Lloyd's Register

Lloyd's Register Energy - Drilling

Risk and Reliability Response to BOP operations

Blow Out Preventer Pull or No-pull decision support

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Innovation comes after denial and before success

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- The BOP risk model background
  - why was it made and for what purpose?
- The project
  - how was it done and by whom?
- The solution
  - what is the result and how is it used?
- The conclusion
- The Future
  - continuous innovation: the way forward in progress

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The tragic accident in April 2010 in the Gulf of Mexico can be marked as the moment that confirmed the idea for making a subsea BOP (Blow Out Preventer) risk model.

It showed that society, enabled by (social-)media, is our biggest stakeholder with its own risk acceptance perception.

Society ….is all of us,
and our biggest stake is the safety of life and environment for ourselves and our dear-ones.

ISO –IEC guide 51:
Safety is the freedom of unacceptable risk

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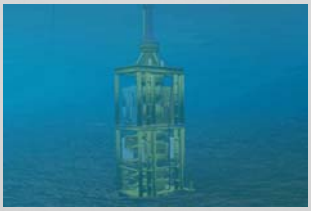
Societal risk awareness and its (non-) acceptance created an even stronger need to manage these risks and became the foundation for the demand for a solution to enable this.

- *The industry was faced with a very conservative approach to BOP component failure.*
- *This conservatism was fed by the fear that something could go as wrong as we all saw happening but was also very costly.*

A focal point of attention and contribution to what happened in April 2010 became the subsea BOP.



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This lead to the definition of the following objective:

"enable assistance in decision making if a BOP needs to be pulled or not with a risk based consistent component failure investigation and effect modelling and due communication"

A subsea BOP is a special system and among few systems combining multiple functions:

- (drilling) **operations** control
- risk **prevention** tool (preventer)
- **emergency response** tool

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A subsea BOP is also
- highly regulated
- not visible or well accessible when operational

These combinations mean simple component failures can cause severe risk exposure and non-compliance.

But what to do when a component may have or has failed?

Objective assessment and consistent communication about the risk of a failed BOP component to decide to continue or suspend operations has proven to be challenging.

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Nowadays drilling operations are always balancing between conflicting factors:
NPT (Costs) – Risk (Safety) - Compliance

The challenge we faced required a collaborative and innovative approach.

- high (society and industry) stakes
- a joined effort with five involved parties
- no route-map but the main objectives
- an industry looking at us

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What made it succeed?

I worked with people that were involved in the extreme circumstances after the accident and who lost colleagues

That made me very humble and realizing we just could not fail: there was too much at stake: safety and lives.

I worked with a wonderful team and this team effort, including our client, was the one of the most contributing factors for our success.

I am proud on what we did,
how we did it and what we achieved.

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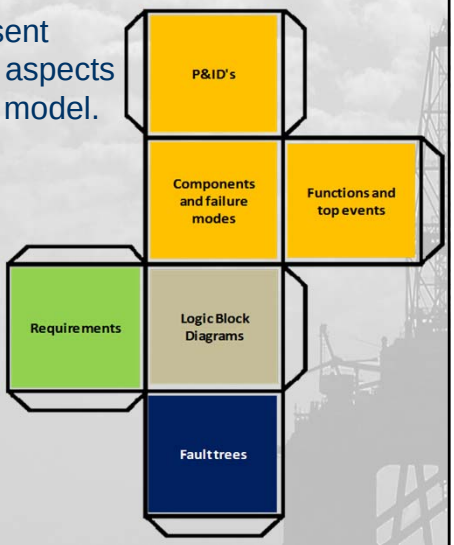
The total risk model is like a three dimensional cube with six sides that input and affect the outcome and each other.

The cube's three dimensions represent the complexity and interaction of all aspects of a complete BOP system and risk model.



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How is all this information combined to become a Risk Model?

Requirements that decide on the risk (consequence-) level calculated by the Fault trees.
Minimum capabilities;
for BOP Model CFR, API etc.

TOP
TOP
TOP
TOP

Functional Block Diagrams: Block diagram A

A3
ups-253.c
A1
A4
Fault tree A

FMEA

	Failure mode	effect
AA		
AB		
1.0 / ups-253.c	failure mode	
D		

Fault tree and model outcome

Fault tree A

TOP
TOP
TOP
TOP

A2:
1.0 / ups-253.c failure mode #
A1
A4
A3

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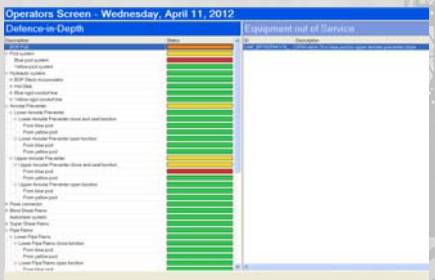
A BOP risk model assesses the effect of component failure taking regulations, specifications and operational procedures into account.
Component failure effects are pre-populated during risk model production based on as-build P&ID's

Risk levels of the whole BOP, a subsystem or component are expressed in a color-coding traffic-light alike.

- Red
- Orange
- Yellow
- Green



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BOP risk model solution:

- Risk-based approach in balancing the conflicting factors
- Consistent, transparent pull or no pull decision assistance and motivated decision reporting all stakeholders
- Better prioritization of maintenance
- Industry credit: done with a major drilling contractor
- Regulator agreement on methodology (BSEE)
- Does not take away or replace thinking, competence or responsibility
- Enables training and can make what-ifs: play with different failure scenarios

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Preventing one unnecessary BOP pull proves the value of BOP risk modelling.
Saving one life with a BOP risk model makes it invaluable

Being able to asses the risk of component failure is one thing…..

what about **preventing** from failing and failure effects?

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After the first “BOP risk models” were used it soon became apparent that the Drilling industry became keen to apply methods to be ahead of the risk of BOP component failure: balance NPT / Cost-Safety

From risk identification to risk mitigation:
adding to successful operational performance

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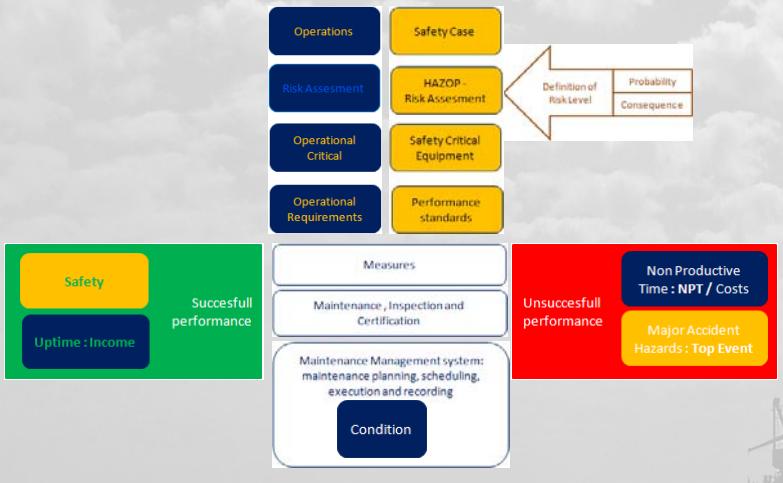

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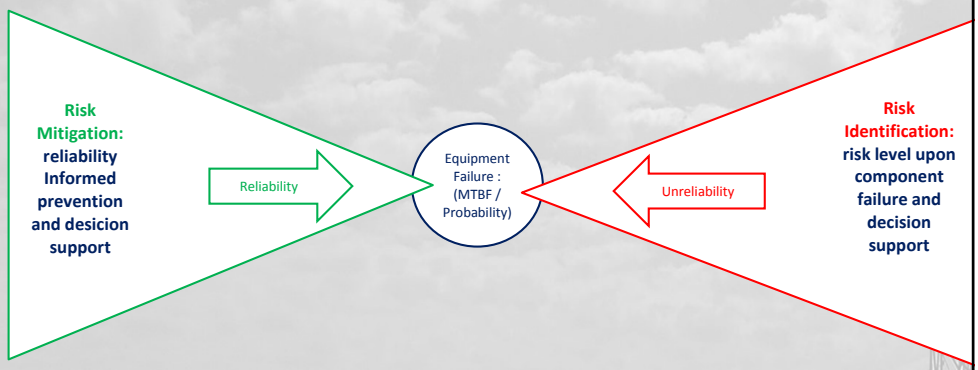

Our practical approach to these needs and future requirements.

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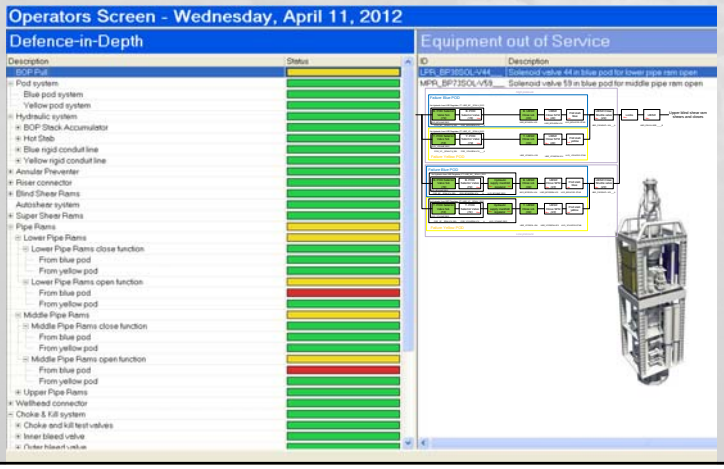
A phased approach for continuous innovation:

Phase 1
The BOP risk model.



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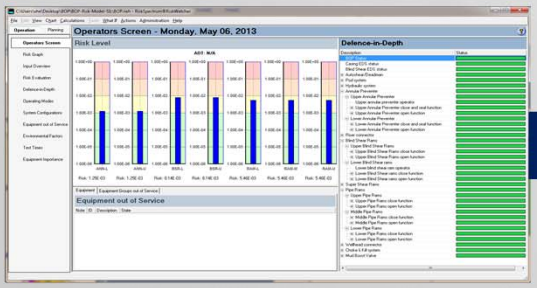
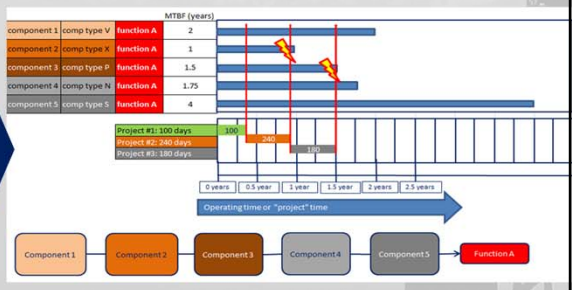
Phase 2:

Application of reliability informed :

- Failure prevention programs and decision support.
- System reliability for optimized operations performance.
- Functional Safety i.e. SIL.
- Cost – Reliability balanced IBWM.





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Phase 3:

Component condition (real time) monitoring i.e. with use of fibre optic sensors to identify early degradation adding to failure prevention and failure prevention program verification

Thank you for your attention.

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