
Well integrity —

Part 2:

**Well integrity for the operational
phase**

Intégrité du puits —

Partie 2: Intégrité du puits pour la phase opérationnelle
iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/TS 16530-2:2014

<https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb72fb9d06a/iso-ts-16530-2-2014>



iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/TS 16530-2:2014](https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb72fb9d06a/iso-ts-16530-2-2014)
<https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb72fb9d06a/iso-ts-16530-2-2014>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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	vi
Introduction	vii
1 Scope	1
2 Normative references	2
3 Terms, definitions and abbreviated terms	2
4 Abbreviated terms	8
5 Well integrity management system	10
5.1 Well integrity management.....	10
5.2 Well integrity management system.....	10
6 Well integrity policy and strategy	10
6.1 Well integrity policy.....	10
6.2 Well integrity strategy.....	10
7 Resources, roles, responsibilities and authority levels	11
7.1 Organizational structure.....	11
7.2 Competency.....	11
8 Risk assessment aspects of well integrity management	11
8.1 General.....	11
8.2 Risk assessment considerations for well integrity.....	12
8.3 Risk assessment techniques.....	15
8.4 Application of risk assessment in establishing monitoring, surveillance and maintenance requirements.....	16
8.5 Application of risk assessment in the assessment of well integrity anomalies.....	17
8.6 Failure rate trending.....	17
9 Well barriers	18
9.1 General.....	18
9.2 Barrier philosophy.....	18
9.3 Well barrier envelopes.....	19
9.4 Well barrier element.....	19
9.5 Documenting of well barrier envelopes and well barrier elements.....	20
10 Well component performance standard	20
10.1 General.....	20
10.2 Acceptance criteria and acceptable leak rates.....	21
10.3 Measuring the leak rate.....	23
10.4 Effects of temperature.....	23
10.5 Direction of flow.....	23
10.6 Integrity of barriers to conduct well maintenance and repair.....	23
10.7 ESD/related safety systems.....	23
10.8 Well component operating procedure.....	24
11 Well operating and component limits	24
11.1 Well operating limits.....	24
11.2 Well load and tubular stress analysis.....	25
11.3 Further well-use review.....	26
11.4 End-of-life review.....	26
11.5 Management of change to the operating limits.....	26
12 Well monitoring and surveillance	26
12.1 General.....	26
12.2 Monitoring and surveillance frequency.....	27
12.3 Shut-in wells.....	27
12.4 Suspended wells.....	27

12.5	Visual inspection	28
12.6	Well logging	28
12.7	Corrosion monitoring	29
12.8	Cathodic protection monitoring	29
12.9	Erosion monitoring	30
12.10	Structural integrity monitoring	30
13	Annular pressure management	32
13.1	General	32
13.2	Management	32
13.3	Sources of annular pressure	32
13.4	Annulus pressure monitoring and testing	33
13.5	Frequency of monitoring tubing and annulus casing pressures	33
13.6	Identification of an annulus pressure source	34
13.7	Maximum allowable annular surface pressure	34
13.8	Maintaining annulus pressure within the thresholds	37
13.9	Review and change of MAASP and thresholds	37
14	Well handover	38
14.1	General	38
15	Well maintenance	39
15.1	General	39
15.2	Replacement parts	40
15.3	Frequency of maintenance	40
15.4	Component testing methods	40
15.5	Leak testing	42
16	Well integrity failure management	43
16.1	General	43
16.2	Integrity failure ranking and prioritization	43
16.3	Well failure model	43
17	Management of change	44
17.1	General	44
17.2	Integrity deviation process	45
17.3	Deviation from the well performance standard	45
17.4	MOC Process	45
18	Well records and well integrity reporting	46
18.1	General	46
18.2	Well records	47
18.3	Reports	47
19	Performance monitoring of well integrity management systems	48
19.1	Performance monitoring and continuous improvement	48
19.2	Performance review	48
19.3	Key performance indicator monitoring	50
20	Compliance audit	51
20.1	General	51
20.2	Audit process	52
	Annex A (informative) Well integrity roles and responsibilities chart	53
	Annex B (informative) Example of competency matrix	54
	Annex C (informative) Barrier element acceptance table	55
	Annex D (informative) Well barrier schematic	56
	Annex E (informative) Example — Performance standard for well safety critical elements	58
	Annex F (informative) Well barrier elements, functions and failure modes	59
	Annex G (informative) Example of possible well leak paths	62

Annex H (informative) Example of leak testing gas lift valves	64
Annex I (informative) Leak rate determination calculations	66
Annex J (informative) Well operating limits	69
Annex K (informative) MAASP calculations	71
Annex L (informative) Example — A change in MAASP calculation	79
Annex M (normative) Information required of well handover	81
Annex N (informative) Function testing by analysing hydraulic signature	84
Bibliography	86

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/TS 16530-2:2014](https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb72fb9d06a/iso-ts-16530-2-2014)

<https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb72fb9d06a/iso-ts-16530-2-2014>

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

<https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-9c1525f026a1/iso-ts-16530-2:2014>

ISO/TS 16530 consists of the following parts, under the general title *Well integrity*:

— *Part 2: Well integrity for the operational phase*

The following parts are under preparation:

— *Part 1: Life cycle governance manual*

Introduction

This Technical Specification has been developed by producing operating companies for oil and gas, and is intended for use in the petroleum and natural gas industry worldwide. This Technical Specification is intended to give requirements and information to the Well Operator on managing well integrity for the operational phase. Furthermore, this Technical Specification addresses the minimum compliance requirements for the Well Operator, in order to claim conformity with this Technical Specification.

It is necessary that users of this Technical Specification are aware that requirements above those outlined in this Technical Specification can be needed for individual applications. This Technical Specification is not intended to inhibit or replace legal requirements; it is in addition to the legal requirements; where there is a conflict the legal requirement always takes precedence. This can be particularly applicable where there is innovative or developing technology, with changes in field or well design operating philosophy.

This Technical Specification addresses the process of managing well integrity by assuring compliance to the specified operating limits for identified well types, that are defined based on exposure of risk to people, environment, assets and reputation, supported by associated well maintenance/monitoring plans, technical reviews and management of change.

The following terminology is used in this Technical Specification.

- a) The term “shall” or “must” denotes a minimum requirement in order to conform to this Technical Specification.
- b) The term “should” denotes a recommendation or that which is advised but not required in order to conform to this Technical Specification.
- c) The term “may” is used to indicate a course of action permissible within the limits of the document.
- d) The term “consider” is used to indicate a suggestion or to advise.
- e) The term “can” is used to express possibility or capability.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/TS 16530-2:2014

<https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb72fb9d06a/iso-ts-16530-2-2014>

Well integrity —

Part 2:

Well integrity for the operational phase

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This Technical Specification provides requirements and methods to the oil and gas industry to manage well integrity during the well operational phase.

The operational phase is considered to extend from handover of the well after construction, to handover prior to abandonment. This represents only the period during the life cycle of the well when it is being operated and is illustrated in [Figure 1](#).

The scope of the Technical Specification includes:

- A description of the processes required to assess and manage risk within a defined framework. The risk assessment process also applies when deviating from this Technical Specification.
- The process of managing well integrity by operating wells in compliance with operating limits for all well types that are defined based on exposure of risk to people, environment, assets and reputation. The management of well integrity is supported by associated maintenance/monitoring plans, technical reviews and the management of change.
- The assessment of existing assets (wells / fields) in order to start the process of Well Integrity Management in accordance with this technical specification.
- The handover process required when changing from one activity to another during the operational phase.

The scope of the Technical Specification applies to all wells that are utilized by the oil and gas industry, regardless of their age, type or location.

The scope of the Technical Specification does NOT apply to:

- The periods during well intervention or work-over activities but it DOES include the result of the intervention and any impact that this can have to the well envelope and the associated well barriers.
- The equipment that is required or used outside the well envelope for a well intervention such as wire-line or coiled tubing or a pumping package.

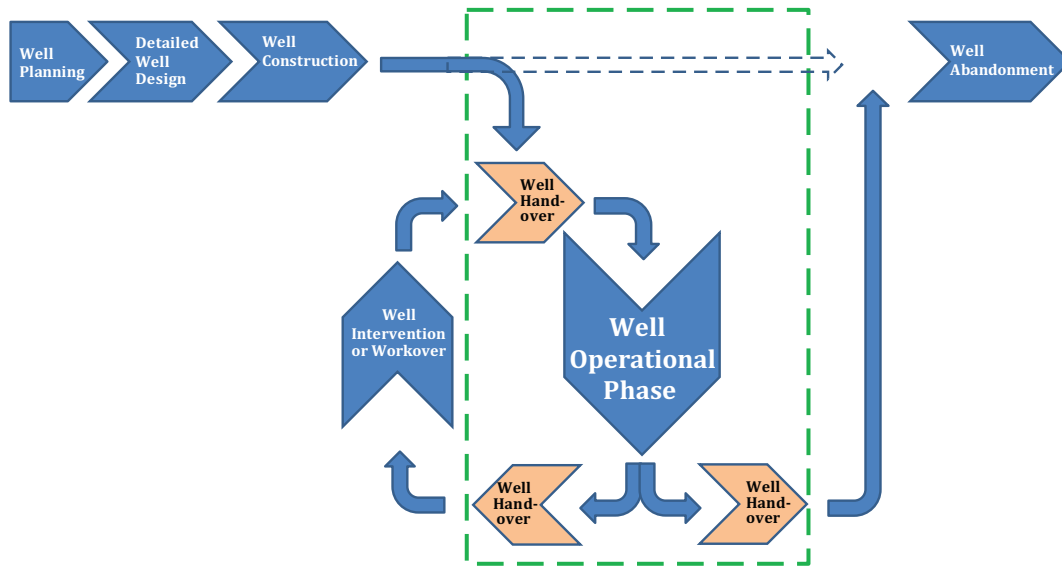


Figure 1 — Illustration of the scope of this Technical Specification

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10417:2004, *Petroleum and natural gas industries — Subsurface safety valve systems — Design, installation, operation and redress*

API RP 14H, *Recommended Practice for Installation, Maintenance and Repair of Surface Safety Valves and Underwater Safety Valves Offshore, Fifth Edition*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

3.1

A-annulus

designation of annulus between the production tubing and production casing

[SOURCE: API RP 90, modified]

3.2

abandoned well

permanent subsurface isolation of the well

3.3

ambient pressure

pressure external to the wellhead

Note 1 to entry: In the case of a surface wellhead, the pressure is zero psig. In the case of a subsea wellhead, it is equal to the hydrostatic pressure of seawater at the depth of the subsea wellhead, in psig.

[SOURCE: API RP 90, modified]

3.4**anomaly**

condition that differs from what is expected or typical, or which differs from that predicted by a theoretical model

3.5**B-annulus**

designation of annulus between the production casing and the next outer casing

Note 1 to entry: The letter designation continues in sequence for each outer annular space encountered between casing strings, up to and including the surface casing and conductor casing strings.

[SOURCE: API RP 90, modified]

3.6**breaking of containment**

breaking into the containment system of integrity or barrier envelope

3.7**competency**

ability of an individual to perform a job properly through a combination of training, demonstrated skills and accumulated experience

3.8**component**

mechanical part, including cement used in the construction of a well

3.9**conductor casing**

element that provides structural support for the well, wellhead and completion equipment, and often for hole stability for initial drilling operations

Note 1 to entry: This casing string is not designed for pressure containment, but upon completion of the well, it may have a casing head; therefore, it can be capable of containing low annular pressures. For subsea and hybrid wells, the low pressure subsea wellhead is normally installed on this casing string.

[SOURCE: API RP 90, modified]

3.10**consequence**

expected effect of an event that occurs

3.11**deep-set**

below or close to the production packer, or at the cap rock of a reservoir to isolate the production tubing or casing from the producing reservoir

3.12**deviation**

departure from a standard

3.13**double-block and bleed principle**

operation with two valves or seals, in series, or a valve and a blind cap in all relevant, utilized flow paths into and out of the well that are not connected to a closed system

3.14**failure**

loss of intended function

3.15

failure mode

description of the method of failure

3.16

failure modes and effects analysis

FMEA

procedure used in design, development and operations management for the analysis of potential failure modes within a system for classification of the severity and likelihood of the failures

3.17

failure mode, effects, and criticality analysis

FMECA

extension of FMEA (3.16) that in addition includes an analysis of the criticalities to evaluate the seriousness of the consequences of a failure versus the probability of its occurrence

3.18

fault

abnormal, undesirable state of a system element (e.g. entire subsystem, assembly, component) induced by the presence of an improper command or absence of a proper one, or by a failure

Note 1 to entry: All failures cause faults, not all faults are caused by failure.

3.19

flow-wetted

any surface that is exposed to fluids coming from a pressure source for that fluid

3.20

handover

act or process of transferring responsibility for operating a well from one competent party to another, including both custody to operate (certificate) and the requisite data and documents which describe the well construction

3.21

hazard

source of potential harm or a situation with a potential to cause loss (any negative consequence)

[SOURCE: API RP 90, modified]

3.22

hybrid well

well drilled with a subsea wellhead and completed with a surface casing head, a surface tubing head, a surface tubing hanger, and a surface Christmas tree

Note 1 to entry: A hybrid well can have either one (single-bore production riser) casing string or two (dual-bore production riser) casing strings brought up from the subsea wellhead and tied back to the surface equipment. These wells are typically located on floating production platforms, such as spars or TLPs.

[SOURCE: API RP 90, modified]

3.23

impairment

state of diminished ability to perform a function, but not yet failed

3.24

inflow testing

use of the tubing or casing pressure to perform leak testing

3.25

intervention

operation to enter the well through the Christmas tree

3.26**leak**

unintended and, therefore, undesired movement of fluids, either to or from, a container or a fluid containing system

3.27**casing/liner**

casing string with its uppermost point inside and near the bottom end of a previous casing string using a liner hanger

3.28**major hazard**

hazard (3.21) with a potential for causing major accidents, i.e. involving fatality due to fire or explosion, major pollution, multiple fatalities, or severe damage to the installation

3.29**maximum allowable annulus surface pressure****MAASP** **P_{MAASP}**

greatest pressure that an annulus can contain, as measured at the wellhead, without compromising the integrity of any element of that annulus, including any exposed open-hole formations

3.30**the operational phase**

is considered to extend from handover of the well after construction, to handover prior to abandonment, indicating the life cycle of the well while being operated

3.31**Well Operator-imposed annulus pressure**

casing pressure that is Well Operator-imposed for purposes such as gas lift, water injection, thermal insulation, etc

[SOURCE: API RP 90, modified]

3.32**performance standard**

statement, which can be expressed in qualitative or quantitative terms as appropriate, of the performance required of a safety-critical element in order to ensure the safety and integrity of the installation

3.33**pressure test**

application of a pressure from an external source (non-reservoir pressure) to ascertain the mechanical and sealing integrity of a component

3.34**primary well barrier**

first well barrier envelope that the produced and/or injected fluids contact and that is in-place and functional during well operations

3.35**production casing**

innermost string of casing in the well

Note 1 to entry: Production fluids enter the casing below the production packer and continue to the surface through the production string. At a minimum, the production casing is rated for the maximum anticipated pressure that can be encountered from the production zone.

[SOURCE: API RP 90, modified]

3.36

production riser

on fixed platforms, the casing strings rising from the seafloor to the wellhead or, on hybrid wells, the casing strings attached to the subsea wellhead rising from the seafloor to the surface wellhead

[SOURCE: API RP 90, modified]

3.37

**production string
completion string**

string consisting primarily of production tubing, but also including additional components such as the surface-controlled subsurface safety valve (SCSSV), gas lift mandrels, chemical injection and instrument ports, landing nipples, and packer or packer seal assemblies

Note 1 to entry: The production string is run inside the production casing and used to conduct production fluids to the surface.

[SOURCE: API RP 90, modified]

3.38

production tubing

tubing that is run inside the production casing and used to convey produced fluids from the hydrocarbon-bearing formation to the surface

Note 1 to entry: Tubing can also be used for injection. In some hybrid wells, for example, tubing is used as a conduit for gas for artificial lift below a mudline pack-off tubing hanger to isolate the gas-lift pressure from the production riser.

[SOURCE: API RP 90, modified]

iteh STANDARD PREVIEW
(standards.iteh.ai)

3.39

reliability

probability that equipment can perform a specified function under stated conditions for a given period of time

ISO/TS 16530-2:2014
<https://standards.iteh.ai/catalog/standards/sist/0aeb1dc1-bb4d-4537-9b8e-0eb721b9d06a/iso-ts-16530-2-2014>

3.40

risk

combination of the consequences of an event and the associated likelihood of its occurrence

3.41

risk assessment

systematic analysis of the risks from activities and a rational evaluation of their significance by comparison against predetermined standards, target risk levels or other risk criteria

Note 1 to entry: Risk assessment is used to determine risk management priorities.

3.42

safety critical element

part of the installation or plant that is essential to maintain the safety and integrity of the installation

Note 1 to entry: This includes any item that is intended to prevent or limit the effect of a major hazard or which, upon failure, can cause or contribute substantially to a major hazard affecting the safety or integrity of the installation.

Note 2 to entry: Safety-critical elements include measures for prevention, detection, control and mitigation (including personnel protection) of hazards.

Note 3 to entry: Within the context of this Technical Specification, an installation is considered as a well.

3.43**secondary well barrier**

second set of barrier elements that prevent flow from a source

[SOURCE: API RP 90, modified]

3.44**shut-in well**

well with one or more valve(s) closed in the direction of flow

3.45**subsea well**

well completed with a subsea wellhead and a subsea tree

[SOURCE: API RP 90, modified]

3.46**subsea wellhead**

wellhead that is installed at or near the seabed

3.47**surface casing**

casing that is run inside the conductor casing to protect shallow water zones and weaker formations and may be cemented within the conductor string and is often cemented back to the mud-line or surface

Note 1 to entry: The surface wellhead is normally installed on this string for surface wells.

[SOURCE: API RP 90]

3.48**suspended well**

well that has been isolated from the producing reservoir via a deep-set down-hole isolation device (mechanical or cement plug)

Note 1 to entry: Components above the isolation device are no longer considered flow wetted.

3.49**sustained annulus pressure (SAP)**

pressure in an annulus that

- a) rebuilds when bled down;
- b) is not caused solely by temperature fluctuations; and
- c) is not a pressure that has been imposed by the Well Operator

[SOURCE: API RP 90, modified]

3.50**thermally induced annulus pressure**

pressure in an annulus generated by thermal expansion or contraction of trapped fluids

[SOURCE: API RP 90, modified]

3.51**verification**

examination, testing, audit or review to confirm that an activity, product or service is in accordance with specified requirements

3.52**well barrier element**

one or several dependent components that are combined to form a barrier envelope that, in combination, prevent uncontrolled flow of fluids within or from a well