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Well integrity in drilling and well operations
The NORSOK standards make extensive references to international standards. Where relevant, the contents of a NORSOK standard will be used to provide input to the international standardisation process. Subject to implementation into international standards, the NORSOK standard will be withdrawn.
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Annex A (Normative) Leak test pressures and frequency for well control equipment
Foreword

NORSOK (The competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead time and eliminate unnecessary activities in offshore field developments and operations.

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness as part of the NORSOK initiative and supported by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Engineering Industries). NORSOK standards are administered and issued by SN (Standard Norge).

The purpose of NORSOK standards is to contribute to meet the NORSOK goals, e.g. by replacing individual oil company specifications and other industry guidelines and documents for use in existing and future petroleum industry developments.

The NORSOK standards and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as extensive references in the authorities’ regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, the contents of a NORSOK standard will be used to provide the Norwegian industry-input to the international standardisation process. Subject to development and publication of implementation into international standards, the relevant NORSOK standard will be withdrawn.

Introduction

This revision was initiated to make this NORSOK standard compliant with changes in legislation and adapted to evolving and new technology. In this revision, the user will find that the standard has been completely reorganised and that the content and structure is different than the previous revision. The intention has been to make it easier to find information and provide flexibility to include Managed Pressure Drilling, acceptance criteria for casing cement applied in the drilling, production and plug & abandonment activities, include new well barrier element acceptance tables (formation, alternative material to updating or revising this NORSOK standard in the future without altering its structure. Consequently, the cement). The changes from the previous revision are not marked.

The following main changes are implemented in this revision: HOL

- The focus of this NORSOK standard is well integrity, which is the application of technical, operational and organizational solutions to reduce the risk of uncontrolled release of formation fluids throughout the entire
life cycle of the well and of course safety aspects. Recommendations for best practices are not dominant. This led to renaming this NORSOK standard to "Well integrity in drilling and well operations".

- The descriptions are mostly insensitive to type of well and type of installation.
- Clear and concise requirements (shall) and guidelines (should) have been applied to stress their importance and to differentiate the process of handling deviations from these.
- Overlapping or duplication of text or topics in other standards has been minimized.
- Well barrier related terminology with definitions has been established in lack of apparent international standard definitions.
- Pre-defined WBSs for most common situations have been included.
- A library of 50 defined WBEs with acceptance criteria has been added, which the user can apply to define a well barrier with associated standard acceptance criteria.
- Listings of situations for which well control action procedures should be in place are included.
- Underbalanced drilling and completion operations and sidetracking, plugging and abandonment activities are significantly altered.
- Production activities and pumping operations are new.

The user is encouraged to study the following "roadmap to understanding" to get a quick overview of how this NORSOK standard is structured and how to obtain the "full" overview of related requirements and guidelines:
1 Scope
This NORSOK standard focus on well integrity by defining the minimum functional and performance oriented requirements and guidelines for well design, planning and execution of well operations in Norway.

2 Normative and informative references
The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown or proved that they meet or exceed the requirements and guidelines of the standards referenced below.

2.1 Normative references

ISO 10405, Petroleum and natural gas industries – Care and use of casing and tubing.
ISO 10416, Petroleum and natural gas industries – Drilling fluids laboratory testing.
ISO 11960, Petroleum and natural gas industries – Steel pipes for use as casing or tubing for wells.
ISO 13533, Petroleum and natural gas industries – Drilling and production equipment – Drill-through equipment.
ISO/DIS 13628-7, Petroleum and natural gas industries – Design and operation of subsea production systems – Part 7: Completion/workover riser systems.
ISO 14310, Petroleum and natural gas industries – Downhole equipment – Packers and bridge plugs.
API Bull 5C2, Performance Properties of Casing, Tubing, and Drill Pipe.
API RP 5C7, Coiled Tubing Operations in Oil and Gas Well Services.
API RP 7G, Drill Stem Design and Operation Limits.
API Spec 6FA, Fire Test for Valves.
API Spec 6FB, Fire Test for End Connections.
API Spec 6FC, Fire Test for Valve With Automatic Backseats.
API Spec. 7, Rotary Drill Stem Elements.
2.2 Informative references

None.

OLF 117  Recommended guidelines for Well Integrity

3 Terms, definitions and abbreviations

For the purposes of this NORSOK standard the following terms, definitions and abbreviations apply.

The terminology used in this NORSOK standard for well barriers is based on:

- **Primary well barrier**: This is the first object that prevents flow from a source. Example - blue items: Strippers + CT-BOP + surface test tree.

- **Secondary well barrier**: This is the second object that prevents flow from a source. Example - red items: Lower riser package + production tree + wellhead.

- **Well barrier element**: An object that alone cannot prevent flow from one side to the other side of itself. Example: CT-BOP.

- **Common well barrier element**: This is a barrier element that is shared between primary and secondary barriers. Examples: Body of LRP, X-mas tree and production wing valve.

- **Intermediate well barrier stage**: This is the stage(s) of a well barrier element activation sequence before the ultimate well barrier stage is reached. Examples: Leak in CT strippers – close CT pipe rams.

- **Ultimate well barrier stage**: This is the final stage of a well barrier element activation sequence which normally includes closing a shearing device. Example: Closed CT shear ram (primary barrier) or closed master valve (secondary barrier).

- **Working well barrier stage**: This is the stage which shows the well barrier elements that are used to confine the pressure in a normal working mode. Example: Closed CT strippers + CT body + surface test tree w. closed wing valve.
3.1 Terms and definitions

3.1.1 A-annulus
annulus between the tubing and the production casing

3.1.2 Abnormally pressured
means that the formation/reservoir or zones where the pressure exceeds the normal, regional hydrostatic pressure of a seawater column with reference gradient.
Note – Also refer to LAT the definition for over-pressured

3.1.3 Activity
preparation for and implementation of operations
3.1.4 **B-annulus**
annuli between the production casing and the previous casing string

3.1.5 **can**
verbal form used for statements of possibility and capability, whether material, physical or casual.

3.1.6 **common well barrier element**
barrier element that is shared between the primary and secondary well barrier

3.1.7 **critical activity or operation**
activity or operation that potentially can cause serious injury or death to people, or significant pollution of the environment or substantial financial losses

3.1.8 **deep water well**
water depth exceeding 600 m LAT

3.1.9 **design factor**
ratio between the rated strength of the material over the estimated load

3.1.10 **discharge line**
line between the pump that is used for pumping and the first permanent valve on a WBE

Examples - Surface production tree, wellhead.

3.1.11 **double block**
two valves or other barrier elements in series above the sea floor shall be closed in order to prevent unintentional flow to the environment

3.1.12 **double block and bleed**
two valves or other barrier elements in series above the sea floor with bleed off capabilities between the two valves, shall be closed in order to prevent unintentional flow to the environment

3.1.13 **electrical cable**
wire consisting of individual steel strands woven around one or more electrical conductors to provide sufficient strength to perform desired electrical work in a well

3.1.14 **energised fluids**
liquefied gases or liquid containing gases
3.1.13
HPHT well

3.1.15
fracture pressure
fracture initiating pressure

3.1.16
gas lift barrier
barrier envelope that prevents flow to the environment from an artificial/injected gaslift source
Note: this barrier differs from the definition for the barrier towards the formation/reservoir source.

3.1.17
high pressure and high temperature well (HPHT)
well with expected shut-in pressure exceeding 690 bar, 10,000 psi, (69 MPa), or a static bottomhole temperature higher than 150 °C

3.1.18
inflow test
defined differential created by reducing the pressure on the downstream side of the well barrier or well barrier element

3.1.19
kick tolerance
maximum influx to equal MAASP
Note - MAASP is based on volume that can be circulated out of well without breaking down the weakest zone in the wellbore, normally assumed to be at casing shoe well.

3.1.20
managed pressure drilling (MPD)
An adaptive drilling operation where process used to precisely control the dynamic bottom-hole annular pressure in the wellbore is equal to or slightly higher than the pore pressure of the formation being drilled profile throughout the wellbore.

3.1.21
may
verbal form used to indicate a course of action permissible within the limits of the standard

3.1.22
minimum formation stress
is the fracture closing pressure
3.1.23 normal pressure
formation or zones where the pressure is equal to the normal regional hydrostatic pressure gradient

3.1.13 3.1.24 operation
sequence of planning and execution tasks that are carried out to complete a specific activity

3.1.19 permanent abandonment

3.1.25 over-pressured
formation or zones where the pressure is in excess of the normal, regional hydrostatic pressure gradient

3.1.26 permanently abandoned
well status, where the well or part of the well, will be plugged and abandoned permanently, and with the intention of never being used or re-entered again

3.1.14 3.1.27 3.1.20 permanent well barrier
well barrier consisting of WBEs that individually or in combination creates a seal that has a permanent/eternal characteristic

3.1.21 a well barrier which permanently seals a source of inflow

3.1.15 3.1.28 pipe light
trippping mode where pressure forces acting upwards on the cross sectional area of the work string is larger than the weight of the string

3.1.16 3.1.29 3.1.22 plug
"cement" plug (see Table 24) or mechanical plug

3.1.23 an object or material placed in the well with intention to function as a fundament or as a qualified barrier element

3.1.30 plugging
operation of securing a well by installing required well barriers

3.1.17 3.1.31 3.1.24 potential source of inflow
A formation which contains free gas, movable hydrocarbons, or movable water with permeability, but not necessarily a reservoir overpressure

3.1.25 Note: Hydrocarbons are normally movable unless they are residual or have extremely high viscosity (i.e. tar)
3.1.32
pressure testing

application of differential pressure to a valuedetect leaks in a well barrier, WBE or other objects that equals or exceeds the item or system WPare designed to confirm its pressure integrity at rated WConfine pressurised fluids (liquid or gas)

3.1.34
primary well barrier

first object well barrier that prevents flow from a potential source of inflow

3.1.35
procedure

series of steps that describes the execution of a task or piece of work

3.1.36
production operation

organizational unit that is responsible for the integrity of the well during production

3.1.37
reservoir

permeable formation or group of formation zones originally within the same pressure regime, with a flow potential and/or hydrocarbons present or likely to be present in the future

3.1.38
riser margin

additional fluid density to add to the hole below the mudline required to compensate for the differential pressure between the fluid in the riser and seawater in the event of a riser disconnect

3.1.39
secondary well barrier

second object well barrier that prevents flow from a potential source of inflow

3.1.40
shall

verbal form used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted, unless accepted by all involved parties

Note - The deviation process for handling of deviations and non-conformity with "shall" requirements and "should" guidelines in this NORSOK standard shall be in accordance with responsible party’s system for handling of deviations. These systems shall describe procedures for how to deviate from requirements and guidelines listed in the regulatory regulations with guidelines and the responsible party’s steering documentation.

3.1.41
shallow gas
free gas or gas in solution that exists in permeable gas formation(s) which are penetrated before installing the surface casing and BOP has been installed

Note - The gas can be normally pressured or abnormally pressured.

3.1.26
should
verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

Note - The deviation process for handling of deviations and non-conformity with “shall” requirements and “should” guidelines in this NORSOK standard should be in accordance with responsible party’s system for handling of deviations. It is assumed that these systems describe procedures for how to deviate from requirements and guidelines listed in the regulations with guidelines and the responsible party’s steering documentation.

3.1.27
simultaneous activities
activities that are executed concurrently on a platform or unit, such as production activities, drilling and well activities, maintenance and modification activities and critical activities

3.1.28
slickline
slick string of uniform diameter with sufficient strength to convey WL tools to their operating depth

3.1.38
single strand of uniform diameter wire to convey tools to their operating depth

3.1.44
suspension of well in operation
well status where the well is temporarily plugged, XT is installed, and the well barriers are monitored

3.1.45
suspension well under construction/intervention
well status, where the well operation is suspended without removing the well control equipment.

Example - Rig skidded to do short term work on another well, strike, rough weather conditions, waiting on equipment, etc.

3.1.39
Example: Disconnect due to WOW

3.1.46
surface casing
the last casing installed prior to drilling into an abnormally pressured formation or a formation containing hydrocarbons.

3.1.49
temporary abandonment
the casing which first allows installation of the BOP

3.1.47
temporarily abandoned
well status, where the well is abandoned and/or the well control equipment is removed, temporarily plugged with the intention that the operation will be resumed within a specified time frame (from days up to several years), BOP or XT removed
Example - Pulling BOP for repair, re-entry at a later stage to perform sidetrack or well test, skidding rig to do higher priority well work, assessment of well data and converting a well from an exploration to a development well, etc.

3.1.293.1.41

through tubing drilling and completion
drilling and completing operations conducted through the in situ tubing

3.1.303.1.42

trip margin
incremental increase in drilling fluid density to provide an increment of overbalance in order to compensate for pressure reduction due to swab effects while pulling out of swabbinghole

3.1.313.1.43

ultimate well barrier stage
final stage of a WBE activation sequence which normally includes closing a shearing device

Note - This stage normally describes the use of a shearing device.

3.1.44

3.1.51

under balanced drilling (UBD)
a drilling operation activity employing equipment and controls where the dynamic bottom-hole pressure exerted in the wellbore is intentionally lower less than the pore pressure of in any part of the exposed formations, with the intention of bringing formation being drilled fluids to the surface.

3.1.323.1.45

well barrier
envelope of one or several dependent well barrier elements preventing fluids or gases from flowing unintentionally from the formation into the wellbore, into another formation or to surface the external environment

3.1.333.1.46

well barrier element (WBE)
object that alone can a physical element which in itself does not prevent flow from one side to the but in combination with other side of it self WBE’s forms a well barrier

3.1.343.1.47

well barrier element acceptance criteria (EAC)
technical and operational requirements and guidelines to be fulfilled in order to qualify the well barrier element for its intended use

3.1.353.1.48

well control
collective expression for all measures that can be applied to prevent uncontrolled release of well bore effluent fluids to the external environment or uncontrolled underground flow
3.1.56
well control incident
incident in which a failure of barrier(s) or failure to activate barrier(s), results in an unintentional flow of formation fluid into the well, into another formation or to the external environment.

3.1.57
well control action procedure
specified sequence of planned actions/steps to be executed when the primary well barrier fails
Note - This normally describes the activation of the secondary well barrier, e.g. shut in of well.

3.1.49
well construction team
organizational unit that has drilled and completed the well

3.1.50
well influx/inflow (kick)
unintentional inflow of formation fluid from the formation into the wellbore

3.1.51
well integrity
application of technical, operational and organisational solutions to reduce risk of uncontrolled release of formation fluids throughout the life cycle of a well

3.1.52
well intervention
collective expression for deployment of tools and equipment in a completed well.
Example - Coiled tubing, wireline and snubbing operations.
Collective term for slickline, braided line, or electric line
### 3.2 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AMV</td>
<td>annulus master valve</td>
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<tr>
<td>ASCSSVASV</td>
<td>annulus surface controlled sub-surface valve</td>
</tr>
<tr>
<td>BHA</td>
<td>bottom hole assembly</td>
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<tr>
<td>BHP</td>
<td>bottom hole pressure</td>
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<tr>
<td>BOP</td>
<td>blow out preventer</td>
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<tr>
<td>BPV</td>
<td>back pressure valve</td>
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<tr>
<td>CT</td>
<td>coiled tubing</td>
</tr>
<tr>
<td>DIV</td>
<td>downhole isolation valve</td>
</tr>
<tr>
<td>DP</td>
<td>dynamically positioned</td>
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<tr>
<td>EAC</td>
<td>(well barrier) element acceptance criteria</td>
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<td>FACT</td>
<td>(well barrier) element acceptance criteria table</td>
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<td>ECD</td>
<td>equivalent circulating density</td>
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<td>ESD</td>
<td>emergency shut down</td>
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<td>emergency shut down valve</td>
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<td>HPHT</td>
<td>high pressure high temperature</td>
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<td>HSE</td>
<td>health, safety and environment</td>
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<td>ID</td>
<td>internal diameter</td>
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<td>low astronomical tide</td>
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<td>lower marine riser package</td>
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<td>MAASP</td>
<td>maximum allowable annulus surface pressure</td>
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<td>maximum expected design pressure</td>
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<td>maximum expected tubing pressure</td>
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<td>measured depth</td>
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<td>magnetic particle inspection</td>
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<td>maximum section design pressure</td>
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<td>non-return valve</td>
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<td>production master valve</td>
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<td>production shut down</td>
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<td>PWV</td>
<td>production wing valve</td>
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<td>RCD</td>
<td>rotating control device</td>
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