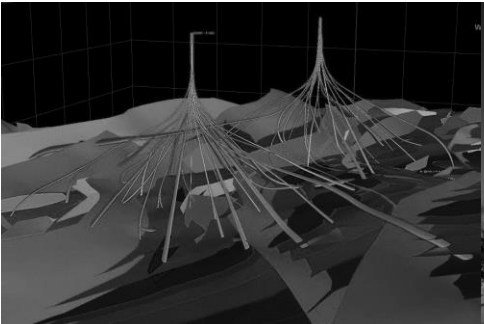
Blowout Risk Assessment Services

Sensitivity Analysis on Jack-up with high pressure Marine Riser

18/10/2024




Drilling Scenarios considered

Blowout Probability of a typical jack-up dry BOP well with high pressure riser

- The phases considered in the analysis are:
- Drill 16" Phase:
    - Drill formation – Annulus and Drill pipe
    - Tripping scenario – Annulus and Drill pipe
- RIH & Cement 13 3/8" Casing:
    - Running Casing - Annulus and Casing
    - Cementing Casing - Annulus and Casing
- Drill 12 1/4" Phase:
    - Drill formation – Annulus and Drill pipe
    - Tripping scenario – Annulus and Drill pipe
- RIH & Cement 10x10 3/4" Casing:
    - Running Casing - Annulus and Casing
    - Cementing Casing - Annulus and Casing

Assumptions

Blowout Probability of a typical jack-up dry BOP well with high pressure riser

- High Pressure Marine Riser Effect:
  - Under any scenario, the failure of the riser leads to the loss of well primary and secondary barriers
  - Based on DNVGL-ST-F201, the time between inspections for the riser is equal to 5 years. This is used as operations time for the calculation of the probability of failure on demand.
  - A well head connector is considered between the K-BOS and the well and between the K-BOS and the Riser

- Riser Reliability $R(t)$:
  - Four scenarios of failure rate (λ) are presented:
    - $5{,}8 \times 10^{-7}$ failure/hr from Oreda Database
    - $2{,}05 \times 10^{-5}$ failures/day from MMS
    - $1{,}55 \times 10^{-5}$ failures/day from Parloc
    - $8{,}09 \times 10^{-4}$ failures/ (km x year) from IOGP – 100 meters are considered for this scenario

- Not included in the analysis: Analysis of Common Cause Failures (CCF)

- The probability of failure on demand of the riser is estimated as:

$$PFD = 1 - R(t) = 1 - e^{-\lambda \, x \, Operation\ time}$$

Assumptions

IOGP Database

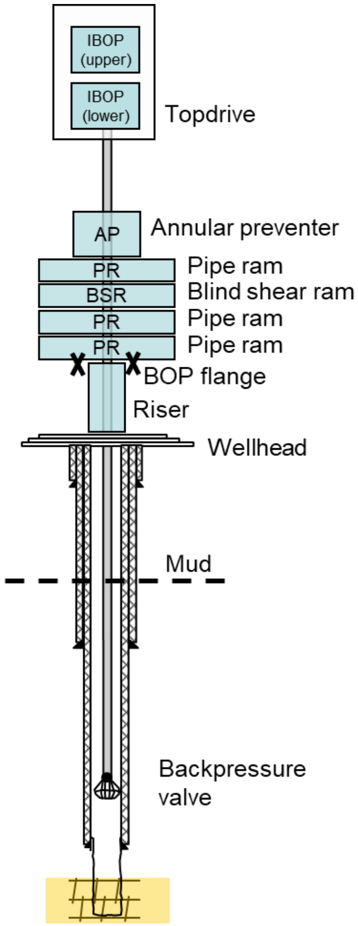
Table 2-4: Example of Breakdown of Failure Frequencies for Steel Risers and Steel Pipelines

Release Source	Hole Size Range (Size to conservatively use in QRA)					Total
	<=1.5 mm (not considered in QRA)	**1.5 – 7 mm (5 mm)**	**7 -30 mm (15 mm)**	**>=30 mm (excl. rupture) (50 mm)**	**Rupture (Full Bore)**	
Riser – Above Sea (per year)	9.63×10^{-5}	4.33×10^{-4}	1.44×10^{-4}	9.63×10^{-5}	8.00×10^{-5}	8.50×10^{-4}
Riser – Below Sea (per year)	9.16×10^{-5}	4.12×10^{-4}	1.37×10^{-4}	9.16×10^{-5}	7.61×10^{-5}	8.09×10^{-4}
Safety Zone – Near (up to 100m) (per year)	8.59×10^{-5}	3.87×10^{-4}	1.29×10^{-4}	8.59×10^{-5}	7.14×10^{-5}	7.59×10^{-4}
Safety Zone – Far (100 m – 500 m) (per year)	5.57×10^{-5}	2.51×10^{-4}	8.35×10^{-5}	5.57×10^{-5}	4.63×10^{-5}	4.92×10^{-4}
Midline (per km year)	2.85×10^{-5}	1.28×10^{-4}	4.27×10^{-5}	2.85×10^{-5}	2.37×10^{-5}	2.51×10^{-4}

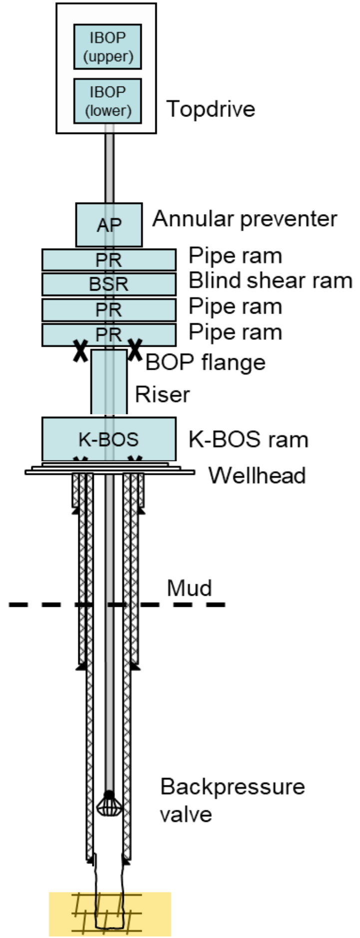
K-BOS applications

Class V BOP considering also Riser failure

- **Base Case**: 18-3/4 15K Subsea BOP Stack, Class V (1AP, BSR, 3PRs) with Primary intervention systems,
- **K-BOS “E-SID”**: K-BOS ram added below the Riser as an additional barrier, totally independent from Surface BOP control system ROV intervention system and Acoustic system.



Base Case
18-3/4 15K Surface BOP Stack - Class V



Base Case
+ K-BOS «E-SID»

K-BOS applications

Calculation bases

- The calculation of the Major Spill Volume probability can be defined as:
  - **Major Spill Probability considering Riser:**

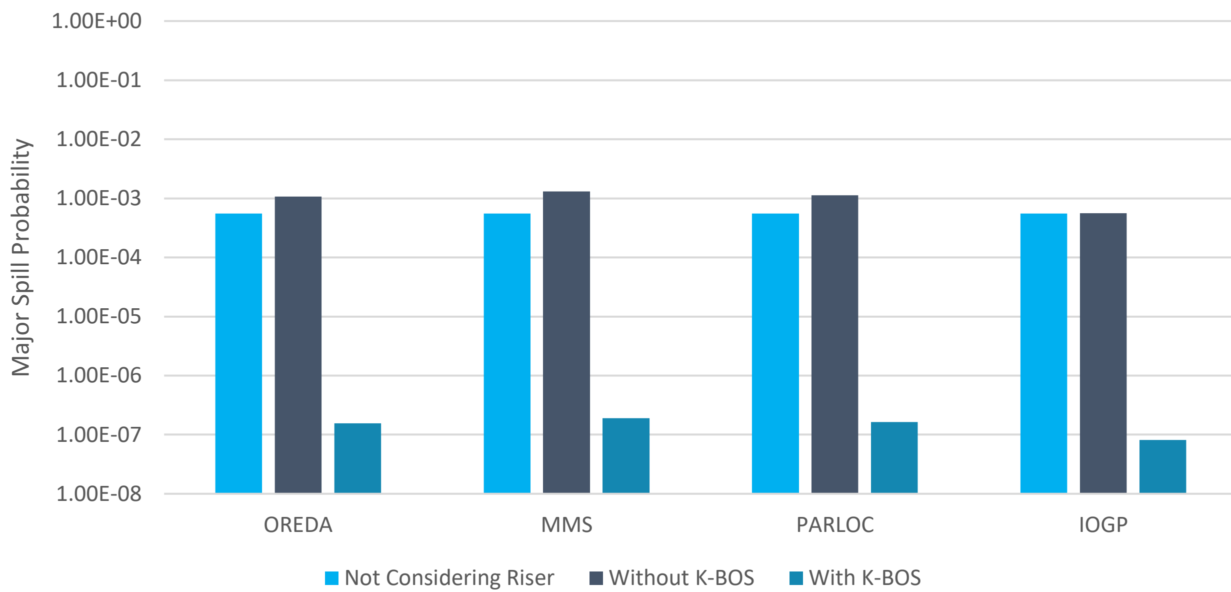
$$\sum_{i}^{number\ of\ operations} (Loss\ of\ well\ barriers_i + PFD\ Riser_i)$$

  - **Major Spill Probability considering Riser + K-BOS:**

$$\sum_{i}^{number\ of\ operations} Failure\ of\ KBOS\ *\ (Loss\ of\ well\ barriers_i + PFD\ Riser_i)$$

Results – Base case

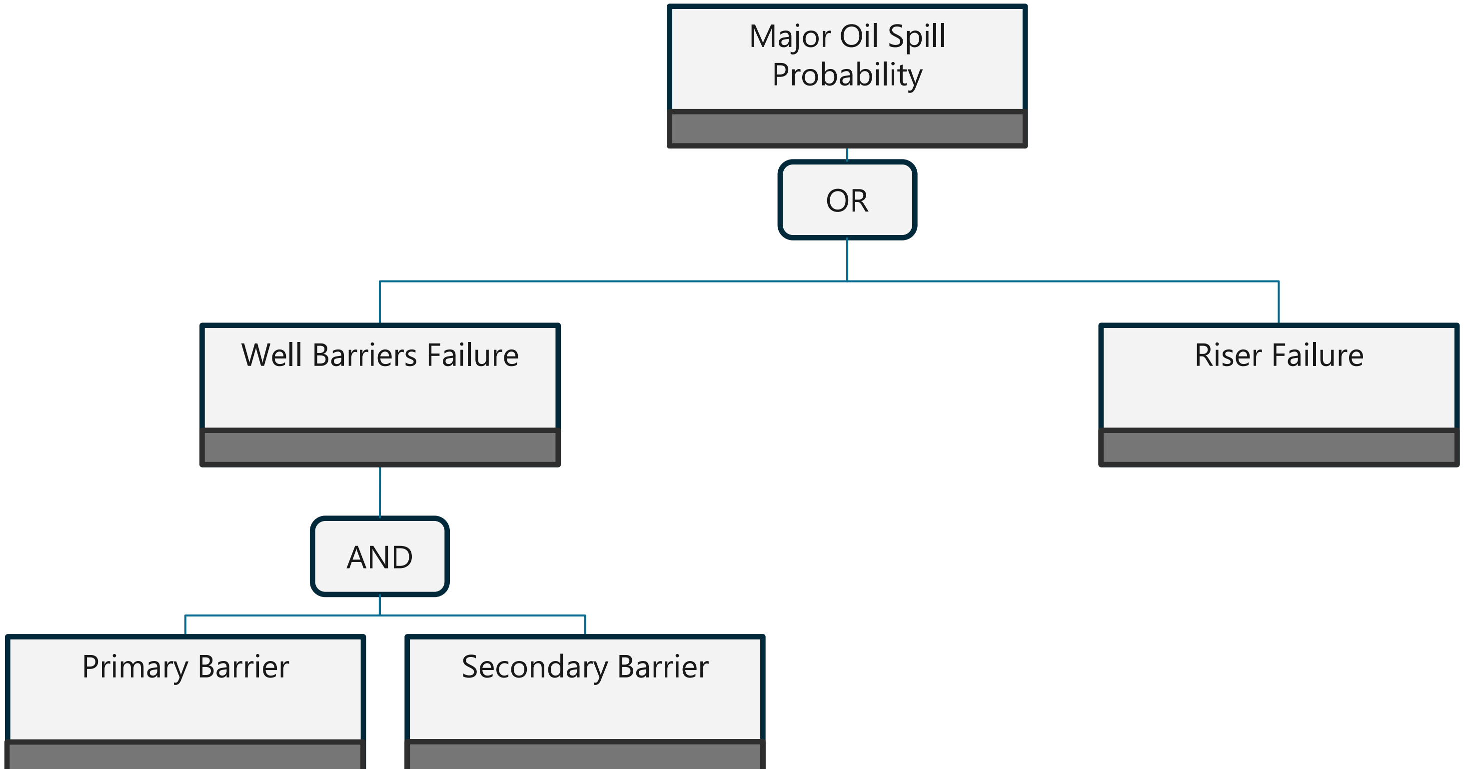
Blowout scenarios with primary and secondary barriers considered in the risk analysis



- **Including K-BOS reduces between 3 and 4 orders of magnitude the probability of major oil spill**

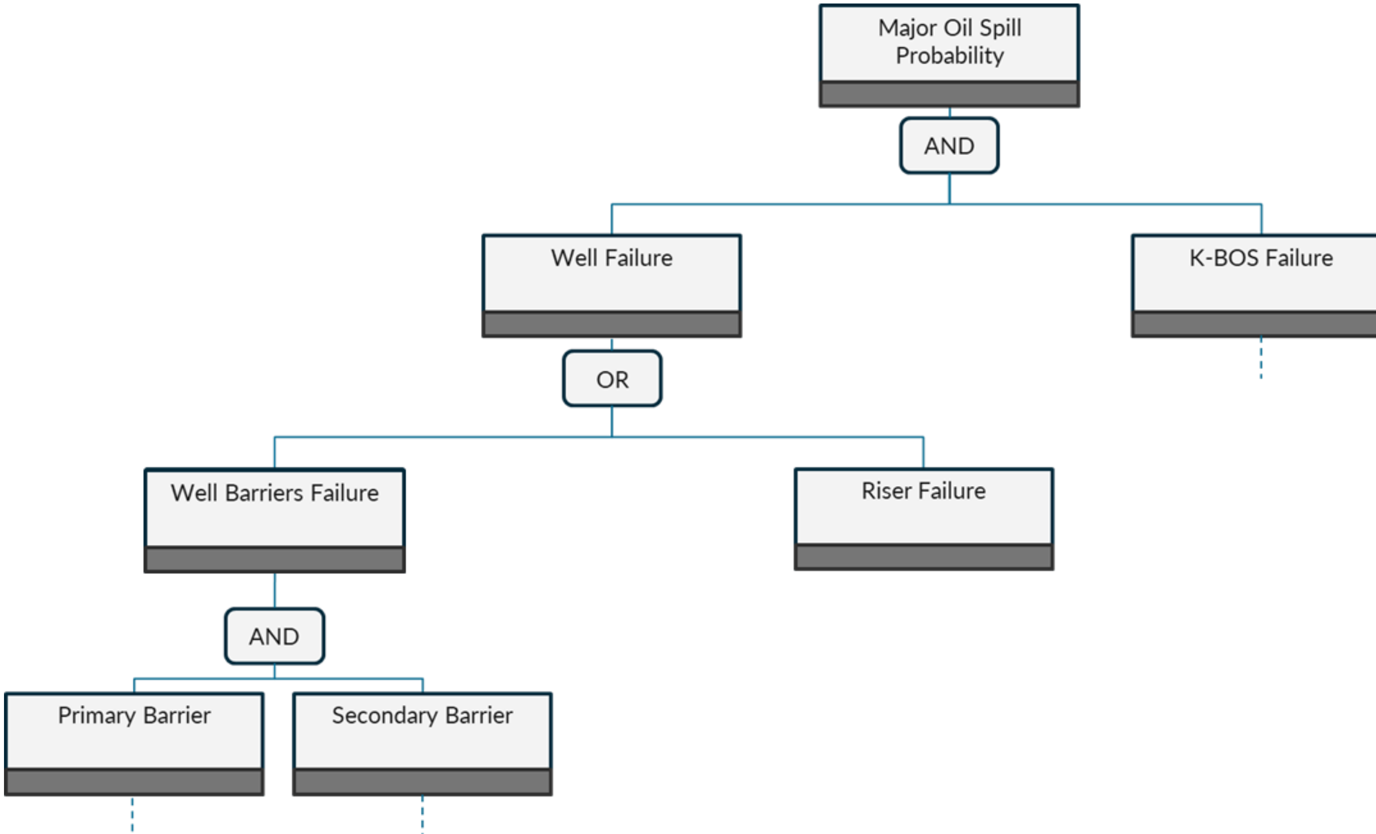
FTA – Base case

FTA for Scenario calculation without K-BOS



FTA – considering K-BOS E-SID

FTA for Scenario calculation with K-BOS



Thank you

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