Petroleum and natural gas industries — Well integrity standard

ISO 16530-1 Well integrity Lifecycle Governance

2015 BSEE Domestic and International Standards Workshop
Houston May 8 th 2015

Presenter Paul Hopmans Project Leader of ISO/DIS 16530-1

Intent of Well integrity life cycle standard

An INDEPENDENT method of applying performance standards that assures well integrity over life cycle of the well.

These performance standards can be existing or to be developed standards in industry or by Well Operator.

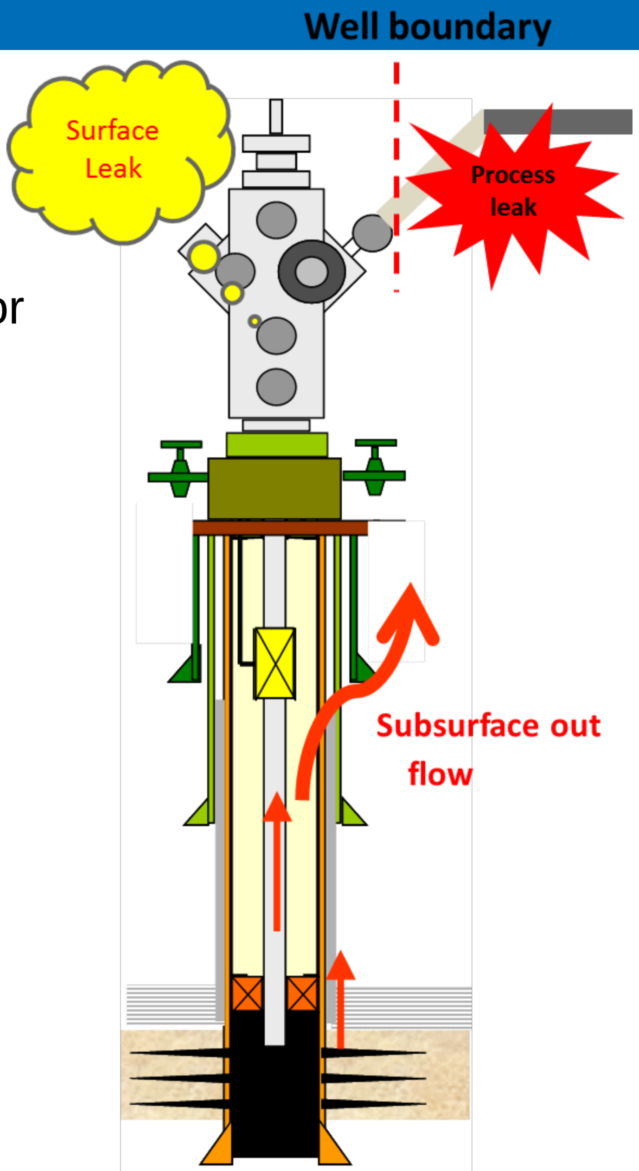
In principle :

The well integrity management system (WIMS) should assure that well integrity is maintained throughout the well life cycle by the application of a combination of technical, operational and organizational processes.

Well Integrity process

Assurance of Well Barriers over lifecycle:

- Barriers for subsurface that prevent outflow or inflow from subsurface
- Barriers that control the effect off loss off containment to surface
- Barriers that control the effect off loss off containment to process
- Barriers for safe well bore access



Well Integrity ISO standard

- Started in 2010 and developed operate phase ISO 16530-2 as technical specification under IOGP Standards solution. Published by ISO August 2014.

- Kicked off phase 2 ISO 16530-1 Well integrity Lifecycle Governance that incorporates operate phase. Working draft delivered by IOGP to ISO in Q4 2014

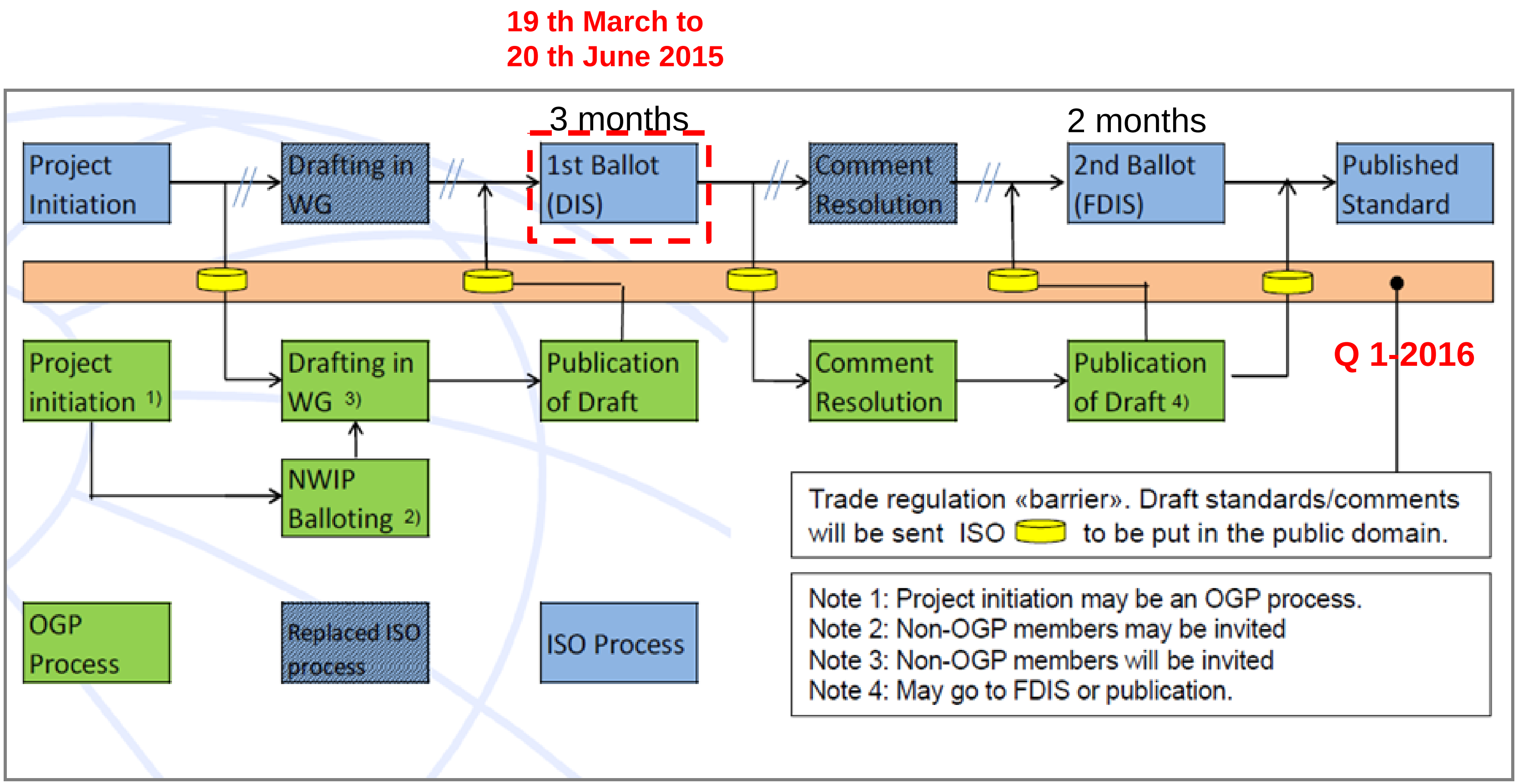
Active participating companies

- Publication of standard 16530-1 by ISO is expected Q1 2016

- Operate phase ISO 16530-2 will be retired after ISO 16530-1 is published

Company
Shell
Hess
Schlumberger
Total
ConocoPhillips
Woodside
Statoil
ExxonMobil
Maersk Oil
TullowOil
Petrobras
Chevron
General Electric
BP

Workflow process IOGP / ISO



Well integrity lifecycle standard ISO 16530-1 is at 1 st Ballot step closing 20 th June 2015

Note: IOGP works as A-liaison, there is no specific agreement between IOGP and ISO

ISO 16530-1 stages of the well life cycle

The “**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.

The “**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 forecast, changes during the well life cycle and assures that the required barriers in the well’s design are based on risk exposure to people and the environment.

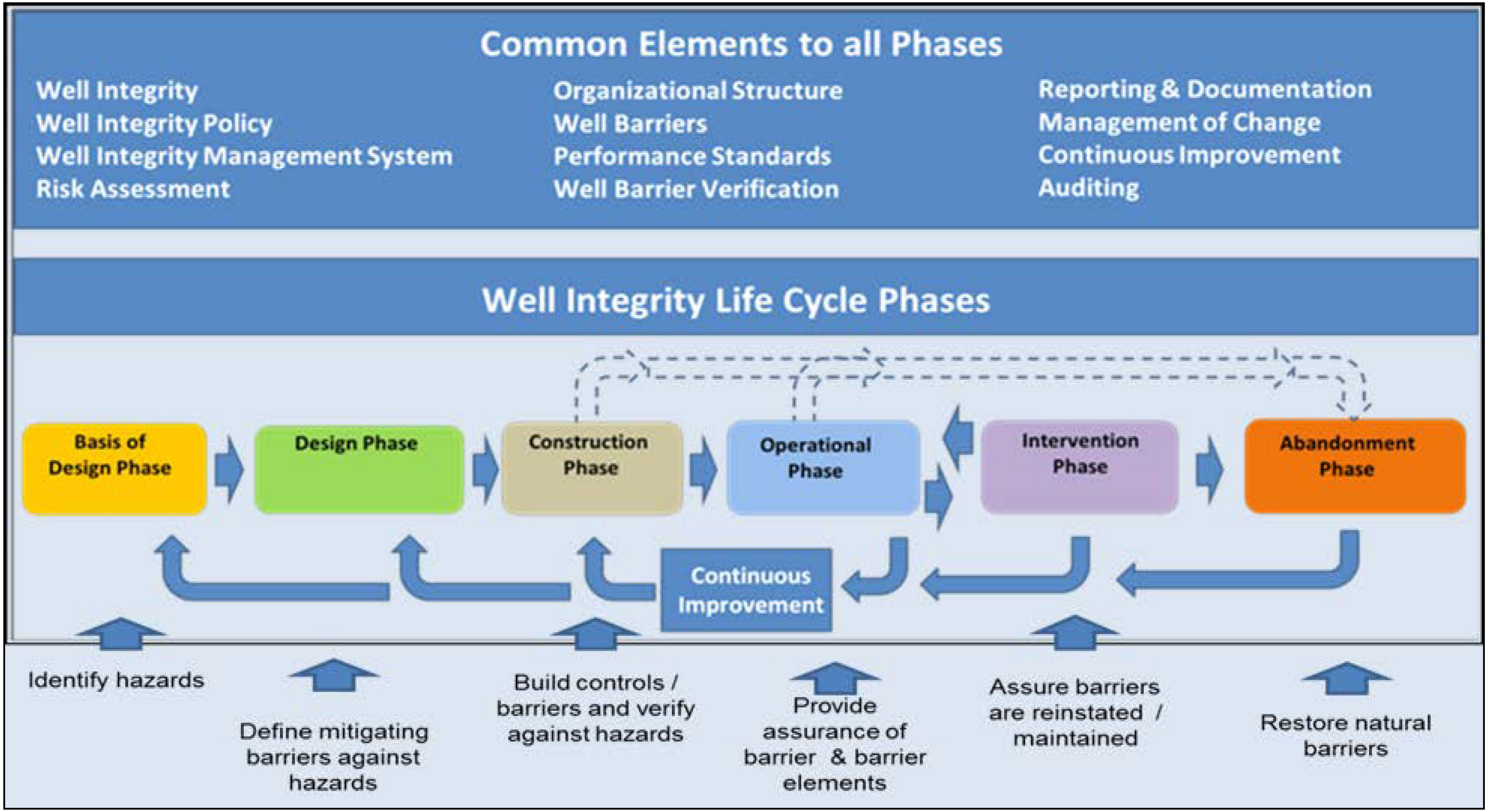
The “**Construction Phase**” defines the required or recommended elements to be constructed (including rework/repair) and verification tasks to be performed in order to achieve the intended design. It addresses any variations from the design which require a revalidation against the identified hazards and risks.

The “**Operational Phase**” defines the requirements or recommendations and methods for managing well integrity during operation.

The **“Intervention Phase”** (including work-over) defines the minimum requirements or recommendations for assessing well barriers prior to, and after, a well intervention which requires breaking the established well barrier containment system.

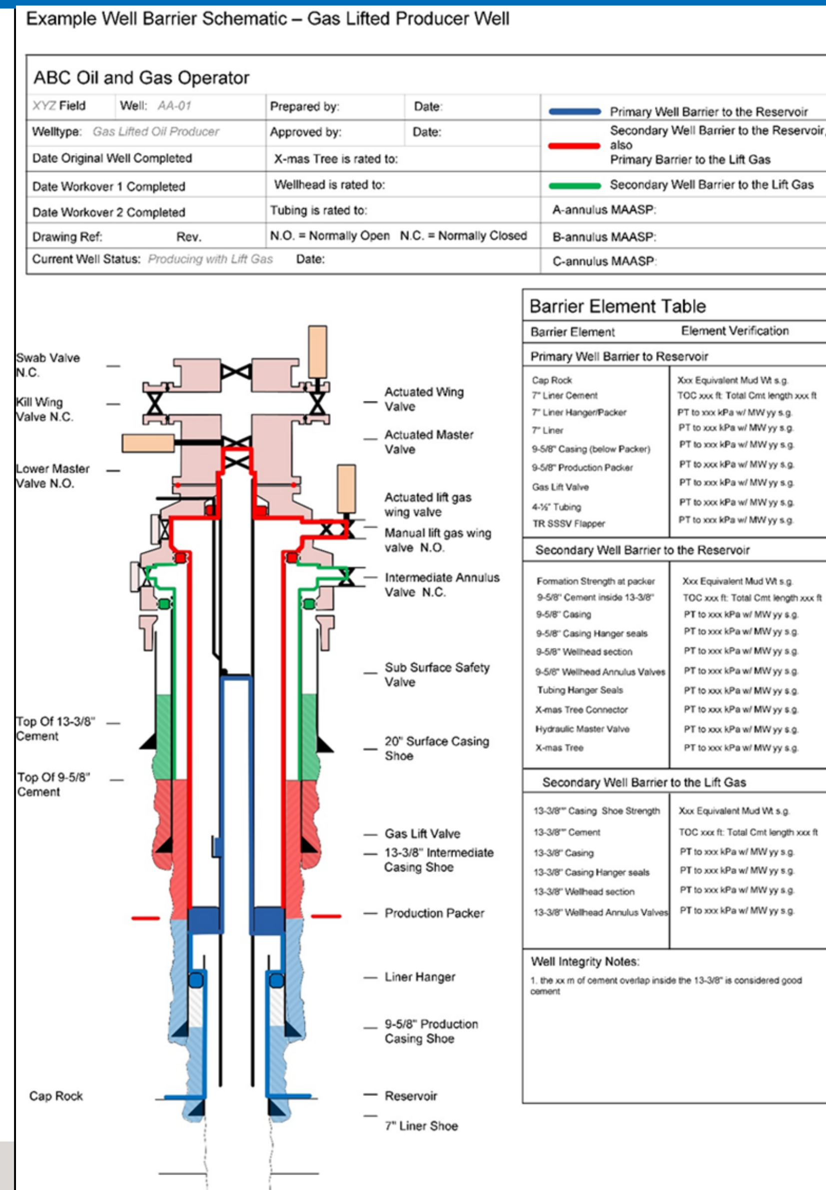
The **“Abandonment Phase”** defines the requirements or recommendations for permanently abandoning a well.

Document structure



Standard includes examples of:

- ❑ Well failure model
- ❑ Testing matrix
- ❑ Cause and effect diagram
- ❑ Performance standard
- ❑ Barrier schematic
- ❑ Operating limits
- ❑ MAASP calculations
- ❑ Competence requirements
- ❑ References to other industry standards



Some of the “shall” statements

1. The Well Operator shall define and document a barrier philosophy that includes barriers to formation fluids, injected fluids, lift gas and power fluids.

2. The effects of temperature changes shall be take into account, especially in subsea or arctic situations, since the wellbore, flow lines, manifolds, risers, etc., cool down quickly when remotely actuated valves are closed.

3. Special considerations that shall be taken into account should be captured here, for example:

4. At the end of each phase in the well life cycle, requirements for documentation, certification and verification shall be met to ensure that management of well integrity is maintained

5. The Well Operator shall apply a management of change (MOC) process to address and record changes to integrity assurance requirements for an individual well or to the well integrity management system.

6. All selected materials and equipment that will be used to establish a well barrier shall be verified against the well programme prior to installation in the well.

7. When a WBE is installed, its integrity shall be verified in accordance with the requirements of the well programme

Barrier requirements Basis of design phase

1. Dimensions and depth labelling (TVD and MD) for all tubular goods and cement (including TOC) defined as WBEs, it is undesirable to pressure-test against a cemented shoe

2. Identifying data acquisition requirements during the construction of the well; This should indicate what data and activities are required during construction for each well section, and specify whether a cement evaluation log, an extended leak-off test, a saturation log, gamma ray tests, etc., are required.

3. Corrosive aquifer casing/cementation and external corrosion protection of surface casing design considerations, e.g. corrosive aquifers that require corrosion controls during well construction, special cementing requirements, or changes to casing specification; cementing requirements, including minimum casing and plug cement heights and logging requirements, as well as the remedial cementing strategy;

4. The Well Operator should define well design performance standards for the WBEs. Performance standards are a set of specifications and qualification criteria that allows the Well Operator to define, design, procure and establish verification requirements for all the individual WBEs, including cement, that make up the well barriers.

Barrier requirement construct phase

The cement should be evaluated in accordance with the requirements of the well programme. If the cementing operation was not according to the requirements of the well programme, the Well Operator should consider using additional alternative verification methods for the barrier.

Indications observed prior, during and after the cementing operation that can impact the plan for establishing a competent barrier element include, but are not limited to:

- substantial loss of returns while pumping cement;
- significant deviation from the cementing plan, such as inability to maintain the desired density of the slurry, use of less than designed volume of slurry, etc.;
- premature returns of cement slurry to surface;
- lift pressure of the cement, measured just prior to bumping the plug, which indicates the top of cement (TOC) is not high enough in the annulus to isolate the uppermost potential flow zone;
- fluid influx prior to, during, or after cementing;
- excessive casing pressure;
- mechanical failure during the cement job, e.g. liner/casing, float collar and cement head failures;
- poor cement bond log results.

Barrier verification testing

1. A verification test is a check whether or not a component meets its acceptance criteria. It includes (but is not limited to) function testing, leak testing, axial load testing (tension and/or compression) and modelling verification.

2. Function testing is a check as to whether or not a component or system is operating as intended. It should be realistic, objective, and the results recorded. It typically (but not exclusively) consists of empirical testing of

3. Pressure testing is the application of a pressure from a known source to ascertain the mechanical and sealing integrity of the component.

4. Inflow testing, or negative testing, utilizes pressure from a remote source such as reservoir or formation pressure.

5. Certain barrier elements may have to be verified by suitable modelling or type testing at the design stage, since operational testing may not be practical or achievable. Examples of such testing include wave load impact on conductors, slam closure rates for SSSVs and pressure rating of installed casings, where it is undesirable to pressure-test against a cemented shoe.