INTERNATIONAL STANDARD

ISO 28781

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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

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Foreword

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

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

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

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

ISO 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)

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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;