Well Integrity Standards & Practices ISO 16530 and API RP90

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Introductions

Alex Crabtree

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Disclaimer

- We do not represent or speak on behalf of ISO, IOGP, or API
- We had the privilege of participating on the working groups with many others to develop these documents

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Poll Question

What parts of the well lifecycle are you involved with?
(Check all that apply)

5

Poll Question

Do you regularly use/apply “Well Integrity Standards”?
(Check all that apply)

6

Poll Question

In your opinion, is the concept of “2 independently verifiable barriers” clearly understood as applied to O&G Wells? (Check one)

7

Poll Question

In your opinion, is there confusion about MAASP and MAWOP? (Check one)

8

Poll Question

In your opinion, has integrity of O&G wells in the last decade?
(Check one)

9

Poll Question

In your opinion, has integrity management of O&G wells in the last decade?
(Check one)

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ISO 16530
Petroleum and natural gas industries — Well integrity
Part 1: Life cycle governance

Alex Crabtree

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ISO 16530 – The History

- Standard initiated by International Association of International Oil & Gas Producers (IOGP)
- Technical Specification ISO 16530-2 Well Integrity in Operate Phase was published in August 2014
- Standard ISO 16530-1 for Well Integrity Life Cycle Governance was started in Q1 2013
- Final standard ISO 16530-1 issued in Q1 2017

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Scope of ISO 16530-1

- Applicable to the life cycle of all wells operated by the petroleum and natural gas industry
- Designed scalable for high and low complex wells.
- Applicable to any well regardless of age, location, status or condition
- Intended to assist the petroleum and natural gas industry to effectively manage well integrity during the well life cycle by providing:
  - Minimum requirements to ensure management of well integrity; and
  - Recommendations and techniques that well operators can apply in a scalable manner based on a well's specific risk characteristics.

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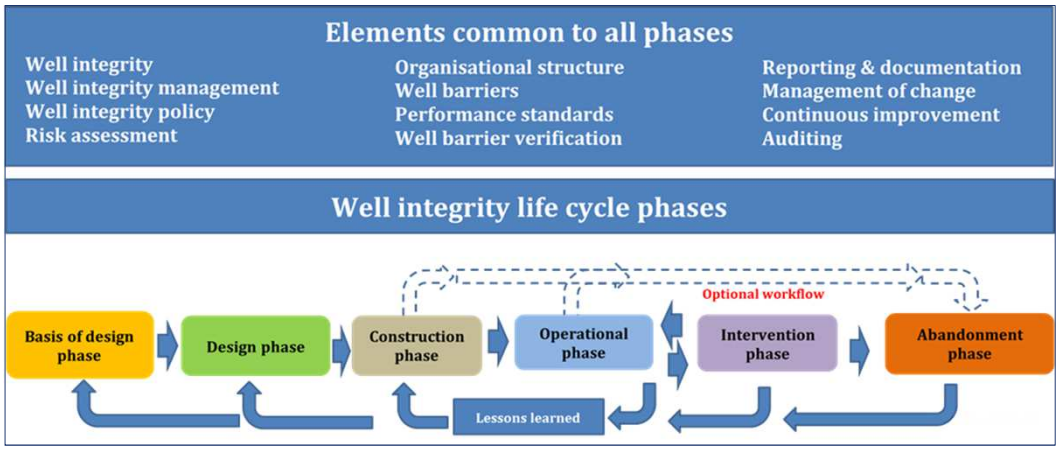
ISO 16530-1 Document Structure



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Well Integrity stages of the well life cycle

- "Basis of Design Phase“
  - Identifies the probable safety and environmental exposure to surface and subsurface hazards and risks that can be encountered during the well life cycle. Once identified, these hazards and risks are assessed such that control methods of design and operation can be developed in subsequent phases of the well life cycle.
- "Design Phase“
  - Identifies the controls that are to be incorporated into the well design, such that appropriate barriers can be established to manage the identified safety and environmental hazards. The design addresses the expected, or forecasted, changes during the well life cycle and ensures that the required barriers in the well's design are based on risk exposure to people and the environment.
- "Construction Phase"
  - Defines the required or recommended elements to be constructed (including rework/repair) and verification tasks to be performed in order to achieve the intended design. It addresses any variations from the design which require a revalidation against the identified hazards and risks.

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Well Integrity stages of the well life cycle

- " Operational Phase“
  - Defines the requirements or recommendations and methods for managing well integrity during operation.
- "Intervention Phase" (including work-over)
  - Defines the minimum requirements or recommendations for assessing well barriers prior to, and after, any well intervention that involves breaking the established well barrier containment system.
- "Abandonment Phase"
  - Defines the requirements or recommendations for permanently abandoning a well

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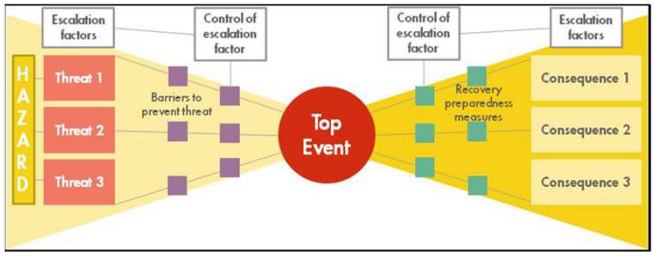
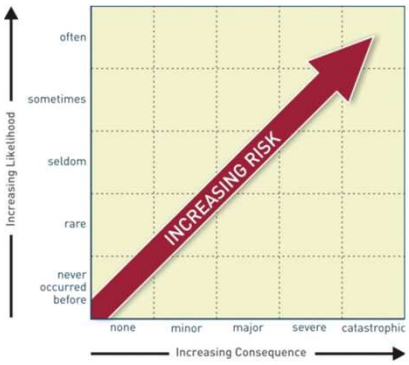
Standard's concept

- Prescriptive on the "What", defined by the **"Shall**" statements.
- Goal setting based on risk based assessment defined by the **"Should"** statements.





- The bow tie concept is explained in the Annex together with the risk register that is carried forward through each life cycle step

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Well Integrity Management System

The WIMS should address the following elements:

- Risk assessment;
- Organizational structure;
- Well barriers;
- Performance standards;
- Well barrier verification;
- Reporting and documentation;
- Management of change process;
- Continuous improvement process;
- Auditing.

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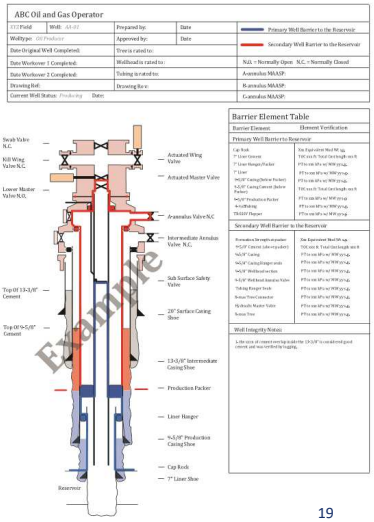
Standard includes examples of:

- Well failure model
- Testing matrix
- Cause and effect diagram
- Performance standard
- Barrier schematic
- Operating limits
- MAASP calculations
- Competence requirements
- Leak rate acceptance matrix
- Risk-based maintenance and inspection matrix
- Well maintenance and monitoring matrix
- Risk register
- Well handover information
- References to other industry standards



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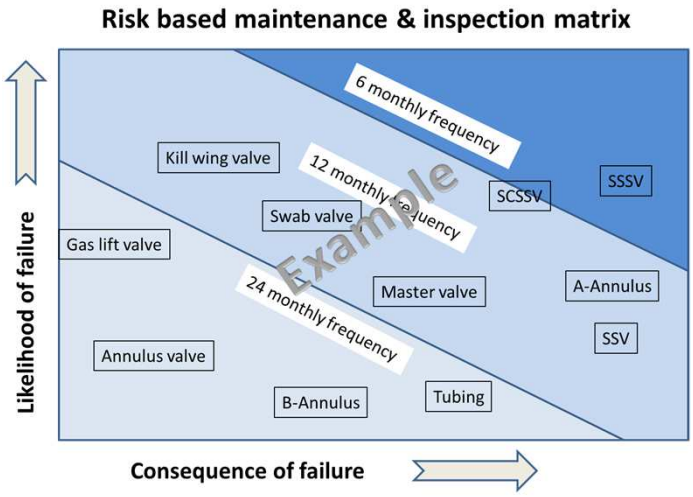
Risk Based Maintenance & Inspection



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Example of The Well failure model

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Example of Well Failure model / Corrective Response Matrix

Time allowed to conduct corrective actions / repair — Failed component (s) / well type	Offshore well	Subsea wells	High pressure well onshore	Medium pressure well onshore	Low pressure well onshore	Hydrostatic well onshore	Observation well
Example Flow wetted component failures single response frequency in months							
Xmas tree master valve	1	3	3	3	3	6	12
Flowing valve	3	3	6	6	6	12	24
subsurface safety valve	1	3	3	3	3	NA	NA
Production packer	6	6	12	12	12	NA	NA
Gas lift valve	3	3	6	6	6	12	24
Tubing	3	6	12	12	12	24	48
Example Flow wetted component failures multi response frequency in months							
X mass tree master valve + subsurface safety valve	1	0	1	2	3	NA	NA
X mass tree Flow wing valve + Master valve	1	0	2	3	4	6	12
Example Non flow wetted component failures multi response frequency in months							
Annulus side out let valve	3	3	6	6	9	12	12
Annulus to Annulus leak	6	6	6	12	12	12	12
Sustained casing pressure investigate	1	1	1	1	1	2	2
Example Non flow wetted component failures multi response frequency in months							
Sustained casing pressure + annulus valve	1	1	1	2	2	3	3
Annulus leak + sustained annular pressure	1	1	1	2	2	6	6
Combined Flow wetted and non flow wetted component failures response frequency in months							
Production tubing + casing leak	1	1	1	2	4	6	6
Master valve + annulus valve	2	2	2	3	6	9	9
Sustained intermediate annular pressure + tubing leak	1	1	2	3	3	6	6

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Annexes - Informative

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Annex	Content
A	Risk assessment techniques
B	Risk register
C	Example of well integrity roles and responsibilities chart
D	Example of a well integrity competence matrix
E	Examples of well barrier elements, functions and failure characteristics
F	Examples of well barriers during the well life cycle and a well barrier schematic
G	Example of performance standard for well barrier elements
H	Function testing by analysing hydraulic signature
I	Determination of leak rate
J	Well handover
K	Examples of key performance indicators
L	Example of hazard identification checklist
M	Example plot of pore pressure vs. formation strength
N	Well barrier element performance requirements
O	Example of leak testing of gas-lift valves
P	Example of well operating limits
Q	Example of possible well leak paths
R	MAASP calculations
S	Example of a change in MAASP calculations

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API RP 90-1 & API RP 90-2
Annular Casing Pressure Management

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API RP 90

- RP 90 "Annular Casing Pressure Management for Offshore Wells", First Edition, August 2006
  - Annular Casing Pressure Management "Risk-based" Program
    - Thermal, Operator-imposed, Sustained Casing Pressure
  - Establish acceptable risk levels for wells with annular casing pressure
    - Annular pressure ≤ 100 psig - little risk, monitor
    - Annular pressure > 100 psig & SCP - must bleed to 0 psig
    - Establish Maximum Allowable Wellhead Operating Pressure (MAWOP) and manage on case-by-case basis

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API RP 90

- RP 90-1 Refresh of "Annular Casing Pressure Management for Offshore Wells", First Edition, August 2006
  - Refresh project began October 2011
  - Update MAWOP to consider all components of annulus
    - RP90: MAWOP focused only on collapse and burst of tubulars
    - RP90-1: MAWOP based on tubular collapse/burst, wellhead rating, packer rating, formation integrity of any exposed zones, etc.
  - Development still in progress

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API RP 90

- RP 90-2 "Annular Casing Pressure Management for Onshore Wells", First Edition, April 2016
  - Focused on Annular Pressure Management for Onshore Wells
  - Developed by separate team from API RP90-1 (some same members on both teams)
  - MAWOP based on tubular collapse/burst, wellhead rating, packer rating, formation integrity of any exposed zones, etc.

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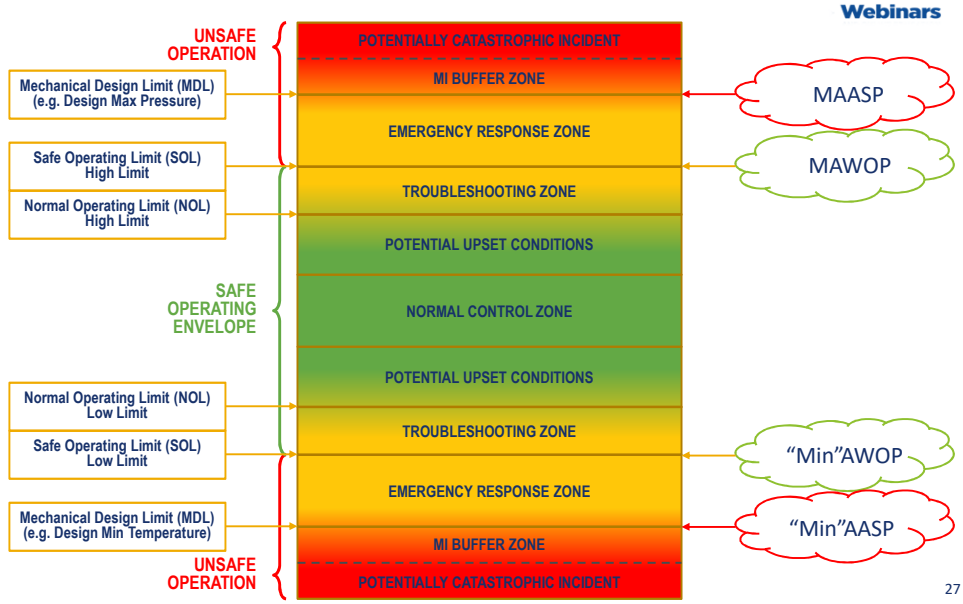
MAASP & MAWOP



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Useful links to obtain Standards

- API RP 90
  https://www.api.org/products-and-services/standards/purchase
- ISO 16530-1
  https://www.iso.org/standard/63192.html?browse=tc
- NORSOK D-010 rev 4
  https://www.standard.no/en/sectors/energi-og-klima/petroleum/norsok-standard-categories/d-drilling/d-0104/
- UK Oil & Gas - Well Life Cycle Integrity Guidelines (Issue 3)
  https://oilandgasuk.co.uk/product/well-life-cycle-integrity-guidelines-issue-3-march-2016/
- Norwegian O&G Association - Recommended Guidelines Well Integrity (Issue 6)
  https://www.norskoljeoggass.no/contentassets/e8f7a98e933b43feb76f823097e2e7b8/117-norwegian-oil-and-gas--recommended-guidelines-well-integrity---rev-6-final.pdf

(Remember to check if your company or institution has a corporate account)

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Questions

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Thank you!

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