15
6.8 Design validation 15
6.9 Design changes 15
6.10 Functional test 16

7 Supplier/manufacturer requirements 16
7.1 General 16
7.2 Documentation 16
7.3 Product identification 18
7.4 Quality requirements 18
7.5 Material documentation 20
7.6 Additional processes 20
7.7 Traceability 20
7.8 Quality controls 20
7.9 Shear device validation 23
7.10 Assembly and functional test 24
7.11 Manufacturing nonconformities 24

8 Handling, storage and preparation for transport 24

9 Repair/redress 25

Annex A (informative) **Applications overview** 26

Annex B (normative) **Validation requirements for subsurface barrier valves** 29

Annex C (normative) **Functional testing** 37

Annex D (normative) **Validation requirements for subsurface-barrier-valve tools** 39

Annex E (normative) **Performance envelopes** 41

Annex F (informative) **Alternate barrier liquid leakage test acceptance criteria** **43**
Annex G (informative) **Debris-settling design validation** **44**
Annex H (informative) **Closure while flowing slurry test** **46**
Bibliography **47**

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 28781 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*.

Introduction

This International Standard has been developed by users/purchasers and suppliers/manufacturers of subsurface barrier valves and related equipment as defined herein and is intended for use in the petroleum and natural gas industry worldwide to give requirements and information to both parties in the selection, manufacture, testing and use. Further, this International Standard addresses the minimum requirements with which the supplier/manufacturer is to comply so as to claim conformity with this International Standard.

This International Standard has been structured with six different types of barrier valves. This differentiation is due to the range of product functionality, such as the direction in which pressure is held and its use in pre- or post-production/injection operations.

This International Standard has been structured with grades of increased requirements in quality control and design validation. These grades allow the user/purchaser to select the level of requirements that are required for a specific application.

There are two quality grades: quality grade Q2 is the minimum grade of quality offered by this International Standard and quality grade Q1 is the highest grade provided. Additional quality requirements can be specified by the user/purchaser as supplemental requirements.

There are three design validation grades, which provide the user/purchaser with a choice of requirements to meet their preference or application. Design validation grade V3 is the minimum grade and V1 is the most stringent grade provided.

Annexes B, C, D and E are normative requirements, where Annexes A, F, G and H are informative.

The International System of Units (SI) is used in this International Standard, however US Customary (USC) or other units are also shown for reference.

It is required that users of this International Standard be aware that requirements beyond those outlined in this International Standard can 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 can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the supplier/manufacturer to identify any variations from this International Standard and provide details.

Petroleum and natural gas industries — Drilling and production equipment — Subsurface barrier valves and related equipment

1 Scope

This International Standard provides the requirements for subsurface barrier valves and related equipment as they are defined herein for use in the petroleum and natural gas industries. Included are the requirements for design, design validation, manufacturing, functional evaluation, repair, redress, handling and storage. Subsurface barrier valves provide a means of isolating the formation or creating a barrier in the tubular to facilitate the performance of pre- and/or post-production/injection operational activities in the well.

The subsurface barrier valve is not designed as an emergency or fail-safe flow controlling safety device.

This International Standard does not cover installation and maintenance, control systems such as computer systems, and control conduits not integral to the barrier valve. Also not included are products covered under ISO 17078, ISO 16070, ISO 14310, ISO 10432, ISO 10423 and the following products: downhole chokes, wellhead plugs, sliding sleeves, casing-mounted flow-control valves, injection valves, well-condition-activated valves or drill-stem test tools. This International Standard does not cover the connections to the well conduit.

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 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 designation codes*

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

ISO 6506 (all parts), *Metallic materials — Brinell hardness test*

ISO 6508 (all parts), *Metallic materials — Rockwell hardness test*

ISO 9000, *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 — Part 1: Water-based fluids*

ISO 18265, *Metallic materials — Conversion of hardness values*

API Manual of Petroleum Measurement Standards, Chapter 10 — Sediment and Water — Section 4: 1999, *Determination of Sediment and Water in Crude Oil by the Centrifuge Method (Field Procedure)*[1)]

ASME *Boiler and Pressure Vessel Code* (BPVC), Section II, Materials Specification — *Part D: Properties*[2)]

ASME, *Boiler and Pressure Vessel Code* (BPVC) — Section VIII — Rules for Construction of Pressure Vessels — Division 1, UW-40: *Procedures for Post-weld Heat Treatment*

ASME, *Boiler and Pressure Vessel Code* (BPVC) — Section VIII: Division 1, Appendix 8: *Methods for Liquid Penetrant Examination (PT)*

ASME, *Boiler and Pressure Vessel Code* (BPVC) — Section IX: *Welding and Brazing Qualifications*

ASTM E165, *Standard Test Method for Liquid Penetrant Examination*

3 Terms and definitions

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

3.1
assembly (noun)
product comprised of more than one component

3.2
ambient temperature
prevailing temperature at test site

3.3
barrier
obstacle or impediment to flow and/or pressure

3.4
base design
design of a specified size, type and model of subsurface barrier valve that has passed the requirements of Annex B and meets the requirements of this International Standard

3.5
batch-lot-traceable
⟨material or components⟩ having undergone the same process or series of processes and being traceable to one batch of material

3.6
casing
pipe extending from the surface and intended to line the walls of a drilled well

3.7
casing-mounted flow-control valves
downhole valves permanently installed as a component of the casing or liner (pipe not extending from the surface and intended to line the walls of a drilled well)

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

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

3.8
city water
water that is provided by the local water utility system and is unprocessed thereafter

3.9
common hardware
non-critical nuts, bolts, set screws and spacers

3.10
design validation
process of proving a design by testing to demonstrate conformity of the product to design requirements

[ISO/TS 29001:2010, 3.1.7]

3.11
design verification
process of examining the result of a given design or development activity to determine conformity with specified requirements

[ISO/TS 29001:2010, 3.1.8]

NOTE Design verification includes activities such as design reviews, design calculations, physical tests, comparison with similar designs and historical records of defined operating conditions.

3.12
downhole choke
downhole device used to restrict flow rates through its ID and not intended to seal as a barrier

3.13
drift diameter
minimum ID of a subsurface barrier valve, expressed as the OD of the drift bar utilized during assembly verification

3.14
drill-stem test tools
downhole tools temporarily set in place for the purpose of evaluating the production potential of the chosen formation

3.15
end connection
subsurface-barrier-valve equipment/tubular connecting interface

3.16
environment
set of conditions to which a product is exposed

3.17
external means
signal or method used to actuate a barrier valve that is instigated by human intention

3.18
fit
geometric relationship between parts

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

3.19
frangible flapper
barrier-valve mechanism characterized by a flapper/seat combination and deactivated by applied pressure or impact resulting in the destruction of the flapper

3.20
function
operation of a product during service

3.21
functional specification
features, characteristics, process conditions, boundaries and exclusions defining the performance and use requirements of the products

3.22
functional test
test processes performed to confirm proper operation of subsurface-barrier-valve products

3.23
heat-lot traceable
⟨material or components⟩ having undergone the same process or series of processes and being traceable to one heat of material

3.24
heat treatment
alternate steps of controlled heating and cooling of materials for the purpose of changing mechanical properties

3.25
informative
⟨information⟩ intended to enlighten the user/purchaser or supplier/manufacturer, without containing requirements

3.26
injection valve
downhole valve that is normally closed and opened by injected flow within the primary conduit and used for long-term well injection to prevent back-flow

3.27
interchangeable
conforming in every detail, within specified tolerances, to both fit and function of a safe design but not necessarily to the form

3.28
interchangeability
state of conforming in every detail, within specified tolerances, to both fit and function of a safe design but not necessarily to the form

3.29
job-lot traceable
batch of material or components that have undergone the same process or series of processes

NOTE This may include more than one heat.

3.30
life cycle
expected period of time or specified number of actuations that the product shall function according to the manufacturer's specifications

3.31
manufacturing
processes and actions performed by an equipment supplier/manufacturer that are necessary to provide finished component(s), assembly(ies) and related documentation, that fulfill 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.

3.32
model
subsurface-barrier-valve products with unique components and operating characteristics that differentiate it from other subsurface-barrier-valve products of the same type

3.33
normative
⟨information or procedures⟩ mandatory for the user/purchaser or supplier/manufacturer to comply with this International Standard

3.34
operating manual
publication issued by the manufacturer, which contains detailed data and instructions related to the design, installation, operation and maintenance of subsurface-barrier-valve products

3.35
operating temperature range
range defined by the minimum and maximum operating temperatures for products as specified by the supplier/manufacturer

3.36
post-production
indicating the point in time when production/injection has begun

3.37
pre-production/injection
indicating the point in time prior to injection or production

3.38
profile
feature that is designed for the reception of a locking mechanism

3.39
proof test
testing specified by the manufacturer, which is performed to verify that the subsurface barrier valve meets those requirements of the technical specification that are relevant to the validation testing performance

3.40
qualified person
individual or individuals with characteristics or abilities gained through training or experience or both as measured against established requirements, such as standards or tests that enable the individual to perform a required function

3.41
rated pressure
maximum subsurface-barrier-valve pressure limit as defined by the supplier/manufacturer for external, internal and barrier differential pressures

3.42
resetting
returning the tool to its original condition without redress or repair

3.43
room temperature
temperature, typically between 15 °C (60 °F) and 26 °C (80 °F)

3.44
sealing element
device preventing passage (i.e. communication) of liquid and/or gas across the interface in which it is placed

3.45
shear device
component designed to disconnect under a predetermined load

3.46
size
relevant dimensional characteristics (nominal tubing/casing) of the product as defined by the supplier/manufacturer

3.47
sliding sleeve
tubing-mounted device designed such that it is activated to open or close communication between the tubing-to-casing annulus by moving a sleeve

3.48
special feature
specific additional functional capability not validated by the validation testing in accordance with Annex B

3.49
stress factor
ratio of the actual stress divided by the yield stress in a given component

3.50
stress relieving
controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses

3.51
substantive change
change to the design that is identified by the supplier/manufacturer as affecting the performance of the product

3.52
subsurface barrier valve
subsurface (below the tubing hanger) valves activated to either open and/or close by external means

NOTE When closed, the subsurface barrier valve provides a pressure obstruction from above and/or below and a means of isolating the formation or creating a barrier in the tubular. It is not an emergency or fail-safe flow controlling device.

3.53
subsurface-barrier-valve tool
tools used with subsurface-barrier-valves to perform their primary function(s) or provide another intended design function

3.54
test vessel
test apparatus that contains the subsurface barrier valve

3.55
type
subsurface-barrier-valve product with unique characteristics that differentiate it from other subsurface-barrier-valve equipment

3.56
validation test
test performed to qualify a particular size, type and model of subsurface-barrier-valve product for a specific grade of service

3.57
well-condition-activated valve
downhole valve that is not activated by intervention or intentional action(s)

EXAMPLE Chemical- or temperature-activation methods.

3.58
wellhead plug
flow-control device located in the primary bore of a wellhead

4 Abbreviated terms

AQL acceptance quality level

BPD barrels per day

NDE non-destructive examination

OD outside diameter

ID inside diameter

MTR material test report

COC certificate of conformity

5 Functional requirements

5.1 General

5.1.1 Functional requirements

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

5.1.2 Product types

5.1.2.1 The user/purchaser shall select one product type from Table 1. Validation testing requirements are specified in Annex B and functional testing requirements are specified in Annex C.

NOTE Product applications and types are discussed in Annex A.

Table 1 — Subsurface-barrier-valve types

	Barrier from above	Barrier from below	Barrier from above and below
Pre-production and/or injection barrier valves	Type A	Type B	Type C
Post-production/injection[a]	Type AA	Type BB	Type CC

[a] Post-production/injection valves are inclusive of pre-production and/or injection barrier-valve capabilities; for example type AA valves include the capabilities of type A valves.

5.1.2.2 Valve types A, B and C are typically designed for use during the completion process, after which they become inactive. Details are listed below:

— type A: barrier valve designed to be a barrier from above, typically for fluid-loss control or reservoir protection and capable of being pressure tested from above;

— type B: barrier valve designed to be a barrier from below, typically for well control or reservoir protection and capable of being pressure tested from below;

— type C: bi-directional barrier valve designed to be a barrier from above and below and capable of being pressure tested in both directions.

5.1.2.3 Valve types AA, BB and CC are designed for use in pre- and post-production/injection applications, where they can be actuated more than once, as specified by product design. Details are listed below:

— type AA: barrier valve designed to be a barrier from above, typically for fluid-loss control or reservoir protection and capable of being pressure tested from above; the valve operates open and closed and maintains its pressure integrity over its predetermined life cycle;

— type BB: barrier valve designed to be a barrier from below, typically for well control or reservoir protection and capable of being pressure tested from below; the valve operates open and closed and maintains its pressure integrity over its predetermined life cycle;

— type CC: bi-directional barrier valve designed to be a barrier from above and below and capable of being pressure tested in both directions; the valve operates open and closed and maintains its pressure integrity over its predetermined life cycle.

NOTE The rated pressures for bi-directional barrier valves are possibly not the same from above and below.

5.1.3 Design validation grades

The user/purchaser shall select one design validation grade from Table 2 for each product design being provided. These are proof of design evaluations that are performed on the base design. The detailed requirements for each validation grade are specified in Annex B.

Table 2 — Subsurface-barrier-valve validation grade summary

V1: Enhanced design validations (V1 includes the requirements of V2)	Design validations and verifications are required to support the manufacturer/supplier rated limits. These include rated pressure range, temperature range, actuation functionality, and all other stated capabilities and a performance envelope in accordance with Annex E. These products conform to V1 acceptance criteria as specified in Annex B.
V2: Design validations	Same as V1 (preceeding) except that these products conform to V2 acceptance criteria as specified in Annex B.
V3: Supplier's/manufacturer's design validations and field history	Design evaluations are specified by the supplier/manufacturer and are intended to meet the requirements of this International Standard. Documented evidence of testing or evaluation results conforming to the supplier/manufacturer defined acceptance criteria meet this requirement. Additionally, a documented field history of successful performance of products in an environment similar to that of the functional requirements, for products of the same size, type and model; see B.3.2.3.2.

5.1.4 Quality grades

The user/purchaser may select one quality grade from Table 3 for each product design provided or may provide specific quality requirements. Products shall be supplied to Q2 unless otherwise specified. A summary of the quality grade requirements is given in Table 4 and the detailed requirements for each grade are given in Clause 7.

Table 3 — Subsurface-barrier-valve quality grades

Q1: Enhanced quality requirements (Q1 includes the requirements of Q2)	This includes material certifications, NDE documentation, traceability records, functional testing documentation and COCs for coatings, overlays, welding, brazing and heat treating. Q1 requires 100 % NDE inspection of components.
Q2: Standard quality requirements	Quality requirements as summarized in Table 4. Q2 allows sample plan NDE inspections as specified by the manufacturer.

5.2 Functional characteristics

The functional characteristics shall include, but not be limited to, the following, as applicable, for each subsurface barrier valve and required tool:

a) type of control system and its limits;

b) methods of actuation (surface-controlled, subsurface-controlled);

c) type of subsurface-barrier-valve closing mechanism (ball, flapper, sleeve, etc.);

d) holding the subsurface barrier valve open without the use of the primary operating mechanism (temporary or permanent lock-open systems);

e) pump-through capability;

f) independent back-up operating system;

g) specific number of cycles, actuations;

h) contingency opening/closing feature/procedure independent of 5.2 f);

i) conditions and/or mechanisms causing valve operation, and the conditions under which the valve is designed to close or open;

j) requirements for retrieval and/or repair;

k) acceptance of the introduction of debris to the wellbore upon actuation.

5.3 Well parameters

The following well parameters shall be specified, as applicable:

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

b) size, mass (weight), grade and material of the casing and tubulars;

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

d) setting depth (maximum required for application) and control fluid type/properties, supply pressure, supply line(s) and connection rating(s);

e) restrictions through which the subsurface barrier valve shall pass and restrictions/profiles through which the subsurface-barrier-valve tools/accessories shall pass;

f) mud type and composition.

5.4 Operational parameters

The operational parameters shall include, but not be limited to, the following, as applicable, for each subsurface barrier valve and required tools:

a) maximum rated pressure, for both external, internal and barrier differential pressures;

b) rated temperature range, for both maximum and minimum in static and operational conditions;

c) maximum allowable pressure drop at maximum flow rate through subsurface barrier valve;

d) loading conditions, including combined loading (pressures, tension/compression, torque, bending, intermittent conditions, such as pressure testing with temporary test plugs) and the corresponding temperature limits anticipated;

e) any well-pumping operations, including parameters such as acidizing (e.g. composition of the acid), sand/proppant description, fluid flow rate, proppant/fluid ratio or sand/fluid ratio, pressure, temperature and exposure time and any other chemicals.

5.5 Environmental compatibility

The following shall be identified for the barrier valve and required tools to ensure environmental compatibility:

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

b) in cases where the user/purchaser has access to corrosion property data and/or research that is applicable to the functional specification, the user/purchaser shall state which material(s) have the ability to perform as required;

c) in cases where the user/purchaser elects to use materials specified by the supplier, the user/purchaser shall provide the necessary environmental conditions to enable the proper selection of materials for the environment;

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

e) environmental conditions during transportation, storage and at surface prior to and during deployment.

5.6 Compatibility with related well equipment

The following information, as applicable, shall be specified to ensure the compatibility of the subsurface barrier valve and required tools with the related well equipment:

a) subsurface-barrier-valve size and the external connection to the well tubulars, the configuration of the external interface connections (these connections are not included in the evaluation of combined loading);

b) details of any devices being run through the subsurface barrier valve, such as, size, type and configuration of the other devices;

c) internal receptacle profile(s) required in the subsurface barrier valve for receiving related well equipment, including sealing bore, dimension(s), eccentricity and respective locations;

d) requirement(s) for continuity of flow path and/or through bore access (size length, etc.), passage of conduits (electrical/hydraulic, etc.) between valve OD and casing ID, and/or open-hole ID restrictions.

5.7 Optional requirements

5.7.1 Alternate liquid leakage test acceptance criteria

The user/purchaser may select an alternate barrier liquid-leakage test acceptance criteria, as provided in Annex F.

5.7.2 Performance envelope for V2

The user/purchaser may request a performance envelope supplied to illustrate the combined effects of pressure, temperature and axial loads for V2 barrier valves; see Annex E.

5.7.3 Additional validation testing

The user/purchaser may select additional validation testing performed as defined in Annex G, and/or in Annex H.

5.7.4 Additional quality requirements

The user/purchaser may require the performance of additional quality inspection operations.

6 Technical specification

6.1 General

The supplier/manufacturer shall provide the user/purchaser with a technical specification that conforms to the requirements defined in the functional specification, or identifies in detail where variance(s) are offered. The supplier/manufacturer shall also provide the user/purchaser with the technical and manufacturing data required by 7.2.

6.2 Technical characteristics

The subsurface barrier valve and barrier-valve-related tools shall perform in accordance with the functional specification, as stated in Clause 5, and within the limitations defined in the product-specific operating manual and design criteria.

6.3 Design criteria

6.3.1 General

Subsurface-barrier-valve designs shall permit prediction and repeatability of conditions required for opening and/or closing. Barrier-valve products shall be designed to meet the design validation requirements and the requirements of the functional specification. Final approval of the design shall be performed and documented by a qualified person(s) other than the person who created the original design.

6.3.2 Design requirements

6.3.2.1 General

The supplier/manufacturer shall establish internal yield pressure, collapse pressure and minimum tensile/compressive strength ratings (excluding end connections), geometrical dimensions and the operational capabilities necessary to meet the requirements of this International Standard.

External pressure, tensile, compression and internal chamber ratings shall be established based on design calculations or full-scale testing using supplier's/manufacturer's approved methods by a qualified person(s).

The supplier/manufacturer shall identify all related tools necessary for the full functionality of the subsurface barrier valve. The design requirements for the related tools and the interface with the specific subsurface barrier valve shall conform to the functional specification. Subsurface-barrier-valve tools shall be designed and manufactured according to the requirements defined for Q2 barrier valves in this International Standard.

Temperature, environment, material properties and combined loading effects on all materials used in subsurface-barrier-valve products shall be considered when establishing the rated pressures and load capabilities. The design shall take into account the effects of pressure containment and pressure-induced loads. Where applicable, specialized and/or intermittent conditions, such as pressure testing with temporary test plugs, shall also be considered in the design.

The additive dimensional tolerances shall be such that proper operation of the subsurface-barrier-valve product is assured. Subsurface-barrier-valve products and components conforming to this International Standard shall be manufactured according to drawings and specifications that contain no significant changes from those of the barrier-valve product that passed the applicable validation test.

6.3.2.2 Considerations

Subsurface-barrier-valve product design shall take into consideration the effects of temperature on all components. The upper temperature limit shall be the lowest high-temperature rating of any component of the subsurface barrier valve. The lower temperature limit shall be the highest low-temperature rating of any component of the subsurface barrier valve. De-rating of metal mechanical properties shall be in accordance with ASME BPVC, Section II, Part D.

Subsurface-barrier-valve product design shall take into account the effects of exposure to and/or retained fluid(s) supplied in the functional specification on all components. Subsurface-barrier-valve product design shall consider the effects of sand, chlorides, corrosion inhibitors and any other chemicals routinely encountered in oil and gas production.

6.3.2.3 Interchangeability

The design, tolerancing, and manufacture of subsurface-barrier-valve components shall be conducted so that interchangeability of components and/or subassemblies of separately manufactured products is possible without affecting the performance of the assembled product, which is required to meet the requirements of design validation.

6.4 Materials

6.4.1 General

Materials for each component shall be stated by the supplier/manufacturer and shall be suitable for the environmental conditions specified in the functional specification. The supplier/manufacturer shall have documented specifications for all materials and materials shall comply with these specifications.

The manufacturer shall have documented procedures that verify that the material used is suitable in the configuration, environment and application required. These procedures shall consider the combination of pressure, temperature, geometric design, its application and environment.

a) The user/purchaser may specify materials for the specific corrosion environment in the functional specification. If the supplier/manufacturer proposes to use another material, the user/purchaser shall agree to the proposed material alternative. This applies to metallic and non-metallic components.

b) Material substitutions for those materials used in the validation-tested subsurface-barrier-valve products are allowed without validation testing. The manufacturer's selection criteria for these substitutions shall be documented and the substituted material shall conform to the design, and to the functional and technical requirements of this International Standard. Material substitutions require approval by a qualified person(s) and the incorporation of supporting documentation into the design file.

c) Substantive changes to materials (metallic and non-metallic) that can affect product performance shall be considered in accordance with 6.9.

6.4.2 Metals

6.4.2.1 General

Metallic materials used in the manufacture of subsurface barrier valves shall meet the requirements in 6.4.2.2 to 6.4.2.4.

6.4.2.2 Specifications

The material specifications shall include

a) chemical-composition limits;

b) heat treatment requirements/conditions, as applicable;

c) mechanical-property limits, including, as a minimum,

   1) tensile strengths,

   2) yield strength (transverse and longitudinal, as applicable),

   3) elongation,

   4) hardness,

   5) toughness, where applicable and as defined by the supplier/manufacturer.

6.4.2.3 Mechanical property testing of heat-treated materials

The heat-treatment process parameters shall be defined in a heat-treatment procedure. Material test reports provided by the material supplier and approved by the supplier/manufacturer or the material test reports provided by the supplier/manufacturer are acceptable documentation of the specified mechanical properties.

Hardness testing is the minimum mechanical property testing required after stress relieving.

6.4.2.4 Stress relieving of welds

Each welded component shall be stress-relieved as specified in the manufacturer's documented specifications or in accordance with ASME BPVC, Section VIII, Division 1, UW-40. Hardness testing is required after stress relieving.

6.4.3 Non-metals

The supplier's/manufacturer's documented 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

a) compound type;

b) mechanical properties, including 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.

6.5 Performance envelope

A performance envelope, as specified in Annex E, shall be prepared for V1 barrier valves. For V2 barrier valves, a performance envelope shall be prepared when requested in the functional specification. The performance envelope of the supplier/manufacturer shall state and graphically illustrate the pressure, temperature and axial load rating, as applicable, for the rated limits of the body of the specific product, exclusive of end connections. The performance envelope may be based on test data and/or calculated data. An example is given in Annex E.

6.6 Design documentation

Documentation of designs for each size, type and model shall include design requirements, functional and technical specifications, methods, assumptions, comparison with previous designs (where applicable), design calculations, design reviews and validation evaluation/testing procedures/acceptance criteria and their approved results required to validate the design. Design requirements shall include those pressures, operational loads, material, environmental and other pertinent requirements on which the design is based.

Drawings, manufacturing specifications, material specifications and material certifications, including yield strength and end-connection identification, and the validation test results shall be retained in accordance with 7.2.1.

Instructions providing methods for the safe assembly and disassembly of the product and stating the operations that are permitted to preclude failure and/or non-compliance with the functional and technical requirements shall be retained. Instructions providing methods for the safe field use of the product shall be defined in the operating manual; see 7.2.2.

6.7 Design verification

Design verification shall be performed to ensure that each subsurface-barrier-valve design meets the 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.

6.8 Design validation

6.8.1 General

The subsurface-barrier-valve designs produced in accordance with this International Standard shall have passed the applicable validation test required in the functional specification and specified in Annex B to qualify each size, type and model. Successful completion of the validation testing process shall qualify other subsurface barrier valves of the same size, type and model as the tested base design of subsurface barrier valve.

NOTE The testing requirements in this International Standard might not be representative of well conditions.

6.8.2 Manufacturer requirements

Prior to validation testing, the subsurface barrier valve shall be proof tested or evaluated to ensure that the valve meets the requirements of the technical specification with the manufacturer's specified safety factors. The manufacturer shall provide the validation test facility with a subsurface barrier valve of each size, type and model and a detailed test procedure that conforms to the requirements of this International Standard. Each product base design provided shall, as a minimum, conform to all the acceptance criteria of the validation test requirements of Annex B.

Pre-test and post-validation testing dimensional inspections of critical dimensions defined by the supplier/manufacturer shall be conducted and documented. For a successful test, all results shall be within the established acceptance criteria, approved by a qualified person(s) and maintained in the design file.

6.8.3 Special feature validation

Special features shall be validated by test to their rated limits or fully evaluated to documented procedures, including acceptance criteria, and shall be approved by a qualified person(s); see B.4.9. The procedures and results shall be incorporated into the design file. Special feature validation testing may be performed by the supplier/manufacturer.

6.9 Design changes

6.9.1 General

Design changes shall be documented, reviewed and approved by a qualified person(s) before implementation. Design changes and changes to design documents shall require the same controls as those applied to the design that has passed the applicable validation and verification requirements of this International Standard.

Design changes shall be reviewed by the supplier/manufacturer against the design verification and validation documents to determine whether or not the change is a substantive one.

A design that undergoes a substantive change becomes a new design requiring design verification and design validation; however, de-rating is allowed in accordance with 6.9.2. All products containing a substantive change shall continue to meet the applicable verification and validation test requirements of the base design.

The supplier/manufacturer shall, as a minimum, consider the following for each design change:

— stress levels of the modified or changed components compared to those of the base design;

— possible functional or operational changes introduced by the design change;

— interchangeability with existing components or previously manufactured assemblies.

6.9.2 De-rating requirements

6.9.2.1 General

De-rating of subsurface barrier valves 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 International Standard, specifically 6.9.2, are satisfied. Increases in ratings require validation testing in accordance with 6.8.

The rated pressure of a de-rated design may be less than that of the base design by a maximum of 50 %. Each de-rated product requires evaluation, justification and design documentation of the changes from this base design. The documentation shall be maintained in accordance with 6.6 and shall be included in the new product's design records.

6.9.2.2 De-rating process

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. The minimum acceptable material condition, minimum acceptable material yield strengths and maximum and minimum temperature effects on the material properties shall be used. The manufacturer shall establish the maximum stress factors in the equivalent components within the de-rated design. The mode of stress and same method of calculation/evaluation shall be applied to the identified components of both product designs.

For each component, the de-rated design's stress factors shall not exceed the maximum stress factors of the same components of the base design.

Adjustments to material thickness or yield strengths shall not exceed the maximum stress factors. The manufacturer shall ensure that the de-rated product conforms to the applicable validation and functional testing requirements.

6.10 Functional test

Each manufactured product shall be successfully tested in accordance with the requirements of 7.10.1 and shall conform to all the acceptance criteria of the functional test requirements of Annex C.

7 Supplier/manufacturer requirements

7.1 General

Clause 7 contains the detailed requirements for each product manufactured under this International Standard to conform to the requirements of the functional and technical specifications. These include requirements for documentation, product identification, quality control, materials, special processes, traceability, inspections, shear device verifications, functional testing and nonconformity dispositions.

7.2 Documentation

7.2.1 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 is designed to prevent 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 two weeks of the request. Documentation shall be retained for a minimum of five years from the date of last manufacture. Table 4 summarizes the quality data that the manufacturer is required to retain and provide and 6.6 contains the design documentation requirements.

Documentation supplied with each unique barrier valve and barrier-valve tool shall include a product operating manual, a functional testing report and the documentation as summarized in the specific quality grade requirements in Table 4.

7.2.2 Operating manual contents

For each order of subsurface barrier valves or tools, the supplied operating manual shall contain the following information, as applicable:

a) methods for safe field use of the product and product hazard identifications;

b) contact information of supplier/manufacturer;

c) manufacturer assembly number and product name;

d) size, type and model;

e) design validation grade, quality grade;

f) operational ratings:

   1) rated pressure and direction(s) of pressure capability,

   2) operating temperature range, including any known temperature exposure limitations,

   3) internal yield and collapse pressures at minimum and maximum rated temperatures,

   4) tensile and compressive rated capacity at minimum and maximum rated temperatures (as applicable and including end connections),

   5) installed operational orientation limits (vertical, horizontal);

g) connection(s) size, weight (mass) and type;

h) product dimensions, including minimum ID, maximum OD, makeup length and dimensional data required for inspection/operations;

i) operational data, including shear pressures, activation loads, etc.;

j) related tool requirements, as applicable;

k) drawings and illustrations of the fully assembled product, including a dimension drawing for fishing purposes;

l) product pre-installation preparation procedures and requirements;

m) installation, operating and special-feature operational procedures;

n) troubleshooting procedures;

o) repair and/or redress limitations and procedures;

p) preparations required for shipment;

q) storage requirements.

7.3 Product identification

Products furnished according to this International Standard shall be permanently identified in accordance with the supplier's/manufacturer's documented specifications. The supplier's/manufacturer's specifications shall define the type, method of application and location of the identifications. Identification shall include, as a minimum, marking all items 7.3 a) through 7.3 j) for quality grade Q1 or marking all items 7.3 a) through 7.3 e) for quality grade Q2.

a) Manufacturer's name or trademark;

b) manufacturer's part number;

c) unique identifying serial number and/or trace number;

d) date of manufacture;

e) direction of installation (e.g. “THIS END UP”);

f) rated pressures and directions and temperature limits;

g) maximum OD;

h) minimum ID;

i) internal tool interaction profile designation, where applicable;

j) actuation pressures, if applicable.

7.4 Quality requirements

This International Standard specifies two quality control grades, Q1 and Q2, that may be selected by the user/purchaser. Products shall be supplied to Q2 unless otherwise specified. Detailed requirements for Q1 and Q2 shall be as specified in Table 4 and detailed in 7.5 through 7.10.

Table 4 — Quality grade requirements for Q1 and Q2

Requirements	Quality grade requirements			
	Q1		Q2	
	Requirement	Ref.	Requirement	Ref.
Supplied documentation	Operating manual Performance envelope - For valves supplied according to grade V1 or to grade V2 when requested.	7.2.2	Operating manual	7.2.2
Retained documentation (as applicable; see 7.2.1)	Certificates of conformity Material test reports Heat treatment certificates Material traceability records Non-destructive examination records Functional testing records Shear device testing records Performance envelope	7.5 7.5 7.6 7.7 7.8.2 7.10 7.9 6.5	Certificates of conformity Material test reports Shear device testing records	7.5 and 7.6 7.5 7.9
Product identification	Marking	7.3 a) to j)	Mark	7.3 a) to e)
Metallic materials	MTR and COC	7.5	MTR and COC	7.5
Casting/forging materials	COC	7.5	COC	7.5
Non-metallic materials	COC on physical properties per batch Visual inspection	7.5 7.8.2.14	COC on physical properties per batch Visual inspection	7.5 7.8.2.14
Heat treatment	Heat treatment certificate	7.6	COC	7.6
Special processes: coatings, welding and brazing	COC stating that processes meet manufacturer's requirements for all components	7.6	COC stating that processes meet manufacturer's requirements for all components	7.6
Component traceability	Heat-lot or batch traceability	7.7.1	Job-lot traceability	7.7.2
Welding	100 % of welds NDE inspected	7.8.2.2 and 7.8.2.1.2	Sample lot NDE inspection	7.8.2.3 and 7.8.2.12
Assembly serialization	Required	7.7.3	None required	—
Hardness	100 % of metallic components hardness-inspected	7.8.2.2 and 7.8.2.5	Sample-lot hardness inspection of metallic components	7.8.2.3 and 7.8.2.5
Component NDE	100 % of metallic components		Sampling-lot of metallic components inspected	
Component dimensions and threads	100 % of components inspected	7.8.2.2, 7.8.2.12 and 7.8.2.13	Sampling-lot inspection	7.8.2.3, 7.8.2.12 and 7.8.2.13
Visual inspection	100 % of components inspected	7.8.2.2 and 7.8.2.14	Sampling-lot inspection	7.8.2.3 and 7.8.2.14
Shear/activation devices	Heat-lot validation	7.9	Heat-lot validation	7.9
Assembly verification	Functional test	7.10	Functional test	7.10

NOTE 7.2 applies to all subclauses of Clause 7 listed.

7.5 Material documentation

Each heat and/or job lot or batch of material used in the manufacture of components shall require the following documents:

a) certificate of conformity (COC) stating that the material meets the manufacturer's documented specifications; see 6.4.1;

b) material test report (MTR) for metallic materials (other than castings and forgings) that the manufacturer shall use to verify that the material conforms to the manufacturer's material specifications; see 6.4.1.

7.6 Additional processes

When processes are used on products conforming to this International Standard, the supplier/manufacturer shall establish specifications for all processes that are not validated by subsequent monitoring or measurement. These specifications shall include the applicable physical and chemical properties, procedures, inspection methods and acceptance criteria that are prepared and approved by a qualified person(s). For products produced according to this International Standard, the processes requiring such specifications are, for example, heat treatment, coatings, overlays, surface treatments, welding or brazing. The supplier/manufacturer shall validate conformance to the specifications and additional processes as they are applied to the components of products complying with this International Standard.

For products supplied to Q1, a heat treatment certificate showing actual times and temperatures is required. For products supplied to Q1 where an additional process (such as quench and temper or surface hardening, etc.) other than heat treatment is applied, a COC shall be provided. For products supplied to Q2, where an additional process is applied, a COC shall be provided.

7.7 Traceability

7.7.1 Heat lot and/or batch traceable

For quality grade Q1, all components except common hardware shall be traceable in accordance with the manufacturer's documented procedures to a heat lot or batch lot and an MTR/COC.

Traceability for a product manufactured according to this International Standard shall be ensured until it leaves the supplier's/manufacturer's inventory.

7.7.2 Job-lot traceable

For quality grade Q2, all components except common hardware shall be traceable in accordance with the manufacturer's documented procedures to a job lot.

Traceability for a product manufactured according to this International Standard shall be ensured until it leaves the supplier's/manufacturer's inventory.

7.7.3 Serialization

For quality grade Q1, assembly serialization is required.

7.8 Quality controls

7.8.1 Specifications and measuring/testing equipment calibration

The supplier/manufacturer shall establish and implement specifications for all quality processes used on products conforming to this International Standard. These specifications shall include the procedures, inspection methods and acceptance criteria and shall be approved by a qualified person(s).

Inspection, measuring and testing equipment used for acceptance shall be used only within its calibrated range and shall be identified, controlled, calibrated and adjusted at specific intervals in accordance with the manufacturer's procedures that are based on an internationally recognized standard, such as ISO/IEC 17025 or ANSI/NCSL Z540-3.

Technologies for inspections with verifiable accuracies equal to or better than those listed in this International Standard may be applied with appropriate documentation and when approved by a qualified person(s).

Calibration intervals for measuring and testing equipment shall be established based on repeatability and degree of usage. Calibration intervals shall be a maximum of three months until a recorded calibration history can be established. Intervals may then be lengthened or shortened based on documented repeatability, amount of usage and calibration history. The calibration interval cannot be increased by more than twice the previous interval, which is not to exceed one year.

Calibration standards used to calibrate measuring equipment shall be checked and approved at least once every three years by an independent outside agency with traceability to the applicable recognized national or international standards agency.

7.8.2 Non-destructive examinations (NDE)

7.8.2.1 General requirements

7.8.2.1.1 Specifications

Non-destructive examinations shall be conducted according to the manufacturer's documented specifications that include acceptance criteria and the requirements of 7.8.2. All NDE instructions shall be approved by a qualified NDE level III examiner in accordance with a national or an international standard, such as ISO 9712 or ASNT SNT-TC-1A. Visual-examination requirements do not require level III approval. Acceptance of all materials/documents shall be permanently indicated either on the materials/documents or in records directly traceable to them.

7.8.2.1.2 Welds

Welds and adjacent heat-affected zones of the sample lot (see 7.8.2.2 and 7.8.2.3) shall be non-destructively examined by one or more of the following methods: radiography, magnetic particle, ultrasonic or liquid penetrant, as designated in the manufacturer's specifications.

7.8.2.1.3 Castings and forgings

Castings and forgings shall be magnetic-particle or liquid-penetrant inspected for surface defects and/or shall be volumetrically inspected by radiographic or ultrasonic techniques to verify conformance with the manufacturer's specifications.

7.8.2.1.4 Indications

Any unacceptable indications shall be removed, repaired according to the supplier's/manufacturer's procedures and re-examined using the original NDE method and acceptance criteria.

7.8.2.2 Quality grade Q1

For quality grade Q1, 100 % of all components shall be inspected in accordance with the relevant subclauses in 7.5 to 7.10, as specified in Table 4.

7.8.2.3 Quality grade Q2

Sample lot examinations are acceptable and shall be performed on a minimum sample lot of 10 % of the job lot in accordance with ISO 2859-1 or with the supplier/manufacturer documented sampling plan with one

component as the absolute minimum. When the inspection produces an unacceptable result, one additional component from the job lot shall be inspected. If it is also found to be unacceptable, then 100 % of the job lot shall be inspected to verify compliance.

7.8.2.4 NDE personnel qualifications

All personnel performing inspections for acceptance shall be qualified in accordance with the supplier's/manufacturer's documented requirements.

Personnel performing visual examinations shall have an annual eye examination, as applicable to the discipline to be performed, in accordance with ISO 9712 or equivalent, such as defined in ASNT SNT-TC-1A.

Personnel performing NDE evaluations and interpretations shall be qualified in accordance with ISO 9712, to a minimum of level II or equivalent, such as defined in ASNT SNT-TC-1A.

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

7.8.2.5 Hardness testing

According to the quality grade (see Table 4), hardness testing on metallic components shall, as a minimum, be in accordance with ISO 6506 (all parts) (Brinell hardness test) or ISO 6508 (all parts) (Rockwell hardness test). ISO 6507 (all parts) (Vickers hardness test) may be used when ISO 6506-1 or ISO 6508-1 cannot be applied due to size, accessibility or other limitation.

NOTE 1 For the purposes of this provision, ASTM E10 is equivalent to ISO 6506, ASTM E18 is equivalent to ISO 6508, and ASTM E92 is equivalent to ISO 6507.

Hardness conversion to other measurement units shall be in accordance with ISO 18265.

NOTE 2 For the purposes of this provision, ASTM E140 is equivalent to ISO 18265.

The durometer hardness of O-rings or other elastomeric packing elements shall be determined in accordance with an International Standard or national standard, such as ASTM D2240 or ASTM D1415. A test specimen manufactured from each batch may be used.

7.8.2.6 Liquid-penetrant inspections

When required by the supplier's/manufacturer's specifications, liquid-penetrant inspection shall be conducted in accordance with ASTM E165 and to the acceptance criteria of ASME BPVC, Section VIII, Division 1, Appendix 8, and the following criteria.

— Any relevant indication [an indication with a major dimension greater than 1,6 mm (0,062 in)] greater than or equal to 4,8 mm (0,187 in) shall be considered unacceptable.

— Any relevant indication on a sealing surface, in root area of threaded connection or in a stress-relief feature of a connection, shall be considered unacceptable.

— Any relevant linear indications (wherein the length is three times the width or more) shall be considered unacceptable.

7.8.2.7 Wet-magnetic-particle inspections

When required by the supplier's/manufacturer's specifications, wet-magnetic-particle inspections shall be in accordance with an international or a national standard, such as ISO 13665 or ASTM E709. The minimum acceptance criteria are those specified in 7.8.2.6.

7.8.2.8 Ultrasonic inspection

When required by the supplier's/manufacturer's specifications, ultrasonic inspections shall meet the requirements and acceptance criteria of an international or national standard such as ASME Boiler and Pressure Code, Section VIII, Division 1, Appendix 12.

7.8.2.9 Radiographic inspection

When required by the supplier's/manufacturer's specifications, radiographic NDE inspections shall meet the requirements of an international or a national standard, such as ASTM E94. Acceptance criteria shall be in accordance with an international or a national standard, such as ASME BPVC, Section VIII, Division I, UW-51.

7.8.2.10 Coatings and overlays

Coatings and overlays shall be performed in accordance with documented instructions that include acceptance criteria approved by a qualified person(s).

7.8.2.11 Welding and brazing

Welding and brazing procedures, activities and personnel qualifications are required in accordance with ASME BPVC, Section IX.

Materials and practices not listed in ASME BPVC, Section IX shall be qualified in accordance with the methods of ASME BPVC, Section IX and approved by a qualified person(s).

7.8.2.12 Component dimensional inspection

Components, except those defined by the supplier/manufacturer as common hardware, shall be dimensionally inspected by a qualified person(s) to ensure proper function and compliance with the 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.

Dimensional tolerances of O-rings shall be in accordance with ISO 3601-1 or equivalent. Other sealing elements shall meet the dimensional tolerances of the supplier's/manufacturer's documented specifications.

7.8.2.13 Thread inspection

Threads shall be inspected to the tolerances, inspection requirements, gauges, gauging practices, gauge calibration and gauge certification to conform to the specified thread manufacturer's documented specifications.

7.8.2.14 Visual inspection

Components shall be visually inspected according to the supplier's/manufacturer's documented procedures, including acceptance criteria, by a qualified person(s) to ensure that all accessible surfaces are free from defects and damage prior to assembly.

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

7.9 Shear device validation

The supplier/manufacturer shall perform a shear-device validation once per heat lot by a qualified person(s) in accordance with the supplier's/manufacturer's documented procedure and acceptance criteria.

7.10 Assembly and functional test

7.10.1 General

Each product shall be assembled and functionally tested according to the requirements and acceptance criteria in Annex C and in the user/purchaser-selected Q1 or Q2 quality requirements. Additionally, the requirements specified in 7.10.2 shall be performed to verify correct assembly.

7.10.2 Assembly requirements

The following are necessary for proper assembly.

a) Make-up torque values for all sealing connections shall be recorded and verified to be within supplier's/manufacturer's documented specifications. End connections are specifically excluded from this requirement.

b) Visual and dimensional (including OD, running OD and ID) inspection of the assembly shall be conducted by a qualified person(s) to ensure conformance to the supplier's/manufacturer's specifications.

c) Components of the product not tested in the requirements of Annex C and that require pressure integrity shall be verified by test, by a qualified person(s), to a supplier's/manufacturer's procedures to meet the acceptance criteria. The results of the successful pressure integrity test shall be documented and become a part of the product-specific quality record.

7.11 Manufacturing nonconformities

The supplier/manufacturer shall establish and maintain documented procedures to ensure that an assembly or component that does not conform to specified requirements is prevented from unintended use or installation. This control shall provide for the identification, documentation, evaluation, segregation (when applicable) and disposition of nonconforming components or assemblies.

Responsibility for review and authority for disposition of nonconforming assemblies or components shall be defined in procedures established by the supplier/manufacturer and carried out by a qualified person(s).

8 Handling, storage and preparation for transport

Subsurface-barrier-valve products shall be handled and stored according to the documented specifications of the supplier/manufacturer to prevent deterioration.

Subsurface-barrier-valve equipment shall be packaged for transport according to the documented specifications of the supplier/manufacturer to prevent damage to the equipment from normal handling and contamination. All material provided as protection for transport shall be clearly identified for removal prior to equipment use.

Requirements for storage after transport shall be identified in the product operating manual.

9 Repair/redress

Repair of subsurface-barrier-valve products shall be conducted according to procedures established by the supplier/manufacturer and shall return 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 the original manufacture.

Redress activities shall be defined in and conducted according to the product-specific operating manual and are limited to the replacement of non-metallic sealing elements that have passed the validation and functional testing requirements or common hardware items followed by applicable functional test carried out and the results approved by a qualified person(s).

Annex A
(informative)

Applications overview

A.1 General

This annex provides general information for users/purchasers of subsurface barrier valves to help familiarize them with the capabilities and limitations of these products. Included are possible applications for barrier valves, types, operational capabilities and limitations for barrier valves, and the categories into which barrier valves are organized within this International Standard.

Information is provided on some of the possible benefits of controlling flow and pressure in a well by using barrier-valve technology during the completion installation, and after the completion has been on production or injection for some time.

A.2 Barrier-valve system descriptions

For the purposes of this International Standard, barrier valves are defined as a valve assembly that provides an obstacle or impediment to flow and/or pressure (see 3.52). The scope of this International Standard indicates that a barrier valve is not considered as an emergency or fail-safe flow-controlling safety device. Barrier-valve systems include the primary and secondary operational tools that are designed and tested with the subsurface barrier-valve designs. Consideration shall be given to assuring that the systems are fully compatible with the specific well construction and operational plans for its life cycle.

Valve types A, B and C are typically designed for use during the completion process, after which they become inactive.

Valve types AA, BB and CC are designed for use in pre- and post-production/injection application where they may be actuated more than once, as specified by product design.

A.3 Applications of barrier-valve systems

In its most basic application, a barrier valve is placed in the wellbore to isolate the flow from travelling from one section of the completion to another. This isolation can be between either the reservoir and the surface or between two producing zones. When closed, it forms a “barrier” to flow or pressure from above, below or both. A barrier valve may be placed within the upper or lower completion.

Principal uses include operation as a subsurface lubricator, zonal separation as in sand control applications, fluid-loss control and to provide a two-way barrier for well protection and pressure testing from above. Barrier-valve systems provide post-production/injection tubing closures for temporary well shut-ins and/or when downhole pumping units are removed for servicing.

Barrier-valve systems are offered in a wide variety of designs and configurations to match the completion requirements and supplier's/manufacturer's design selections. There are a variety of designs and associated tools required to fully operate them. Therefore, the requirements of this International Standard are written in a general and performance-based manner. Detailed operational capabilities and limitations are included in the supplier's/manufacturer's product-specific operating manual.

A.4 Barrier valve system types

A.4.1 Type A

A type A valve holds pressure from above and is used only for pre-production or pre-injection.

Type A valve systems may isolate the lower completion while the upper completion is being run. Typically, the barrier valve is positioned just below the liner hanger or packer when the lower completion is installed. After the intervention and installation work is complete on the liner section (i.e. gravel pack, perforating, acid stimulation, etc.), the barrier valve is typically closed. This isolation protects the reservoir from possible damage from completion fluid during the installation of the upper completion. Once the upper completion is installed, the barrier valve may be opened, either mechanically or hydraulically or by other means. The type A valve is designed for use only during the completion process.

Another use is as a packer-setting valve run directly below the packer in the upper completion to allow setting of the packer hydraulically; it may then be opened to provide access to the well bore below.

A.4.2 Type AA

A type AA valve holds pressure from above and is used in pre- and post-production/injection applications.

Type AA valve systems provide the functionality of type A valves with the added capability to function after the well has been on production or injection. Typically, this valve type is run under the liner hanger or packer and provides protection of the reservoir from completion fluids during the initial installation and any subsequent recompletions. For example, an electric submersible pump (ESP) completion requires the ability to pull the ESP without disrupting the lower completion. By utilizing a type AA valve, this is achieved by closing the valve prior to pulling the upper completion, thus isolating the reservoir from potentially damaging fluids. This type AA valve may also be used to protect the ESP from potential damage from reverse flow. Once the ESP is reinstalled, the valve is opened again by a mechanical, hydraulic or other means as the design allows.

A.4.3 Type B

A type B valve holds pressure from below and is used in pre-production or pre-injection.

Type B valve systems may be utilized to install a completion in an under-balanced well. By installing the valve below the liner hanger or packer, the valve holds the pressure of the reservoir below the liner and allows installation of the upper completion without using a snubbing unit. Once the completion is installed, it is opened, allowing the well to flow to the surface.

NOTE A type B barrier valve is not a safety valve.

A.4.4 Type BB

A type BB valve holds pressure from below and is used in both pre- and post-production/injection.

Type BB valve systems provide the functionality of type B valves with the added capability to function after the well has been on production or injection; however, BB type valves are not fail-safe closed. One application of a type BB valve is its use in injection-type wells. This allows the operator to inject into the formation for pressure support in the reservoir. When the injection is stopped, the valve is closed (mechanically or hydraulically or by other means) to keep the formation pressure from pushing the injected fluid back to the surface. This process may be repeated as required and allowed by the limitations of the design.

A.4.5 Type C

A type C valve holds pressure from above and below and is used in pre-production/injection.

Type C barrier-valve systems provide the combined capabilities of types A and B valves, since they hold pressure from both directions. One common use for this valve is as a packer setting and/or tubing test valve. When installed directly below the packer, it provides a “plug” to allow pressurizing the tubing to either set a packer or test the tubing. Once this is complete, it may be opened either mechanically or hydraulically or by other means to provide wellbore access.

Another application is to install the type C valve in the liner below the liner hanger or packer, thus providing isolation between the upper completion and the lower completion during installation of the upper completion. Once the installation is complete, the valve is opened, providing communication from the upper completion to the lower.

A.4.6 Type CC

A type CC valve holds pressure from above and below and is used for pre- and post-production/injection.

Type CC valve systems provide the functionality of type C valves with the added capability to function after the well has been on production or injection. Typically installed below the tubing hanger, this type of valve isolates the upper and lower completions, both during and after the production or injection starts. This type of installation allows the operator to install the lower completion and then suspend the well until installation of the upper completion. Once the upper completion is installed, the valve may be opened to allow communication between the upper and lower completions. Anytime after the initial installation, the valve may be closed again to isolate the upper from the lower completion. This action allows a recompletion of the upper section or any number of other actions. To re-establish communications between two sections of the well, the valve may be opened within the product's design limits.

Annex B
(normative)

Validation requirements for subsurface barrier valves

B.1 General

To conform to the requirements of this annex, each product design shall pass all requirements within the limits specified, to the acceptance criteria defined, and with suitable documentation of the applicable processes, acceptance criteria and evaluation results required for design validation. The defined evaluations and testing parameters shall validate the stated performance and capabilities of the product. All tests and product related data for a valid, successful test shall be recorded in detail and retained as a portion of the product's design file following approval by a qualified person(s).

B.2 Design validations

B.2.1 V1 or V2 validations

Each subsurface-barrier-valve size, type and model selected as grade V1 or grade V2 shall be evaluated/tested to the criteria provided in this annex, as applicable.

Successful completion of the validation testing process shall qualify products of the same size, type and model as the tested product. This process shall be documented in accordance with 6.8.2 and 7.2 and shall include acceptance criteria for each aspect or capability that is claimed. In the event that multiple products of the identical design are required by design limitations (such as single-use products) to complete the testing defined, each shall be identified within the applicable test and the compiled validation report shall indicate all the products used for that purpose.

WARNING — Ensure that all equipment that is tested is designed and documented as compatible with the applied loads under the applied conditions prior to beginning testing.

B.2.2 V3 validations

Each subsurface-barrier-valve size, type and model selected as grade V3 shall conform to the requirements of B.3.2.3.2.

NOTE Requirements and limitations for design changes and de-rating processes are included in 6.9.

B.3 General requirements

B.3.1 Preliminaries

Verify that the model and unique identifying numbers appearing on the test product are in agreement with those included on the test report. The testing shall be conducted on a complete assembly. Each action (test, requirement, etc.) shall be passed in all aspects within the defined acceptance criteria in the order the tests are presented herein (as technically applicable and justified) and without repair or redress during the defined processing.

B.3.2 Test facility

B.3.2.1 General

Test facilities shall provide all the equipment required to achieve the defined testing parameters and to measure the stated acceptance parameters to an accuracy that meets or exceeds the defined requirements. All fluids used in the testing shall be defined and documented in the test report.

B.3.2.2 Calibration requirements

Inspection, testing and measuring equipment used in product validation shall conform to the requirements of 7.8.1.

B.3.2.3 Testing and evaluation criteria

B.3.2.3.1 General

Testing and evaluations shall be performed to a documented testing procedure that includes all of the requirements necessary to perform a successful test and meet the defined acceptance criteria. All testing results shall be recorded. For completion of a successful test, the product shall be tested and perform within the limits specified for all required steps. Test-facility anomalies occurring during testing that have no effect on product testing performance may be accepted when documented and approved by a qualified person(s). Each evaluation report shall be signed and dated by the qualified person(s) conducting and approving the test results.

B.3.2.3.2 V3 design validation

V3 design validation shall be compiled and approved by a qualified person(s) to the supplier's/manufacturer's procedures and acceptance criteria, which as a minimum shall include

a) design verifications, including assembly processes, body integrity, operational capability and drift testing; or

b) detailed field history of successful performance of 20 products of the same size, type and model of each product with a successful field operation.

B.4 Validation processes

B.4.1 Assembly evaluation

Qualified person(s) shall collect the components, visually inspect each to verify its condition, dimensionally inspect the critical and dynamic surfaces, assemble the product and evaluate all fits, finishes and operations against established criteria. The assembly processing shall follow the supplier's/manufacturer's documented procedures, including fluids, lubricants and methods. Any variance from the requirements shall be documented and corrected prior to initiating the testing process. Each component of the test product shall be traceable to its unique material and processing. Each product evaluated shall be dimensionally inspected in accordance with 6.8.2.

B.4.2 Body integrity evaluation/test

B.4.2.1 Procedures for V2 and V1

Each product design shall be pressure tested in several representative incremental levels from the minimum to the maximum, and at the maximum rated pressures and temperature limits of the internal rating. The supplier's/manufacturer's product-specific test procedure shall demonstrate the valve-body integrity to contain internal pressure to the specified acceptance criteria in B.4.2.2. Test at several representative incremental

pressures, (for example, 25 %, 50 %, 75 % and 100 % of any stated pressure rating) and at the minimum and maximum rated temperatures. Hold each representative pressure for a minimum of 15 min after stabilization and inspect for leakage.

Validation of the product ratings of axial loads (tensile/compressive) and external-to-internal pressure ratings may be established by calculation or test. Where calculations are used, the supplier/manufacture shall have documented procedures and acceptance criteria that have a proven history of validity. Where testing is used as the means of validation, the requirements of the previous paragraph apply.

B.4.2.2 Acceptance criteria V2 and V1

Applied pressures shall be measured and recorded continuously at a sampling rate sufficient to identify variations and trends for the period of the test and shall be reviewed and accepted by a qualified person(s). Any measured (exceeding 0,5 % of the applied pressure after stabilization) and/or visible leakage from the valve body is cause for test failure.

B.4.3 Operational evaluations/tests

B.4.3.1 General

Each product design shall be evaluated and/or tested to open and/or close at the minimum and maximum levels of the product's rated pressures and temperatures using the stated primary opening mechanism for V1.

For V2 product designs, testing at the minimum and maximum rated temperatures can be replaced with a documented component-level qualitative analysis of the operational mechanism's dynamic forces at the rated temperature limits. This analysis shall verify the capability of the product design to operate at the rated temperature limits.

These evaluations and/or tests shall be performed a minimum of 1 1/2 times the stated number (minimum of two times) of operations (as applicable without repair and or redress, with the exception of resetting the tool) in accordance with the manufacturer's/supplier's procedures.

If applicable to the previous design, it is required that the barrier-valve mechanism be manipulated open and closed utilizing the supplier's/manufacturer's barrier-valve tool that is specified for well operations.

B.4.3.2 Acceptance criteria for V2

V2 product designs may be validated by component-level, documented quantitative analysis and/or comparison to proven designs and/or testing results of similar designs by a qualified person which are then approved by a second qualified person, or by a successful validation test as defined in B.4.3.1. Full functionality is required throughout the tests and/or verifications. The product shall perform in accordance with the supplier's/manufacturer's operator's manual stated operational capabilities.

B.4.3.3 Acceptance criteria for V1

V1 product designs shall be successfully validation tested according to the criteria defined in B.4. Full functionality is required throughout the testing and the product shall perform in accordance with the supplier's/manufacturer's operator's manual stated capabilities.

B.4.4 Barrier mechanism tests

B.4.4.1 General

Validation level V2 products shall be tested according to the requirements of B.4.4.2. Validation level V1 products shall be tested according to the requirements of B.4.4.2 and B.4.4.3. For type C valves, the differential test shall be performed from both directions.

B.4.4.2 Liquid leakage test

B.4.4.2.1 General

The supplier's/manufacturer's product-specific test procedure shall require the demonstration of the barrier mechanism to contain differential pressure with city water or similar liquid to the specified acceptance criteria. Ensure that the valve is actuated to the closed position in accordance with the supplier's/manufacturer's specified procedure.

Pressure shall be applied across the barrier mechanism to 1 378 kPa ± 138 kPa (200 psi ± 20 psi), 50 % ± 689 kPa (100 psi), and 100 % ± 689 kPa (100 psi) of the rated pressure of the barrier mechanism, at its maximum and minimum rated temperature limits and the orientation of its most probable use, as specified by the product's design operational capability. Each pressure shall be applied for a minimum of 15 min after pressure and temperature stabilization. Any leakage observed during the hold period shall be measured and recorded.

The barrier mechanism shall be manipulated open and closed at least one time between each series of differential pressures and leakage evaluations (as applicable, without repair and/or redress, with the exception of resetting the tool) in accordance with the manufacturer's/supplier's procedures. Type A and/or B products that are designed to form a barrier one time do not need to be manipulated.

For products that are tested with gas at the rated temperature limits in B.4.4.3, the liquid leakage testing may be performed only at ambient temperature. The user/purchaser may specify the optional leakage rate testing criteria included in Annex F.

B.4.4.2.2 Acceptance criteria for V2

With a defined, documented and stabilized pressure on the backside of the barrier mechanism, pressure up to the required pressure differential. The leakage rate across the barrier mechanism shall not exceed the following limits:

— for type A: 65 ml/min (1 gal/hr) after stabilization at 1 378 kPa (200 psi), and 30 ml/min (0,47 gal/hr) at 50 % and 100 % of rated barrier mechanism pressure;

— for types B and C: 30 ml/min (0,48 gal/hr) after stabilization at 1 378 kPa (200 psi), and 15 ml/min (0,24 gal/hr) at 50 % and 100 % of rated barrier mechanism pressure.

In product designs that require special conditions to affect a seal on the barrier mechanism, the specific conditions shall be identified in the test procedure and in the operating manual. If these conditions preclude leakage measurement as above, then a pressure decay method may be used. The acceptance criteria for pressure decay shall be correlated to those identified above.

B.4.4.2.3 Acceptance criteria for V1

With a defined, documented and stabilized pressure on the backside of the barrier mechanism, pressure up to the required pressure differential. The leakage rate across the barrier mechanism shall not exceed, for types A, B and C, 10 ml/min (0,338 oz/min) after stabilization at 1 378 kPa (200 psi), and 5 ml/min (0,169 oz/min) at 50 % and 100 % of rated barrier mechanism pressure.

In product designs that require special conditions to affect a seal on the barrier mechanism, the specific conditions shall be identified in the test procedure and in the operating manual. If these conditions preclude leakage measurement as above, then a pressure decay method may be used. The acceptance criteria for pressure decay shall be correlated to those identified above.

B.4.4.3 Barrier mechanism gas leakage test for types B and C valves

B.4.4.3.1 Test procedure for V1

Perform the barrier closure leakage test as specified in B.4.4.2 with nitrogen gas as the test medium. This test does not apply to type A barrier valves.

B.4.4.3.2 Acceptance criteria for V1

With a defined, documented and stabilized pressure on the backside of the barrier mechanism, pressure up to the required pressure differential, stabilize and hold for a minimum of 5 min. The leakage rate across the barrier mechanism shall not exceed, for types B and C, 28,4 dm^3/min (1 scfm) after stabilization at 1 378 kPa (200 psi), and 14,2 dm^3/min (0,5 scfm) at 50 % and 100 % of rated barrier mechanism pressure.

In product designs that require special conditions to affect a seal on the barrier mechanism, the specific conditions shall be identified in the test procedure and in the operating manual. If these conditions preclude leakage measurement as above, then a pressure decay method may be used. The acceptance criteria for pressure decay shall be correlated to those identified above.

B.4.5 Differential pressure opening test

B.4.5.1 General

Each product that has a stated capability of opening against a differential pressure shall be tested a minimum of two times (as applicable without redress or rebuild, with the exception of resetting the tool, if required). For type C valves, this shall be performed as two separate tests twice in each direction.

B.4.5.2 Test procedure

Apply the supplier's/manufacturer's maximum specified differential opening pressure, at ambient temperature and at the product's maximum temperature, with suitable fluid across the barrier mechanism, and measure the leakage rate, if any. The barrier shall be opened to allow equalization of pressure in accordance with the requirements of the supplier's/manufacturer's operating manual.

B.4.5.3 Acceptance criteria

The supplier's/manufacturer's product-specific test procedure shall require a demonstration that the barrier mechanism opens, without adversely affecting the valve's further operations, at a specified differential pressure (as applicable in accordance with the design). All fluid volumes in the pressurized test vessel(s) shall be defined in the test report.

At the completion of the openings against differential pressure, the barrier-mechanism leakage shall be evaluated in accordance with B.4.4.2, at maximum rated temperature at minimum and maximum differential rating, as applicable by valve design.

B.4.6 Closure against or with flow test (fluid loss) for types A and C valves

B.4.6.1 General

Each product design shall be tested according to this procedure a minimum of two times to validate the design. This does not apply to valve type B or valves which are normally closed.

B.4.6.2 Test procedure

Establish a flow rate of city water through the valve in accordance with the supplier's/manufacturer's specifications. The valve should then be closed in accordance with the requirements of the operator's manual, as appropriate. The valve shall close at the claimed limits of rates and/or pressures.

These tests shall be performed at ambient temperature a minimum of two times, (as applicable, without repair and/or redress, with the exception of resetting the tool) in accordance with the supplier's/manufacturer's procedures.

B.4.6.3 Acceptance criteria for V2 and V1

The supplier's/manufacturer's product-specific test procedure shall require a demonstration that the barrier mechanism closes, without adversely affecting further valve operations, at a specified flow rate. At the completion of the closings against the flow rate, the barrier-mechanism leakage shall be evaluated in accordance with B.4.4.2, at the resultant temperature from the applied flow rate at minimum and maximum differential rating.

B.4.7 Internal chamber integrity testing

B.4.7.1 General

Each product design's internal-pressure-retaining chamber(s) that are not tested in the body or by integrity-validation tests shall be hydrostatically tested at several representative incremental levels from the minimum to the maximum rated pressures and temperature limits, by a qualified person(s). This may be performed on a subassembly if required by the design.

B.4.7.2 Test procedure

The supplier's/manufacturer's product-specific test procedure shall demonstrate the integrity of all internal pressure chambers to contain internal pressure to the specified acceptance criteria. The barrier valve shall be tested hydrostatically with city water; where a fluid other than city water is used, the manufacturer shall document the test fluid. Test at several representative, incremental pressures, (for example, 25 %, 50 %, 75 % and 100 % of the rated pressure) at the minimum and maximum temperature limits. Hold each representative pressure for a minimum of 15 min after stabilization.

B.4.7.3 Acceptance criteria

Applied pressures shall be measured and recorded continuously for the period of the test and shall be reviewed and accepted by a qualified person(s) according to the acceptance criteria specified in B.4.2.2.

B.4.8 Drift testing

B.4.8.1 General

The supplier/manufacturer shall ID drift each validation-tested valve. The drift shall be appropriate for detecting any substantive changes in the valve's ID dimensions. Drift testing shall be in accordance with the manufacturer's/supplier's procedures and shall conform to the requirements of this International Standard.

Each drift bar shall be permanently marked with a unique identifier and the measured drift-bar dimensions. Each drift bar shall be of a length designated by the supplier's/manufacturer's documentation and shall be a minimum length of six times the specified ID of the product or 609,6 mm (24 in), whichever is greater. Drift bars shall be of no smaller OD than the valve's specified minimum ID, less 0,75 mm (0,03 in) and shall be a full round at the full recorded drift length.

B.4.8.2 Test procedure

Orient the test valve horizontally and pass the drift bar completely through the open test valve in both directions and in a manner that does not inadvertently cause the test valve's closure mechanism to move.

B.4.8.3 Acceptance criteria

The drift bar movement shall be aided by a force no greater than the mass (weight) of the bar while being passed completely through the ID of the test valve in both directions. Flow-activated designs shall be drift-tested to the maximum possible coverage of the bore in accordance with the product design.

B.4.9 Special-feature evaluations

Each special feature and/or capability claimed by the supplier/manufacturer that has not been validated in accordance with the requirements of Annex B and is integral to the product design shall be validated by test/evaluation to its rated limits in accordance with the supplier's/manufacturer's procedures and acceptance criteria.

NOTE Special features are items such as secondary operating mechanism(s), lock-open systems, slam test (ability to close under high loss rate capabilities), centralizers (drilling-/milling-friendly geometry), extreme debris tolerance (cement), ability to lock open during RIH (sleeve) and secondary remote opening mechanism (such as a rupture disk in a flapper).

The supplier/manufacturer shall identify those special features that are to be included in the functional testing. If supplementary tool(s) are required for the functionality of the subsurface barrier valve, these tools shall conform to the requirements of Annex D.

B.4.10 Post testing dimensional inspections

At the completion of the validation testing, each product shall be disassembled and dimensionally inspected in accordance with 6.8.2.

B.5 Validation testing for types AA, BB and CC valves

B.5.1 General

This validation testing demonstrates the valve design's performance for longer-term applications in a flowing environment. Validation testing requirements for types AA, BB and CC valves are in addition to, and are performed after, the successful performance of the requirements of B.4. These tests may be conducted on a valve of the same design in the as-new condition. All applicable tests shall be performed in the order shown (as applicable to the product design) without redress or rebuild of the test valve.

Flow testing of these valves consists of validation with a slurry fluid depending on the stated performance capability, as defined in the product's operator's manual by the supplier/manufacturer. Record all test parameters and specific test results. These results shall be reviewed by a qualified person(s) to determine and document successful testing completion.

For the purposes of this test, city water may be replaced with similar fluids.

B.5.2 Flowing slurry test

B.5.2.1 General

The supplier's/manufacturer's test procedure shall require a demonstration that the valve functions correctly throughout several slurry flows.

B.5.2.2 Flowing slurry preparation

A slurry shall be prepared as follows.

a) Determine the sand content of the slurry in accordance with the API Manual of Petroleum Measurement Standards, Chapter 10, Section 4.

b) Adjust the sand content to 2 % ± 0,5 % by adding 150 µm (100 US mesh) to 180 µm (80 US mesh) sand or by diluting the slurry with city water.

c) Determine the viscosity of the slurry sample with a Marsh funnel viscometer in accordance with ISO 10414-1.

d) Adjust the viscosity to 70 s ± 5 s by adding a viscosifier or diluting the slurry with city water. This evaluation shall be performed and documented at the start and conclusion of each set of tests.

B.5.2.3 Test procedure V2 and V1

The test valve shall be installed in an appropriate fixture to allow the flow of the slurry prepared as given in B.5.2.2 at the applicable rates as given in Table B.1 for a minimum of 60 continuous minutes. Immediately thereafter, stop the flow and close the test valve using the specifications in accordance with the supplier's/manufacturer's operating manual. Perform a barrier-mechanism leakage test in accordance with B.4.4.2 using the flowing slurry prepared as given in B.5.2.2 at the resultant temperature from the applied flow rate. Repeat this process a minimum of an additional nine times or, if the stated number of actuations that are claimed is greater than 10, perform that number of actuations. At the conclusion of all the flowing slurry tests, perform a drift test in accordance with B.4.8. For nominal tubular sizes other than those listed, the flow rates shall be interpolated or extrapolated through the use of the manufacturer's documented methods.

Table B.1 — Slurry flow rates

Nominal tubing siz in	Slurry circulation rate m^3/day (BPD)
2-3/8	79 (500)
2-7/8	124 (780)
3-1/2	178 (1 120)
4-1/2	305 (1 920)
5-1/2	477 (3 000)
7	935 (5 880)

B.5.2.4 Acceptance criteria V2

Acceptance criteria shall be in accordance with B.4.4.2.1 and B.4.8.3.

B.5.2.5 Acceptance criteria for V1

Acceptance criteria shall be in accordance with B.4.4.2.2 and B.4.8.3.

Annex C
(normative)

Functional testing

C.1 General

To conform to the requirements of this annex, each product manufactured shall meet all requirements within the limits specified, and in accordance with the acceptance criteria defined and the results required for functional validation. All test- and product-related data for a valid, successful test shall be recorded in detail and retained after approval by a qualified person(s).

WARNING — Ensure that all equipment that is tested is designed and documented as compatible with the applied loads under the applied conditions before testing.

For the purposes of this test, city water may be replaced with similar fluids.

C.2 General requirements

C.2.1 Preliminaries

Verify that the model and serial numbers appearing on the tested product are in agreement with those included on the test report. The testing shall be conducted on a complete assembly. All required tests shall be passed in all aspects within the defined acceptance criteria and in the order presented (as applicable) without rebuild or redress of the test assembly during the processing.

C.2.2 Test facility

C.2.2.1 General

Test facilities shall provide all the equipment required to achieve the defined testing parameters and to measure the stated acceptance parameters to an accuracy that meets or exceeds the defined requirements. All fluids used in the testing shall be defined and documented in the test report.

Testing shall be discontinued if the barrier valve fails to perform within the limits specified for any step, except when such failures are determined to result from a failure within the test facility that does not affect the validity of the test as determined and approved by a qualified person(s).

C.2.2.2 Calibration requirements

Inspection, testing and measuring equipment used in product validation shall be in accordance with the requirements of 7.8.1.

C.2.2.3 Testing and evaluation criteria

For completion of a successful test, the product shall be tested and shall perform within the limits specified for all required steps. Each evaluation report shall be signed and dated by the qualified person(s) conducting and approving the test results.

C.3 Functional testing

C.3.1 General

All functional testing shall be performed according to a documented procedure with acceptance criteria in the order shown on each assembly as applicable to the product design; where the specified test is not applicable, then the supplier/manufacturer shall specify the functional evaluation performed.

C.3.2 Internal chamber integrity test

Each product that includes a pressure-retaining chamber that is not tested in the body or by integrity-functional tests shall be hydrostatically pressure tested (as applicable) at its maximum rated internal pressure at room temperature by a qualified person(s) using supplier/manufacturer procedures. Included are hydraulic or gas chambers used in the operation of the product and/or other similar pressure-retaining chambers. Hold for a minimum of 10 min after stabilization and inspect for leakage over the hold period. Any measured (exceeding 0,5 % of the applied pressure after stabilization) and/or visible leakage from the chamber is cause for test failure.

C.3.3 Body integrity test

Each product shall be hydrostatically pressure tested at the maximum rated internal pressure at room temperature by a qualified person(s) using supplier/manufacture procedures. Hold for a minimum of 10 min after stabilization and inspecting for leakage over the hold period. Any measured (exceeding 0,5 % of the applied pressure after stabilization) and/or visible leakage from the valve body is cause for test failure.

C.3.4 Barrier integrity test

Each product barrier shall be hydrostatically pressure tested with city water at room temperature across the barrier mechanism in its direction(s) of sealing to 1 378 kPa ± 138 kPa (200 psi ± 20 psi) and 100 % ± 689 kPa (100 psi) of the rated pressure of the barrier mechanism. Hold for a minimum of 10 min after stabilization and measure the leakage over the hold period. Leakage acceptance criteria shall conform to B.4.4.2.1 or B.4.4.2.2, as applicable.

C.3.5 Operational test

Each product shall be tested to open/close without pressure in the ID and at room temperature in accordance with procedures defined in the supplier's/manufacturer's operating manual. One or more primary operating mechanisms shall be evaluated independently in accordance with B.4.3.1. Acceptance criteria shall be in accordance with B.4.3.2 or B.4.3.3, as applicable.

C.3.6 Special-features test

Special features shall be tested in accordance with the supplier's/manufacturer's documented test procedures, including acceptance criteria. These tests may be incorporated into the existing sequence of functional tests, providing they do not cause operational limitations to the product. Results shall be in accordance with the documented acceptance criteria.

C.3.7 Drift test

After all functional testing steps are complete, perform a drift test, as applicable, in accordance with B.4.8.

Annex D
(normative)

Validation requirements for subsurface-barrier-valve tools

D.1 General

This annex describes the design validation testing requirements for subsurface-barrier-valve tools.

The supplier/manufacturer shall perform validation testing of a minimum of one of each size, type and model of barrier-valve tool. Final approval of the design shall be given and documented by a qualified person(s) other than the person who originally created and calculated the design.

Any barrier-valve tool that has all its operating capabilities successfully validated in accordance with the testing procedures in Annex B shall be considered to have met the requirements of Annex D. Operating capabilities that have not been validated during testing in accordance with Annex B shall be validated by the requirements of this annex.

D.2 Design validation testing

D.2.1 General

Each barrier-valve-tool design type, model and nominal size shall successfully complete all steps of the validation-testing procedures within the limits specified and in the order shown (as applicable). Repairs to the tested tool during the testing process are not allowed; any repair requires a restart of the validation testing.

Testing shall be performed with the valve and tool in the orientation (deviation) and index (rotational alignment) of its most probable use and shall be documented in the testing results. All pressures are defined as gauge unless otherwise specified and shall be recorded on time-based equipment.

Successful completion of the validation testing process shall qualify products of the same nominal size, type and model as the tested product. This process shall be documented in accordance with 6.8.2 and 7.2 and shall include acceptance criteria for each aspect or capability that is claimed.

During validation testing of hydraulically operated tools, control-fluid metering may be used to provide a readable hydraulic-control-line pressure trace, where necessary.

Verify that the model and serial numbers appearing on the test tool are in agreement with the test recording materials. Validation testing shall be discontinued if the barrier-valve tool fails to perform within the limits specified for any step, except when such failures are determined to result from a failure within the test facility that does not affect the validity of the test as determined and approved by a qualified person(s).

D.2.2 Test facility

Test facilities shall provide all the equipment required to achieve the defined testing parameters and to measure the stated acceptance parameters to an accuracy that meets or exceeds the defined requirements. Inspection, testing and measuring equipment used in product validation shall conform to the requirements of 7.8.1. All fluids used in the testing shall be defined and documented in the test report.

WARNING — Ensure that all equipment that is tested is designed and documented as compatible with the applied loads under the applied conditions prior to beginning testing.

D.2.3 Procedures

D.2.3.1 General

The barrier-valve tools shall be installed, manipulated and retrieved from a representative barrier valve to duplicate the barrier-valve mechanism in accordance with the procedures and acceptance criteria of the supplier's/manufacturer's operating manual. Test results shall be dated and approved by a qualified person(s). Testing shall validate that the tool operates in accordance with the supplier's/manufacturer's specified parameters.

D.2.3.2 Assembly evaluations

Qualified person(s) shall collect the components, visually inspect each to verify its condition, dimensionally inspect the critical and dynamic surfaces, assemble the product and evaluate all fits and finishes and operations against established criteria. The assembly processing shall follow the supplier's/manufacturer's documented procedures, including fluids, lubricants and methods. Any variance from the requirements shall be documented and corrected prior to initiating the testing process. Each component of the test product shall be traceable to its unique material and processing records.

D.2.3.3 Barrier-valve-tool design validation

Each barrier-valve-tool design shall be tested a minimum of three times to its rated limits and operational capabilities as specified by the supplier/manufacturer. The supplier/manufacturer shall have documented procedures, including acceptance criteria, for each of these tests.

In the event that multiple products of the identical design are required by design limitations (such as single-use products) to complete the testing defined, each shall be identified within the applicable test; the compiled validation report shall indicate all the products used for that purpose.

D.2.3.4 Acceptance criteria

The barrier-valve-tool design shall perform to the supplier/manufacturer specified acceptance criteria.

D.2.3.5 Post-testing evaluations

A qualified person(s) shall disassemble the barrier-valve tool, visually inspect each component to verify its condition, and dimensionally inspect and document the critical and dynamic surfaces. Any damage or deformation caused by or during the validation test shall be documented in the validation test report. Evaluation results shall be reviewed and any necessary changes shall be made to the tool prior to a retest.

Annex E
(normative)

Performance envelopes

E.1 General

For subsurface barrier valves supplied according to grade V1, and, when requested by the user/purchaser, according to grade V2, a rated performance envelope shall be supplied. The supplier/manufacturer shall state the pressure, temperature and axial performance ratings, as applicable, for the product design and shall illustrate those capabilities in static performance envelopes. These envelopes are graphic illustrations of the combined effects of differential pressure and axial loads on a subsurface-barrier-valve design. The product(s) covered by this envelope shall be fully identified on the illustration. Example envelopes are illustrated in Figure E.1.

The performance envelope shall define the supplier's/manufacturer's specified ratings of the barrier-valve design for both the body rating for tubular loading performance after the product is permanently opened and for the product with the closure mechanism in the normally closed position. The area within the boundaries of the envelope defines the design's maximum performance as rated by the supplier/manufacturer.

E.2 Performance envelope required data

The envelopes may be based upon full-scale testing and/or calculated data. The envelopes shall as a minimum include the criteria specified below.

— The boundary lines of the envelope shall represent the supplier's/manufacturer's maximum ratings of compression, tension, burst and collapse for that product design. Each of the illustrated ratings shall have defined increments.

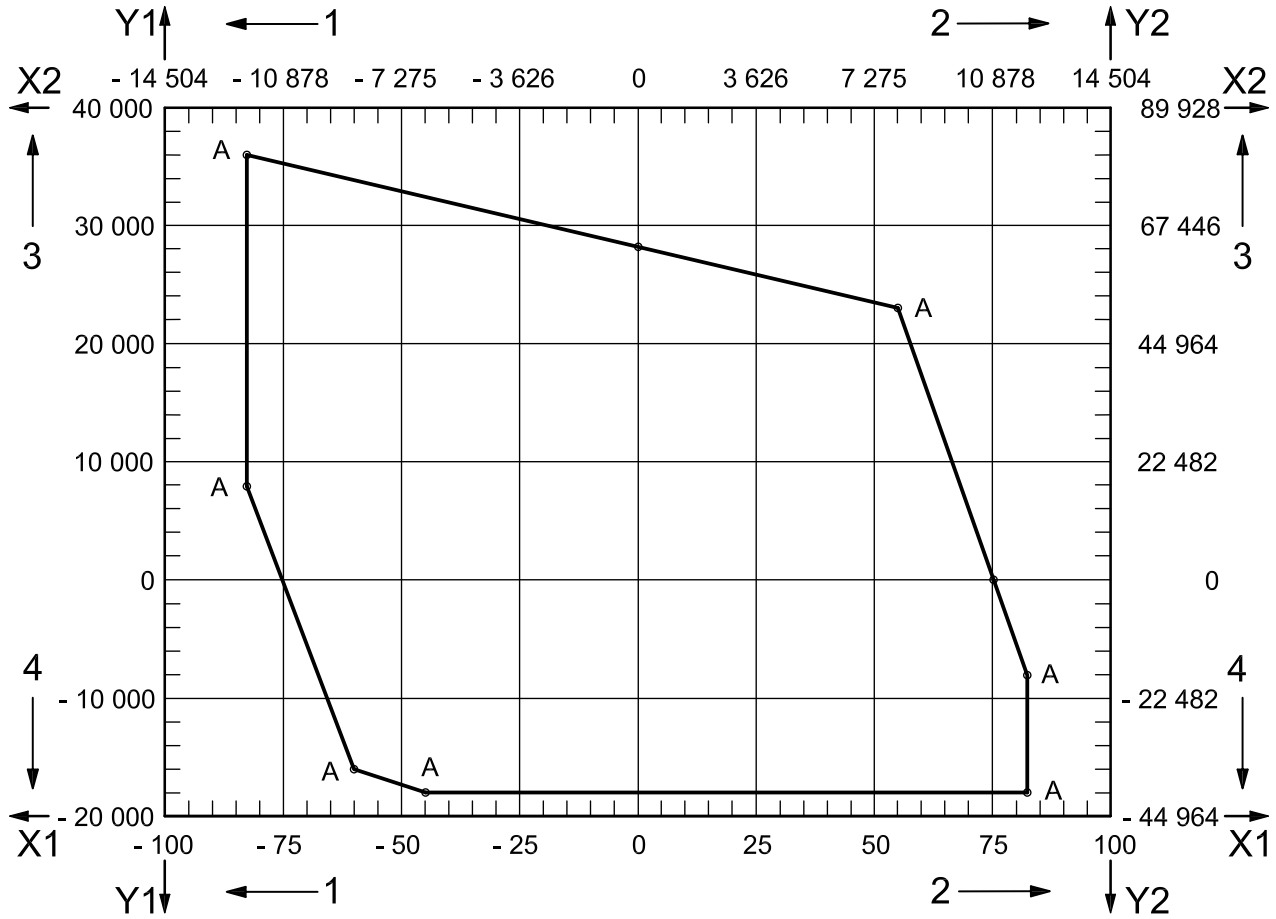
— The product's end connections shall be excluded from the envelope.

— More than one graphic may be used to illustrate the body ratings and the product ratings with the closure mechanism in the closed position.

— A legend that defines the rating increments shall be included. Calculated ratings shall be differentiated from tested points of envelope data.

— The performance envelopes shall be prepared and approved by a qualified person(s).

Users/purchasers shall consider applied loading of the product's applications when designing the completion to ensure that operation of the product is within its rated capability.



Key

1	load from above	X1	pressure, expressed in megapascals
2	load from below	X2	pressure, expressed in pounds per square inch
3	tension	Y1	force, expressed in decanewtons
4	compression	Y2	force, expressed in pounds-force
A	data points		

Figure E.1 — Example performance envelope

Annex F
(informative)

Alternate barrier liquid leakage test acceptance criteria

F.1 General

This annex describes alternate barrier liquid leakage test acceptance criteria, which are implemented when selected by the user/purchaser.

To conform to the requirements of this informative annex when it is selected, each product design shall meet all requirements within the limits specified, to the acceptance criteria defined, with suitable documentation of the applicable processes, acceptance criteria and evaluation results required for design validation. Testing shall be performed in accordance with B.4.4.2 and the requirements defined herein.

This leakage criteria applies to all types of barrier valves when specified by the user/purchaser.

For the purposes of this test, city water may be replaced with similar fluids.

F.2 Acceptance criteria

With a defined, documented and stabilized pressure on the barrier mechanism, pressure up to the required pressure differential with city water or an equivalent test fluid. This test is performed in both directions on types C and CC valve designs.

The leakage rate across the barrier mechanism shall not exceed 0,5 ml/min after stabilization at 1 378 kPa (200 psi), and at 50 % and 100 % of rated barrier mechanism pressure.

In product designs that require special conditions to affect a seal on the barrier mechanism, the specific conditions shall be identified in the test procedure and in the operating manual.

Annex G
(informative)

Debris-settling design validation

G.1 Debris-settling test

G.1.1 General

This annex describes debris-settling design evaluations, which are implemented when selected by the user/purchaser.

These design evaluations are performed on the selected subsurface-barrier-valve designs after they have successfully completed the required validation tests as per Annex B. This annex testing is implemented when selected by the user/purchaser. This test evaluates the ability of the barrier valve to operate when exposed to the specified debris within the valve bore.

The barrier mechanism shall be manipulated opened and closed at least one time between each differential pressure and leakage evaluation (as applicable without redress or rebuild, with the exception of resetting the tool) in accordance with the manufacturer's/supplier's procedures. Each product design shall be tested according to this procedure a minimum of two times to validate the design. Valve designs that have a capability for extended length to accommodate extreme debris accumulations shall be tested in their maximum length configuration.

Each method of actuation claimed by the supplier/manufacturer shall be successfully tested to validate that capability.

As applicable, it is required that the barrier-valve mechanism be manipulated open and closed utilizing the supplier's/manufacturer's specified barrier-valve tool that is used for actual well operations.

G.1.2 Settling debris

The settling debris shall be 20/40 mesh sand having a particle size range between 420 µm (0,016 5 in) and 850 µm (0,033 1 in).

G.1.3 Remote actuation test procedure

To conduct the test, perform the following steps.

a) The barrier mechanism shall be in the closed position and in the essentially vertical orientation. For type B valves, the barrier shall be held in the closed position by pressure.

b) Fill the valve ID with city water; the valve shall be at ambient temperature.

c) Deposit the settling debris (G.1.2) in the valve's primary flow area to a depth equal to the uppermost tubular connection of the valve. The debris level shall be above the sensing point of the trigger mechanism used to actuate the valve's operation.

d) Allow the debris to settle at static conditions for a minimum period of 12 h.

e) Pressure test the barrier valve to 80 % of the barrier's rated pressure for a minimum of 10 min in the direction from which the debris was introduced. For type B valves, this can open the mechanism and, therefore, concludes the testing.

f) Open the valve using the primary opening mechanism in accordance with the operator's manual requirements and procedures.

g) Circulate through valve with city water through the valve's ID in the direction of production or injection as stated in the operator's manual at a maximum rate of 0,64 m^3/min (4 bbls/min) for a minimum of 5 min and a maximum of 10 min.

h) Perform a drift test in accordance with B.4.8.

i) Repeat test once.

G.1.4 Acceptance criteria

The barrier mechanism shall be verified to fully open and pass the drift test as defined in B.4.8.

G.2 Mechanical actuation test in debris

G.2.1 Procedure

This test shall be performed on the selected barrier-valve designs that contain a claimed mechanical actuation capability after they have successfully completed the required validation tests in accordance with Annex B. The testing in this annex is implemented when selected by the user/purchaser. This test evaluates the ability of the barrier valve to operate when exposed to the specified debris within the valve bore.

To conduct the mechanical actuation test, where applicable to the valve design, perform the following steps.

a) The barrier mechanism shall be in the closed position and in the essentially vertical orientation. For type B valves, the barrier shall be held in the closed position by pressure.

b) Fill the valve ID with city water; the valve shall be at ambient temperature.

c) Deposit debris defined in G.1.2 into the valve's primary flow area to a depth equal to the uppermost tubular connection of the valve. The debris level shall be above the sensing point of the trigger mechanism used to actuate the valve's operation.

d) Allow the debris to settle at static conditions for a minimum period of 12 h.

e) Pressure test barrier valve to 80 % of the barrier's rated pressure for a minimum of 10 min in the direction from which the debris was introduced. For type B valves, this can open the mechanism and, therefore, concludes the testing, which shall be indicated in the test report.

f) Open the valve using the mechanical actuation opening mechanism in accordance with the operator's manual requirements and procedures.

g) Circulate city water through the valve's ID in the direction of production or injection, as stated in the operator's manual, at a maximum rate of 0,64 m^3/min (4 bbls/min) for a minimum of 5 min and a maximum of 10 min.

h) Perform a drift test in accordance with B.4.8.

i) Repeat test once.

G.2.2 Acceptance criteria

The barrier shall fully open and pass the drift test as defined in B.4.8.

Annex H
(informative)

Closure while flowing slurry test

H.1 General

The testing in this annex is implemented when selected by the user/purchaser. When selected, the barrier mechanism shall be closed against a flowing slurry to test the barrier valve's ability to close and seal in a slurry environment. At the completion of each closure against flow, the barrier mechanism shall be evaluated in accordance with B.4.4.2, at the resultant temperature from the applied flow rate. In the event that the supplier/manufacturer claims that the sealing differential pressure is less than 1 378 kPa (200 psi), tests shall be performed at the claimed differential pressure.

These tests shall be performed at ambient temperature, a minimum of two times (as applicable, without repair and/or redress, with the exception of resetting the tool) in accordance with the supplier's/manufacturer's procedures. The test shall be performed with the barrier valve in the orientation (deviation) and/or index (rotational alignment) as specified in the product-specific operating manual.

The barrier-valve mechanism shall be manipulated closed and opened (repeated once) utilizing the supplier's/manufacturer's specified barrier-valve tool (if required) that is used for actual well operations.

The test valve shall have successfully passed all previous validation tests in Annex B prior to commencement of this test.

H.2 Slurry composition

The slurry shall be prepared in accordance with B.5.2.2.

H.3 Test procedure

The test is carried out as follows.

a) The slurry flow rate through the valve shall be established, in accordance with the supplier's/manufacturer's specifications. The flow rate shall be maintained for a minimum of 60 continuous minutes. The valve should then be closed in accordance with the operator's manual requirements at the claimed rates and/or pressures.

b) After the barrier valve is closed, a leakage test shall be performed in accordance with B.4.4.2.

c) Following the second closure and leakage test, the barrier valve shall be opened and the opening loads validated as specified by the supplier's/manufacturer's specifications.

H.4 Acceptance criteria

— The test valve shall close in accordance with the product-specific operating manual requirements.

— The barrier valve shall conform to the liquid-leakage acceptance criteria as specified in B.4.4.2.

— Following the second closure and leakage test, the barrier valve shall open conforming to the supplier's/manufacturer's specifications.

Bibliography

[1] ANSI/NCSL Z540-3, *Requirements for the Calibration of Measuring and Test Equipment*[3)]

[2] API Spec 5B, *Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*[4)]

[3] API Bulletin 5C3, *Formulas and Calculations for Casing, Tubing, Drill Pipe, and Line Pipe Properties*

[4] API RP 5C5, *Recommended Practice on Procedures for Testing Casing and Tubing Connections*

[5] ANSI/API RP 13B-1, *Recommended Practice for Field Testing Water-based Drilling Fluids*

[6] ANSI/API Spec 14A, *Subsurface Safety Valve Equipment*

[7] ASME *Boiler and Pressure Vessel Code* (BPVC), Section VII, Division I, UW-51, *Radiographic Examination of Welded Joints*[5)]

[8] ASME *Boiler and Pressure Vessel Code* (BPVC), Section VIII, Division 1, Appendix 12, *Ultrasonic inspection of welds* (UT)

[9] ASTM A269, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*[6)]

[10] ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

[11] ASTM A388/A388M, *Standard Practice for Ultrasonic Examination of Steel Forgings*

[12] ASTM A450/A450M, *Standard Specification for General Requirements for Carbon and Low Alloy Steel Tubes*

[13] ASTM A609/A609M, *Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof*

[14] ASTM A789/A789M-05b, *Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service*

[15] ASTM D395, *Standard Test Methods for Rubber Property — Compression Set*

[16] ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*

[17] ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

[18] ASTM D1414, *Standard Test Methods for Rubber O-Rings*

[19] ASTM D1415, *Standard Test Method for Rubber Property — International Hardness*

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

4) API, 1220 L. Street, Washington, DC 20060, USA.

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

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

[20] ASTM D2240, *Standard Test Method for Rubber Property — Durometer Hardness*

[21] ASTM E10, *Standard Test Method for Brinell Hardness Testing of Metallic Materials*

[22] ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

[23] ASTM E92, *Standard Test Method for Vickers Hardness of Metallic Materials*

[24] ASTM E94, *Standard Guide for Radiographic Examination*

[25] ASTM E140, *Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness*

[26] ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4 1/2 in. [50.8 to 114-mm]) Steel Castings*

[27] ASTM E213, *Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing*

[28] ASTM E273, *Standard Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing*

[29] ASTM E280, *Standard Reference Radiographs for Heavy-Walled (4 1/2 to 12-in. [114 to 305-mm]) Steel Castings*

[30] ASTM E309, *Standard Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation*

[31] ASTM E426, *Standard Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys*

[32] ASTM E428, *Standard Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing*

[33] ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness*

[34] ASTM E570, *Standard Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products*

[35] ASTM E709, *Standard Guide for Magnetic Particle Testing*

[36] BS 2M 54, *Specification for temperature control in the heat treatment of metals*[7)]

[37] ISO 80000-1, *Quantities and units — Part 1: General*

[38] ISO 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

[39] ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

[40] ISO 9606-1, *Approval testing of welders — Fusion welding — Part 1: Steels*

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

7) British Standards Institute, Customer Services, 389 Chiswick High Road, London W4 4AL, UK.

[42] ISO/TR 10949, *Hydraulic fluid power — Component cleanliness — Guidelines for achieving and controlling cleanliness of components from manufacture to installation*

[43] ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*

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

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

[46] ISO 13679, *Petroleum and natural gas industries — Procedures for testing casing and tubing connections*

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

[48] ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

[49] ISO 15611, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience*

[50] ISO 15612, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure*

[51] ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test*

[52] ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

[53] ISO/TS 16431, *Hydraulic fluid power — Assembled systems — Verification of cleanliness*

[54] ISO/TS 29001:2010, *Petroleum, petrochemical and natural gas industries — Sector-specific quality management systems — Requirements for product and service supply organizations*

[55] ISO/IEC 17050 (all parts), *Conformity assessment — Supplier's declaration of conformity*

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

[57] MIL-STD-792, *Identification Marking Requirements for Special Purpose Components*[8)]

[58] SAE AMS-H-6875:1998, *Heat treatment of steel raw materials*[9)]

[59] SAE AS 4059, *Aerospace fluid power — Cleanliness classification for hydraulic fluids*

[60] ASNT SNT-TC-1A, *Recommended practice for personnel qualification and certification in non-destructive testing*[10)]

8) Department Of The Navy, Naval Sea Systems Command, Washington, DC 20376-5160, USA.

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

10) The American Society for Nondestructive Testing, 1711 Arlingate Lane, Columbus, OH 43228-0518, USA.

[61] SPE 23741-MS, *Mechanical Fluid-loss Control Systems Used During Sand Control Operations*, Restarick, H.L, 1992[11)]

[62] SPE 30421-MS, *Downhole Swab Valve Aids in Underbalanced Completion of North Sea Well*, WALKER, TIM, HOPMANN, MARK, 1995

[63] SPE 50678-MS, *Breakthrough Well Suspension Operations in West of Shetland Horizontal Wells*, ELLIOT, G. *et al.*, 1998

[64] SPE 58778-MS, *Pressure-Actuated Isolation Valves for Fluid Loss Control in Gravel/Frac-Pack Completions*, WORLOW, D.W. *et al.*, 2000

[65] SPE 63113-MS, *A successful Completion/Perforation by Use of a Downhole Lubricator Valve: A Case Study from the Siri Field, Danish Sector, North Sea*, OVE B. SVENDSEN *et al.*, 2000

[66] SPE 77712-MS, *Riserless Subsea Completion with Disappearing Plug Technology*, CRAIG STAIR, JOE STUCKEY, 2002

[67] SPE 88696-MS, *Well Integrity Management System (WIMS)*, JAMAL Al-ASHHAB *et al.*, 2004

[68] SPE 96337-MS, *Want to Make Tree Operations Safer? Why Not Use the DHSV as a Barrier?*, K. MUNDAY *et al.*, 2006

[69] ISO 6507 (all parts), *Metallic materials — Vickers hardness test*

11) Society of Petroleum Engineers, 222 Palisades Creek Dr., Richardson, TX 75080, USA.

ICS 75.180.10

Price based on 50 pages