Inspection Needs Supporting Increased Well Integrity

Dr.Robello Samuel

Halliburton Fellow

Robello.Samuel@Halliburton.com

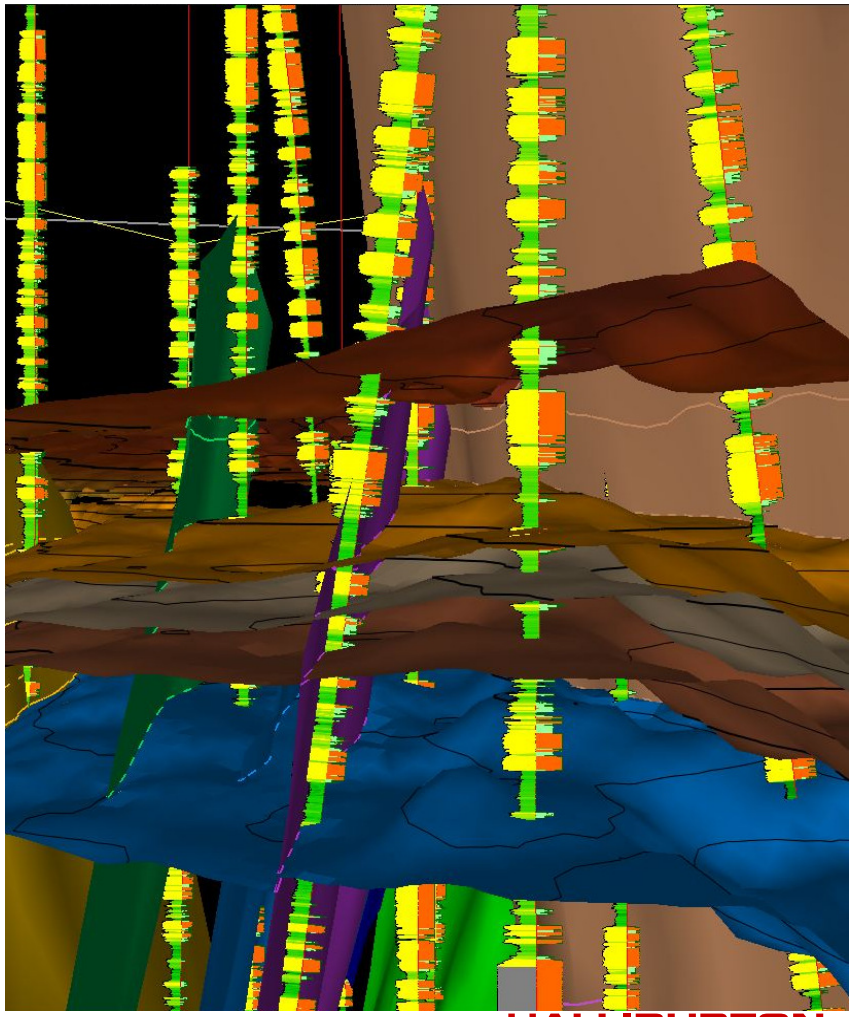
NASA In-Space Inspection Technology Workshop (ISIW 2014) Johnson Space Center, Houston

Solving challenges.™

Context

In-Space

In-Earth



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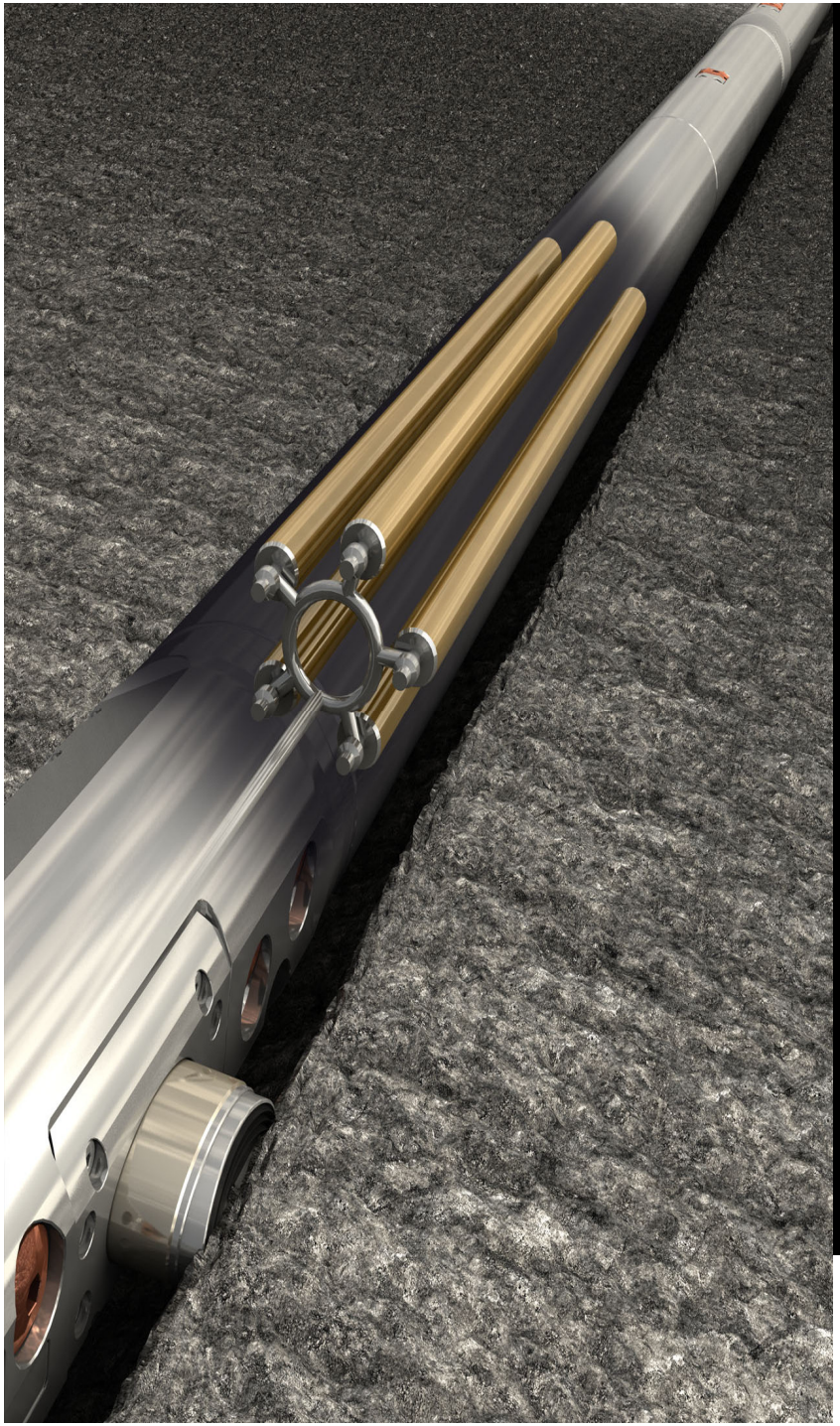

Exploration Drilling

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Oil Well Integrity

- Well Integrity: NORSOK D-010 and API Std 65 (1 & 2)

"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."

API RP 65-2: "Barriers contribute to total system reliability; total system reliability is the probability of barrier success, or one minus the probability that all barriers to uncontrolled flow along a particular path will fail simultaneously."

- Well Reliability as KPI

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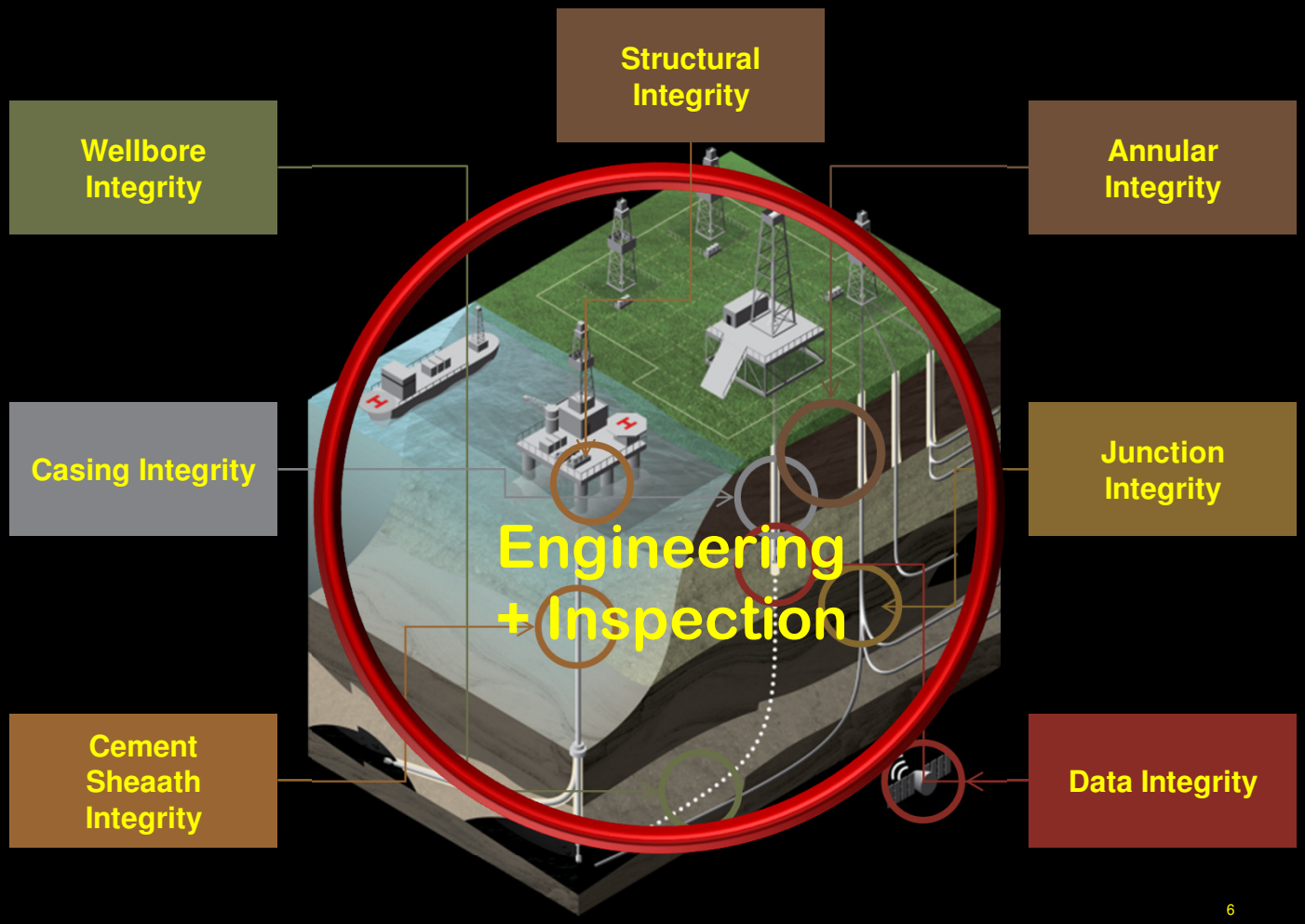
Total Well Integrity Ecosystem



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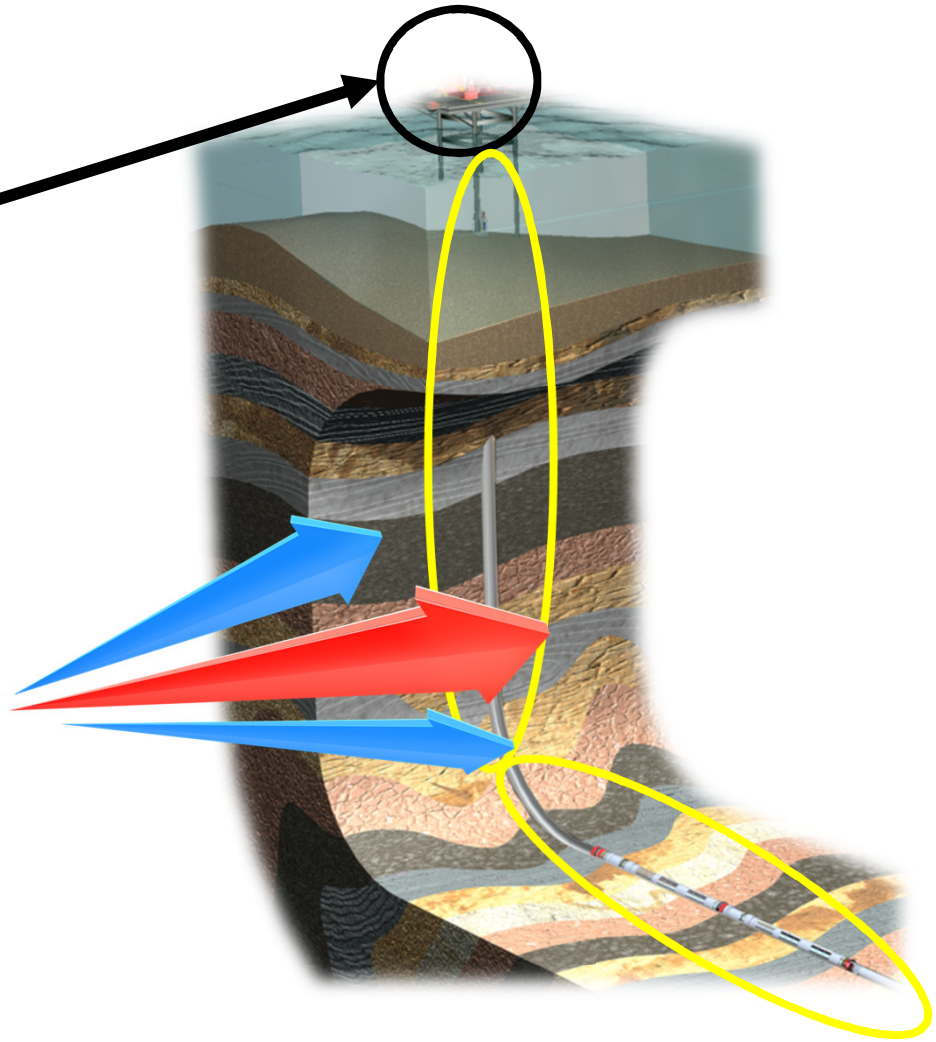
Challenge

Surface

Sub-surface



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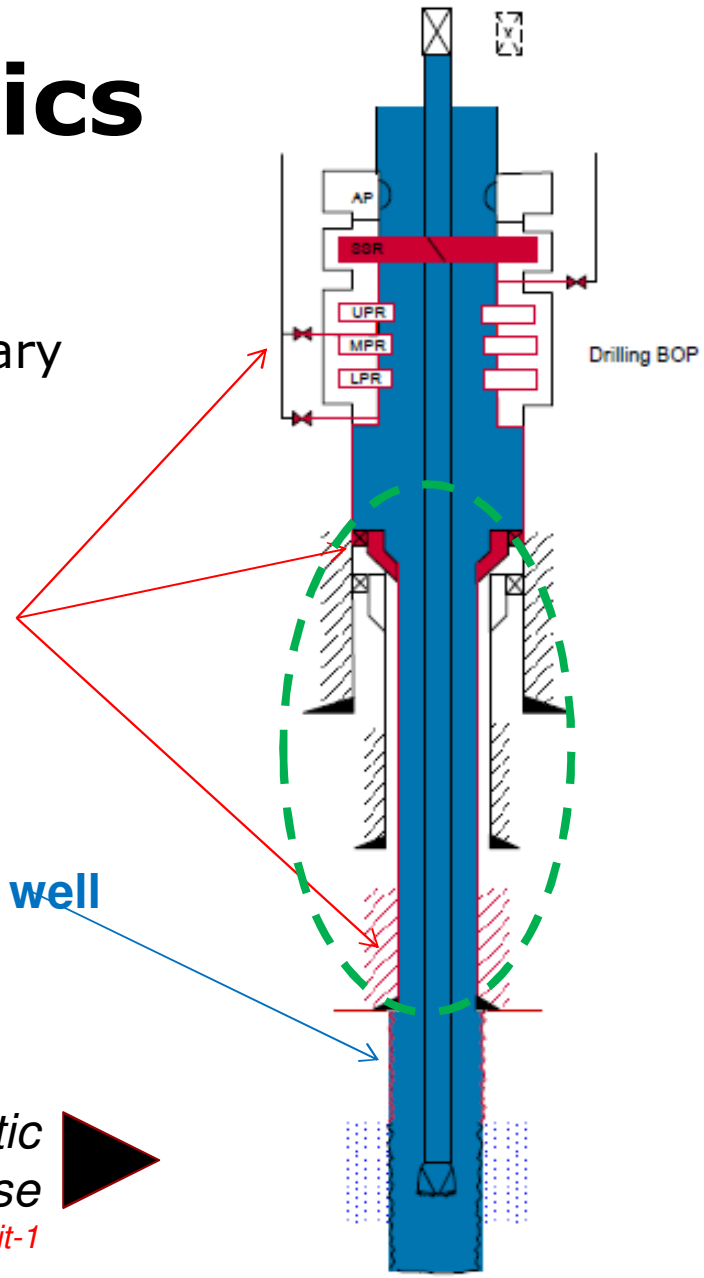
Well Integrity - Basics

- Barriers
  - Mechanical
    - Primary
    - Secondary
  - Operational

secondary barrier is the last set

primary barrier is the fluid column in the well



Well barriers schematic for Drilling Phase

Source: NORSOK D-10 lit-1

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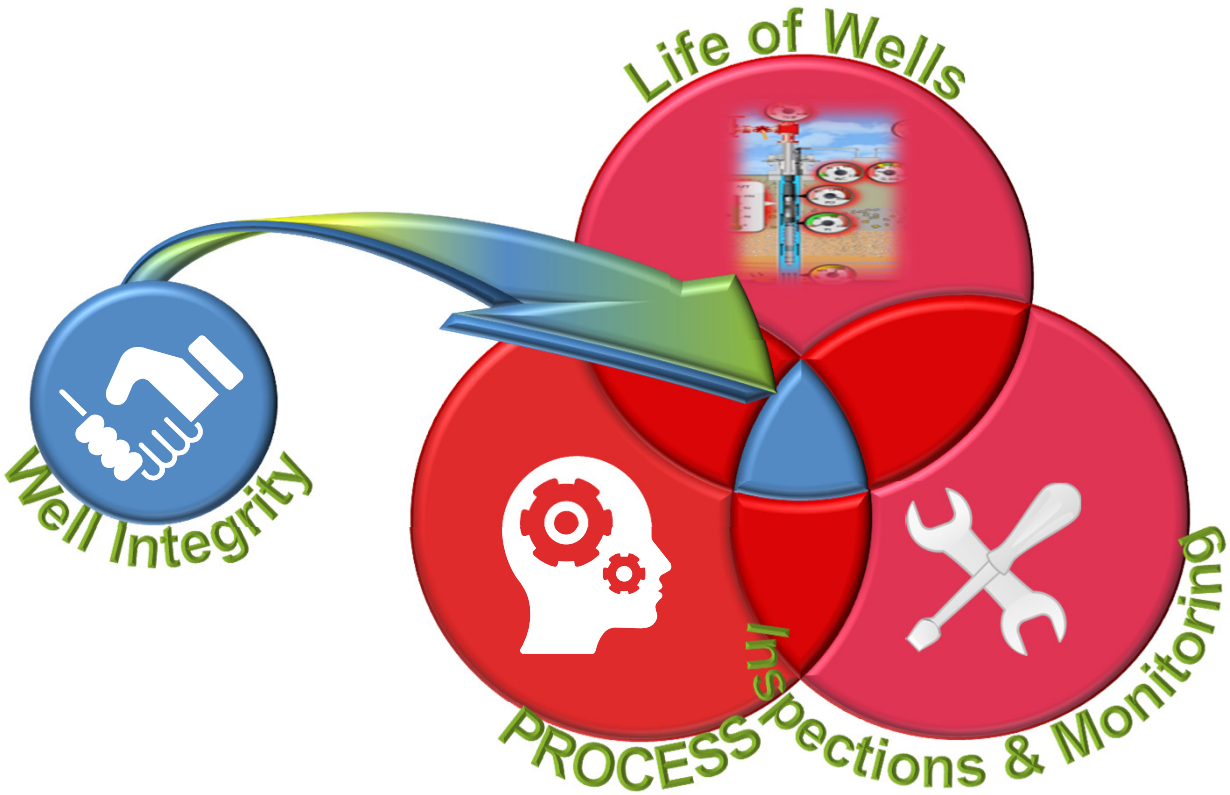
How this is done?

Interconnect

- **Monitor**
- **Inspect**
- **Engineering**
- **Intelligent**



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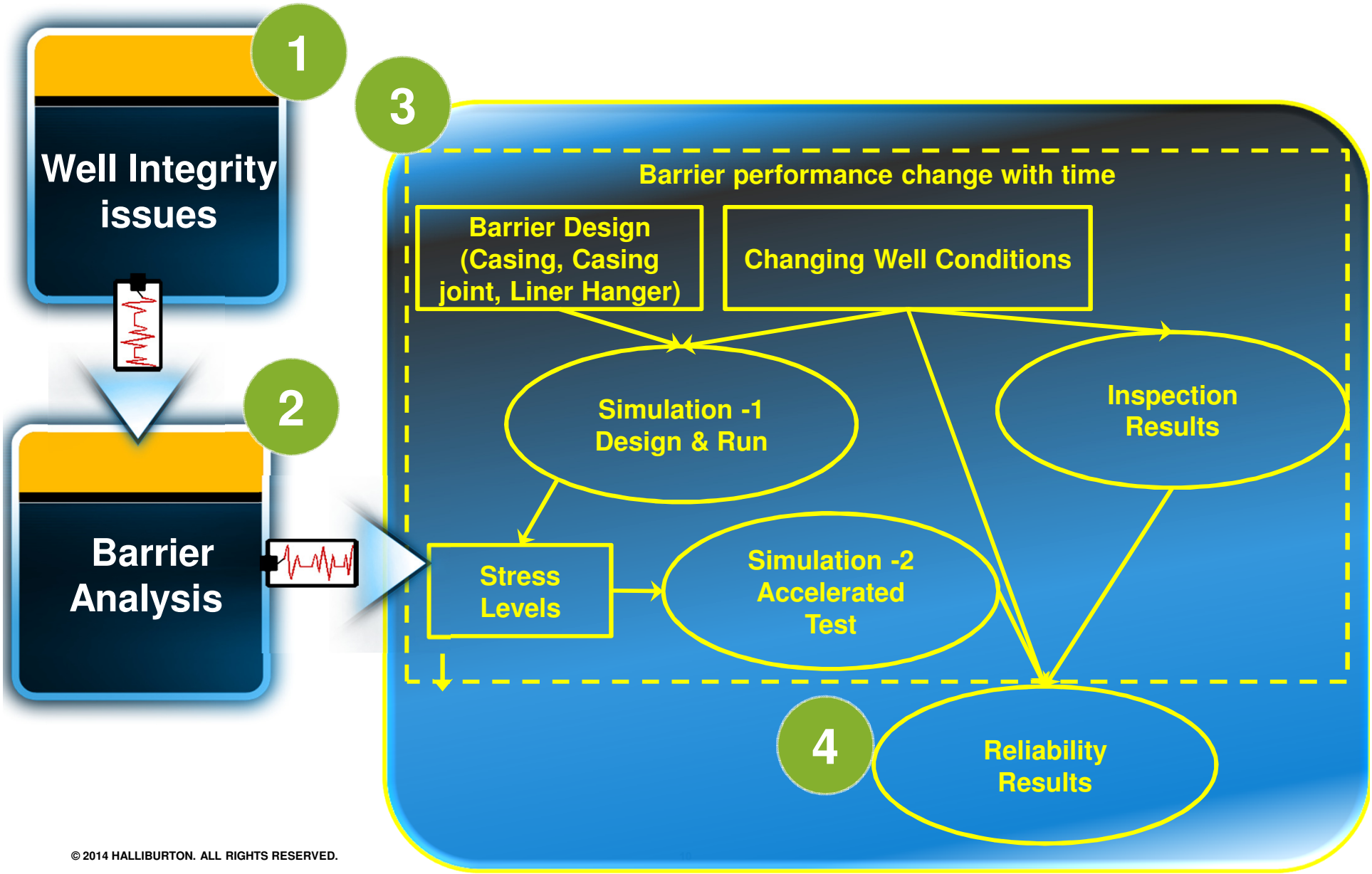
How this is done?



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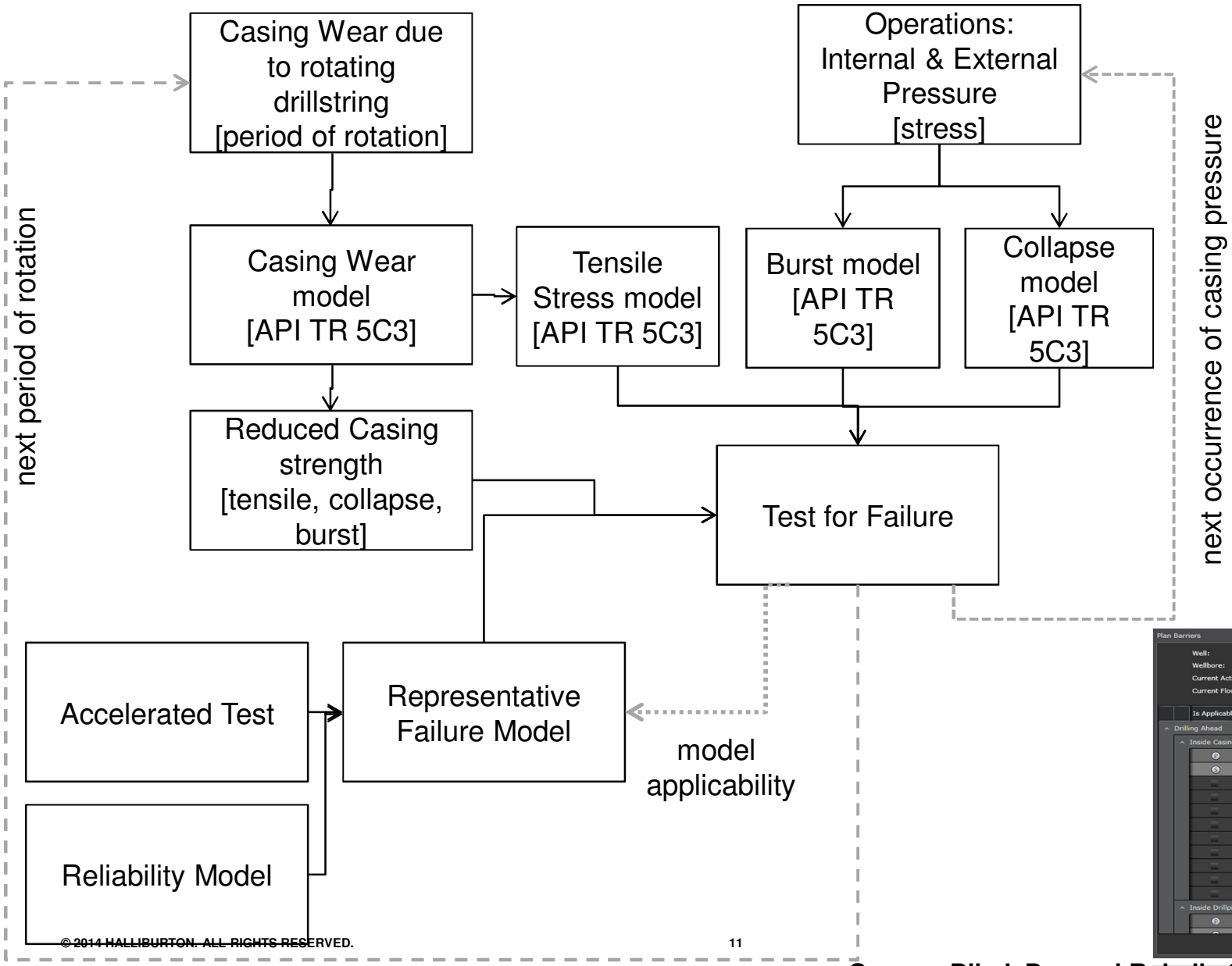
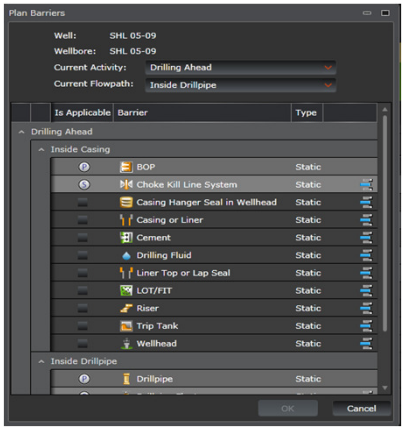
Source: Bibek Das and Robello Samuel

Simulation Design





Source: Bibek Das and Robello Samuel

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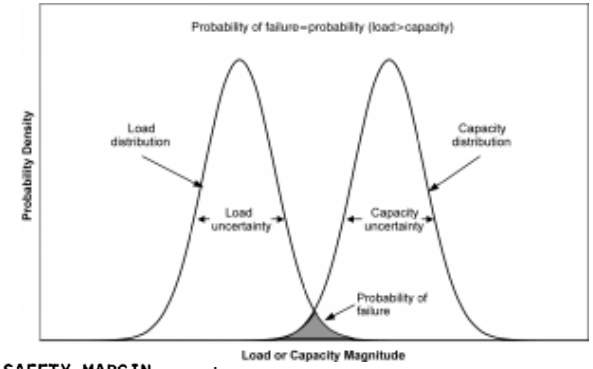
Reliability Mathematics

$$R(t) = 1 - F(t)$$

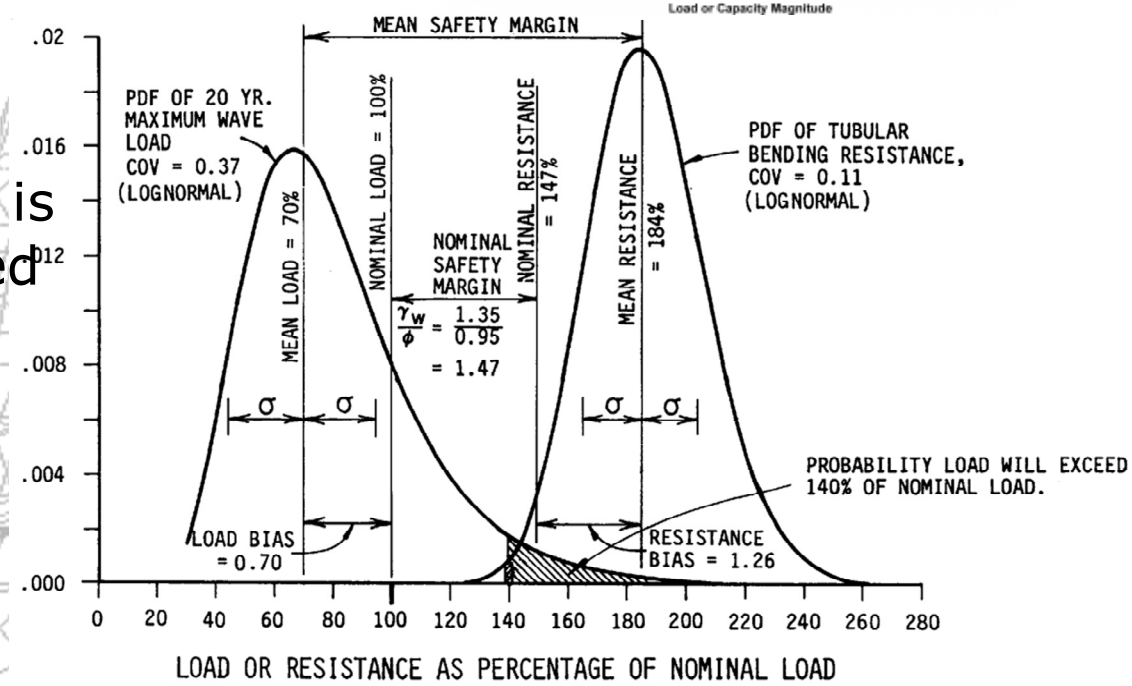
$$F(t) = \int_0^t f(s)ds$$



An acceleration factor is calculated as compared to the use conditions

t_u = AF x t_s

$$f_u(t) = \left(1/AF\right) f_s\left(t/AF\right)$$



Source: API RP 2A

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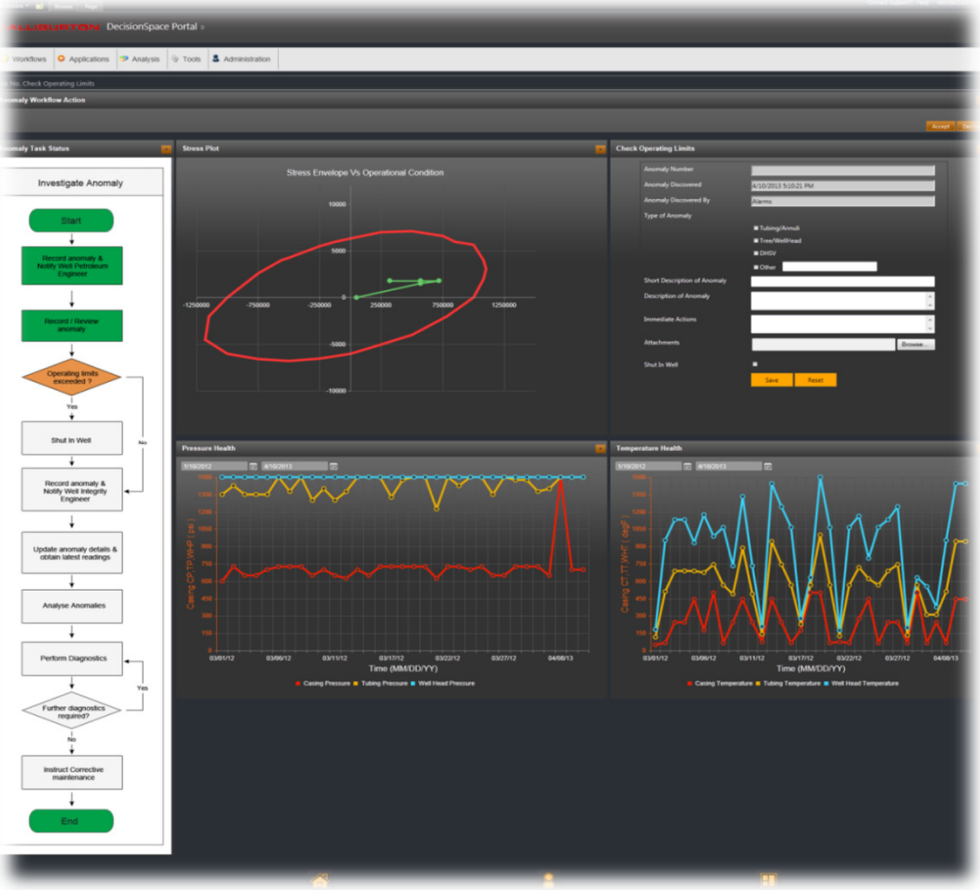
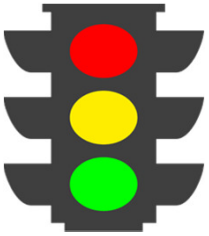
Source: Bibek Das and Robello Samuel

Engineering Health diagnostic System

If the triaxial stress exceeds the yield strength, a yield failure is indicated.

The triaxial safety factor is the ratio of the material's yield strength to the triaxial stress.





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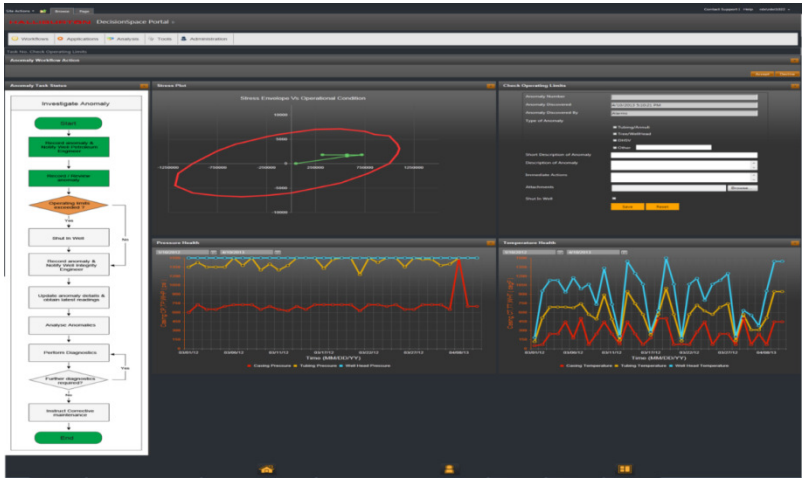
Well Integrity - Inspection

- Extend inspection to potential barrier failures and maintenance schedule

Anomaly



Diagnostic

Engineering, operational and organizational solutions to reduce risk of uncontrolled release of formation fluids throughout the life cycle of a well

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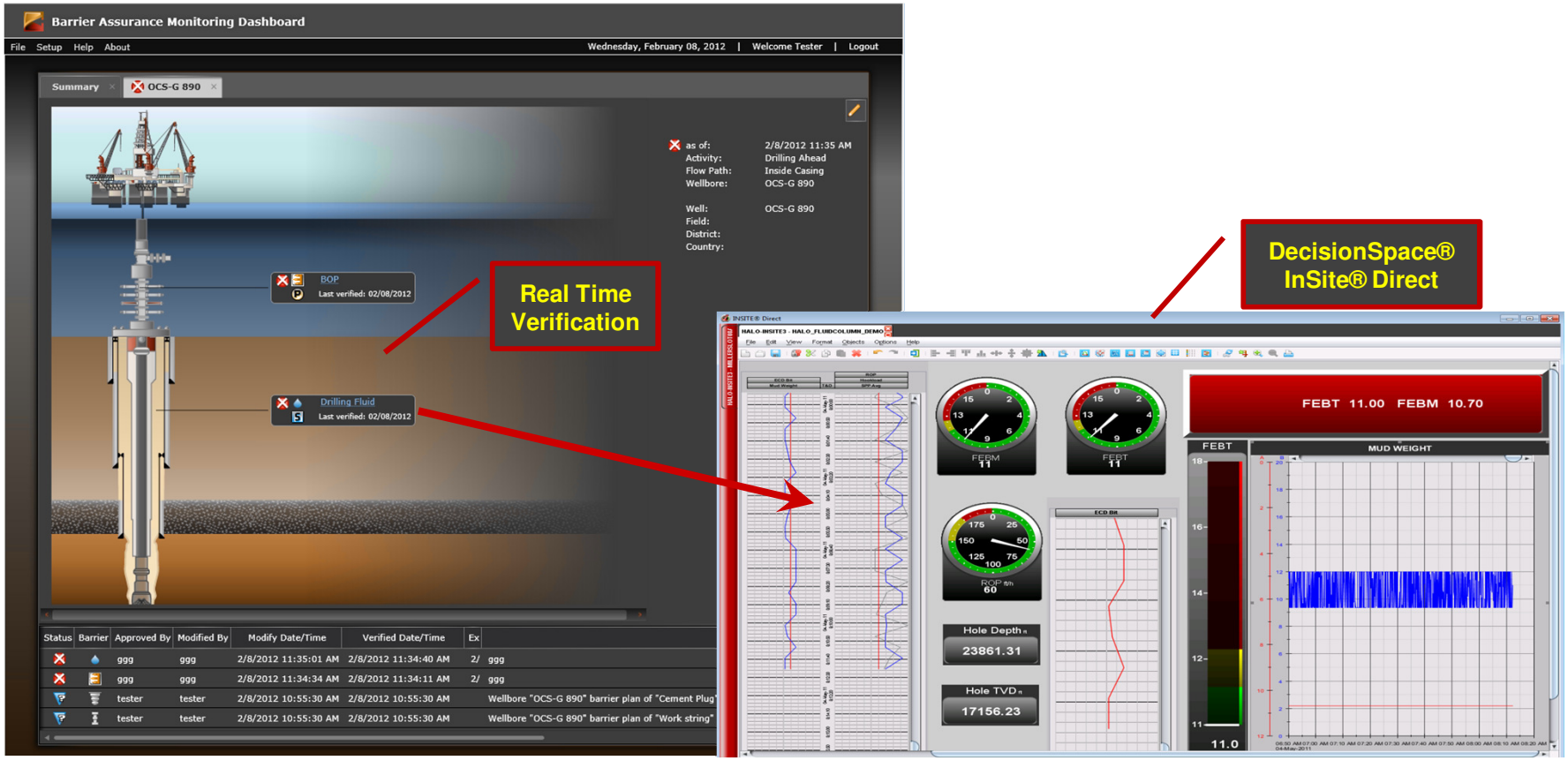
Real Time Integrity Inspection



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Identify Real Time Asset Inspection

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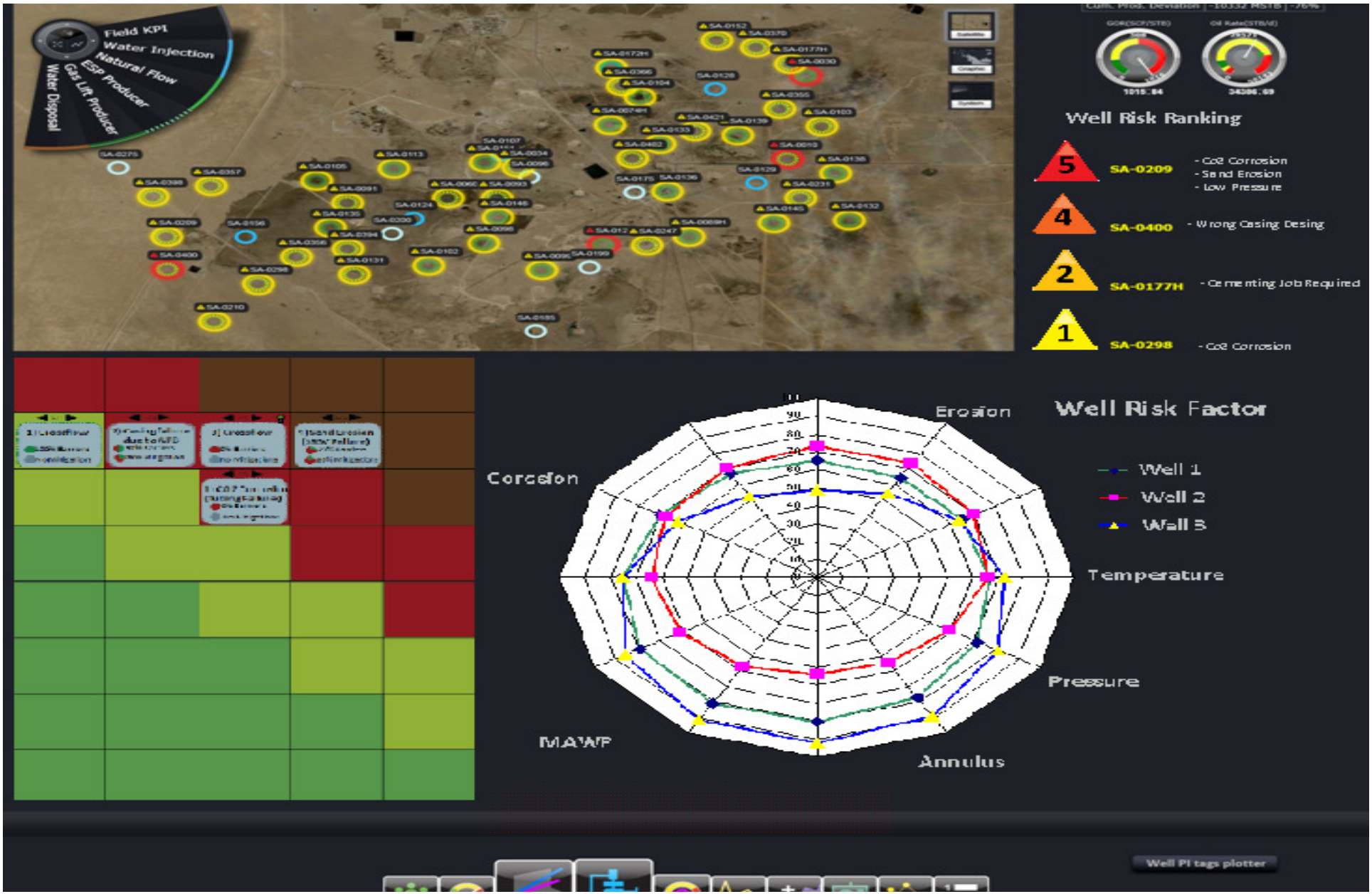
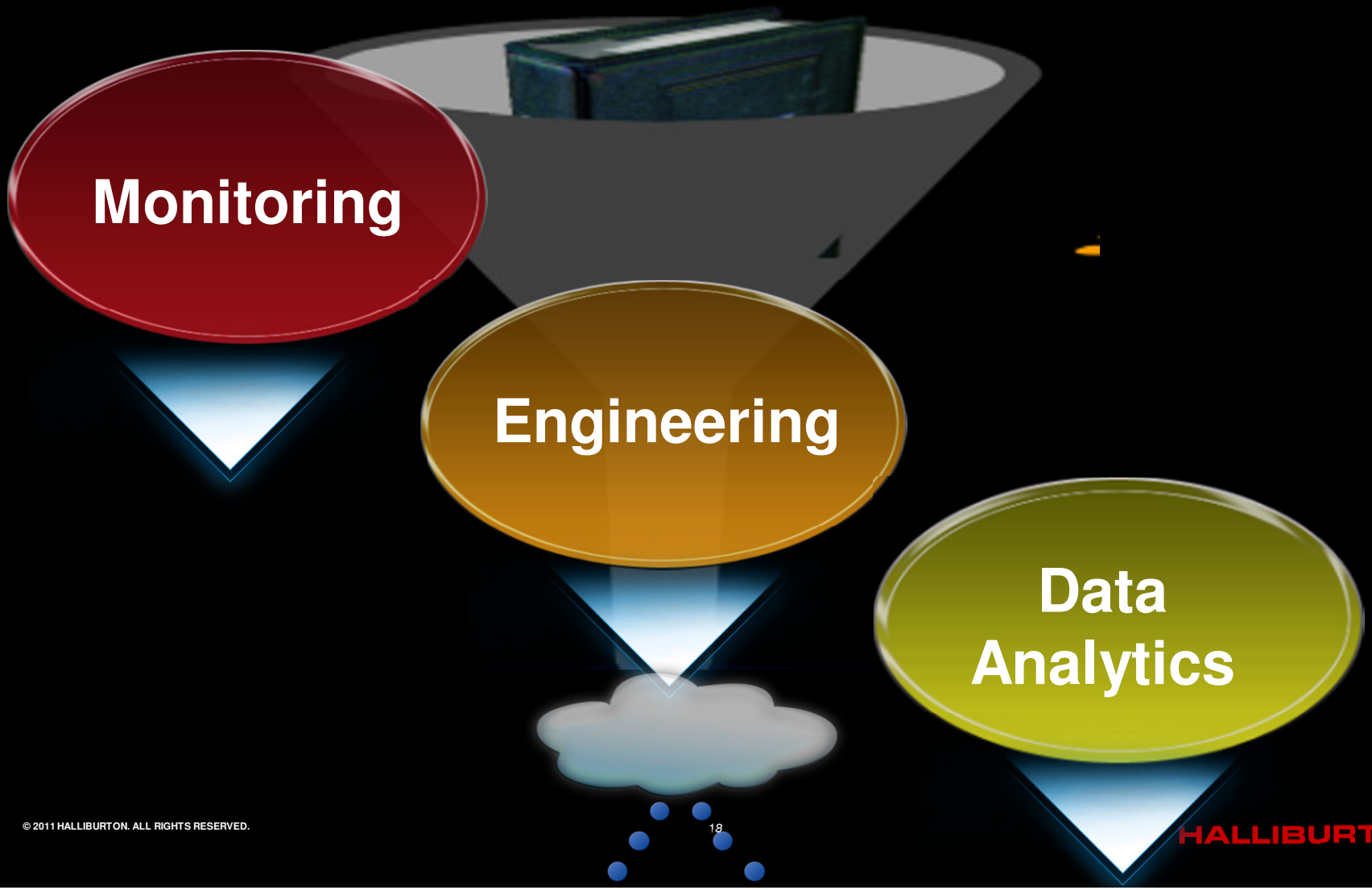
Risk Analysis



Quantum Data



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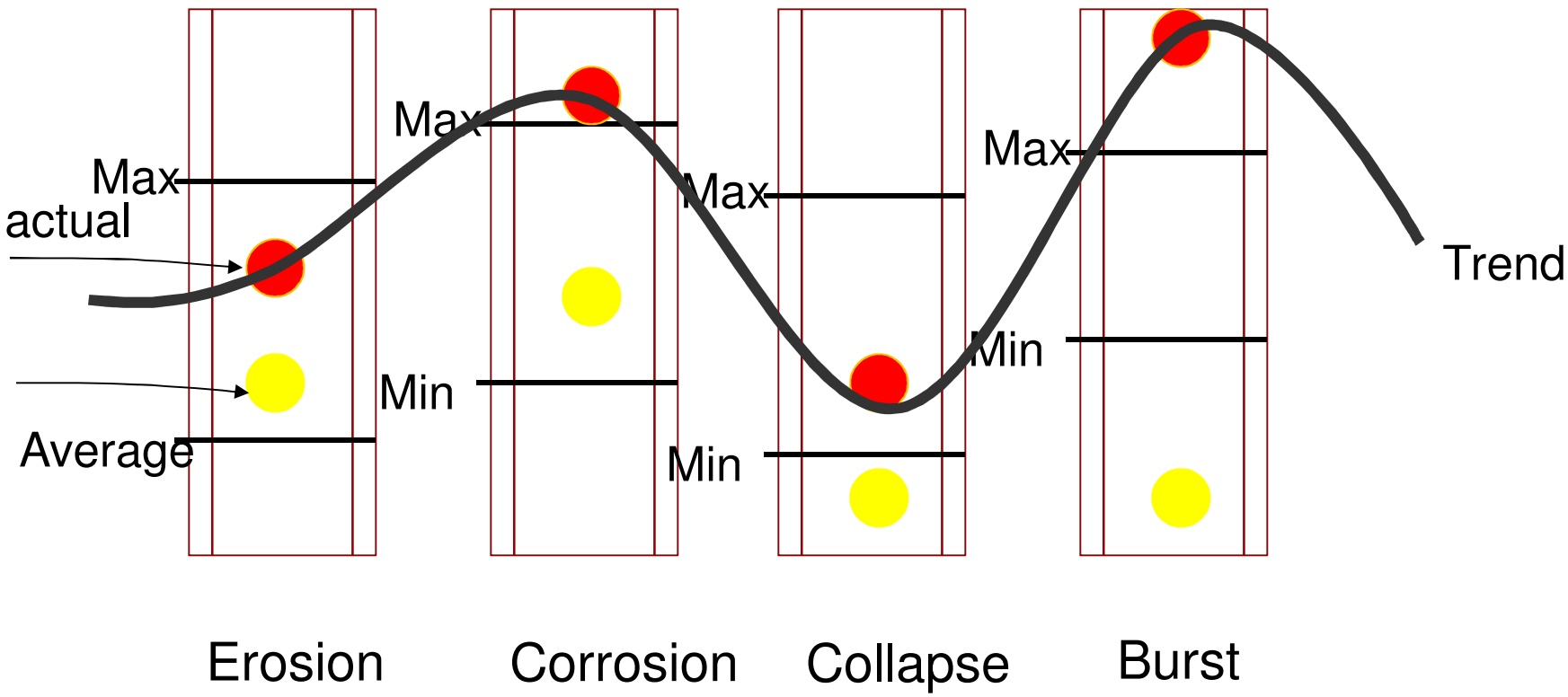
Inspection Dash Board



Source: SPE 164230

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Comprehensive WIM System

Inspection needs

How can we use the "quantum data"?

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Inspection needs

How are we going to use the "quantum data"?

$$\lambda = \sum_{i=1}^{n} \left[\lambda_{ref} \cdot \prod_{j=1}^{m} \pi_j \right]_i$$

$$R_{well} = \psi \prod_{k=1}^{b} R_k$$

Well Integrity Summarization =

Data Informed + Engineering Guided

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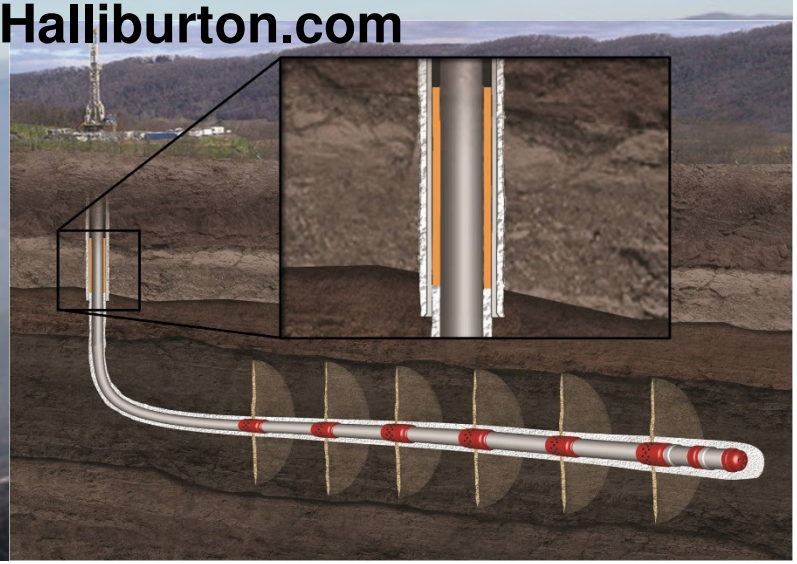
Winning Work In The Exploration Race

Dr.Robello Samuel

Halliburton Fellow

Robello.Samuel@Halliburton.com