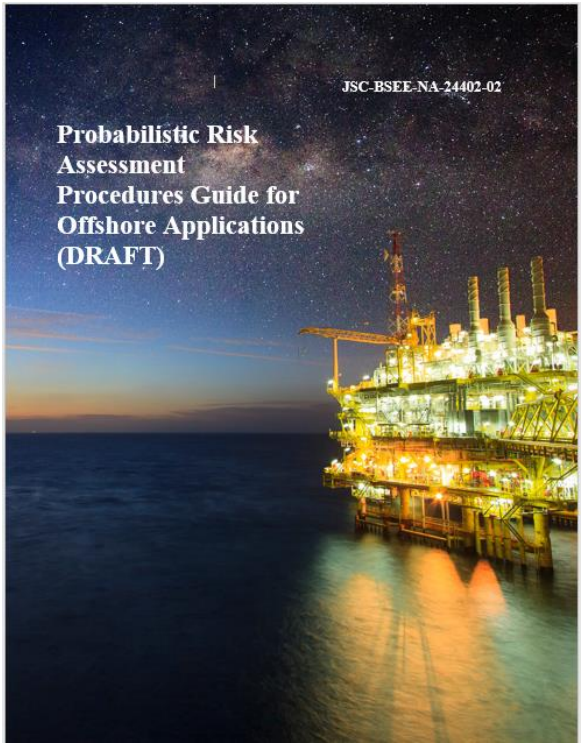
NASA – BSEE
PRA Procedures Guide for Offshore Applications



March 1, 2018

Bob Cross
PRA Lead for BSEE Tasks
NASA Johnson Space Center

BSEE PRA Guide

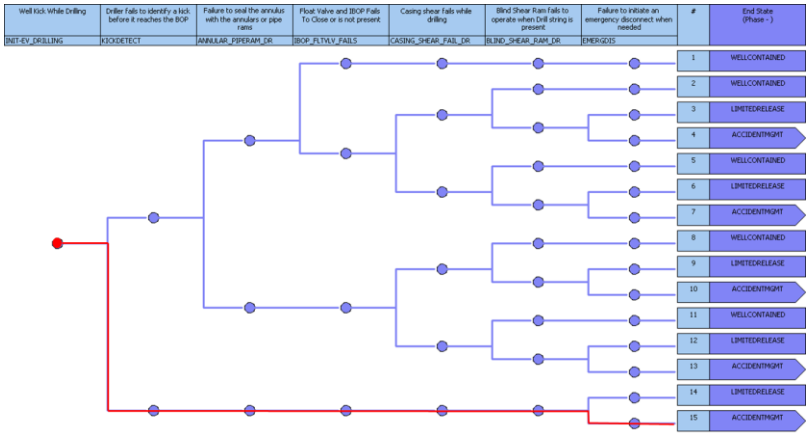
- **Purpose**
  - This Guide is intended to assist in the development of Probabilistic Risk Assessment (PRA) of offshore drilling facilities, in order to support risk-informed decision-making by Bureau of Safety and Environmental Enforcement (BSEE) and by the industry.
- **Scope**
  - This Guide is not a policy document, nor does it establish regulatory requirements. It discusses particular modeling techniques that have been found to be useful in a range of applications for decision-making about complex and high-hazard facilities.
  - It is derived from a combination of the NASA PRA Procedures Guides and is being developed with help from Idaho National Lab (INL).

BSEE PRA Guide

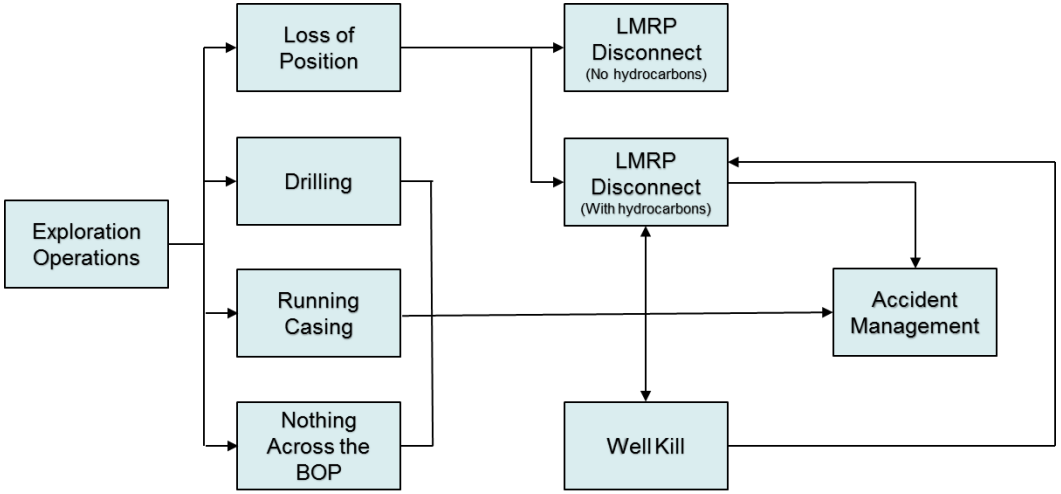
- Section 1 – Introduction
- Section 2 – Risk Analysis Techniques
- Section 3 – Data Development / Quantification
- Section 4 - Results Presentation and Interpretation
- Appendices

BSEE PRA Guide
Section 2, Risk Analysis Techniques

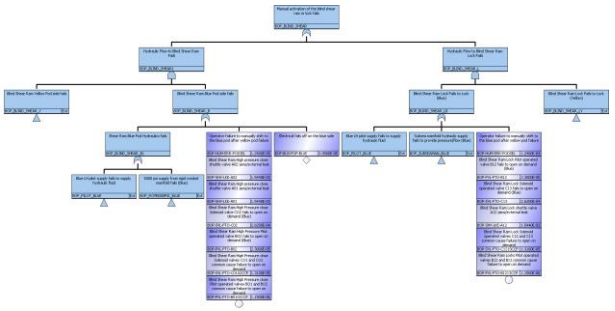
- **How to build a logic model**
  - Fault trees, event trees, simulation
  - Uses a running example for illustration



Event Tree



Running Example



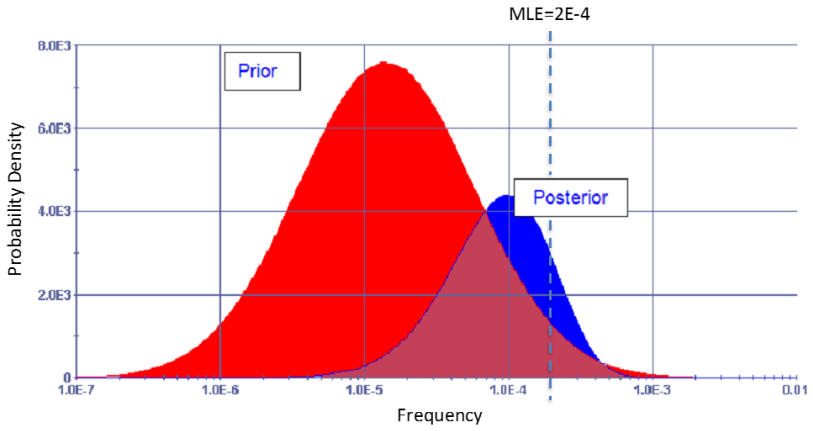
Fault Tree

BSEE PRA Guide
Section 3, Data Development/Quantification

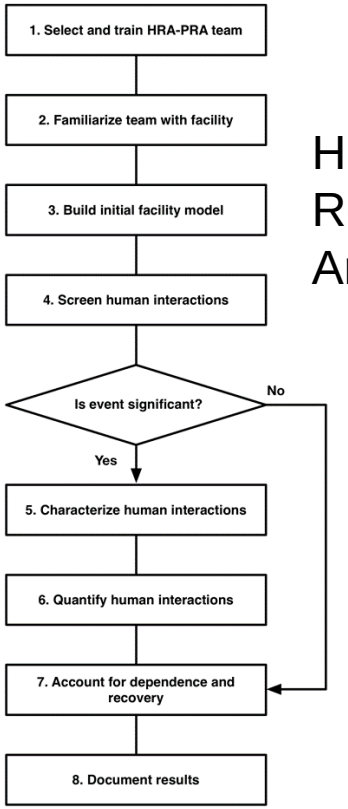
- **How to develop data**
  - Component failure, common cause, human error
  - Using facility specific data – Bayesian updating

Component in operation fails to run, or component changes state during mission (state of component continuously monitored)	Constant failure rate $U = 1 - e^{-\lambda_0 T_m} \approx \lambda_0 T_m$ T_m: Mission time λ_0 : Operating failure rate Approximation is adequate when $\lambda_0 T_m \ll 1$	Number of events k in total exposure time T (total time standby component is operating, or time the component is on line)

Component Failure Rates



Bayesian Updating



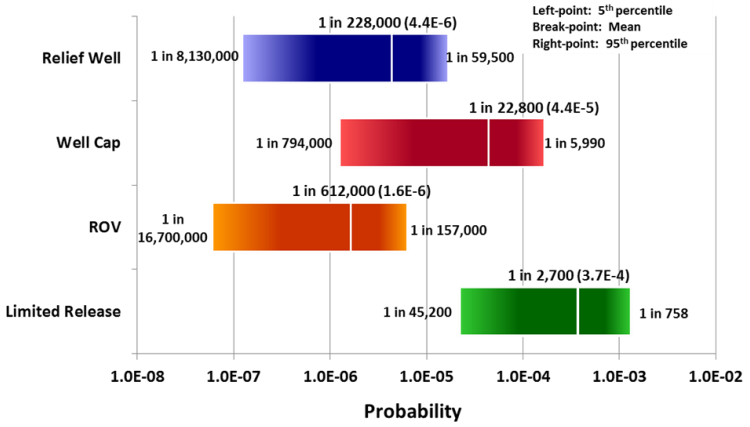
Human Reliability Analysis

BSEE PRA Guide
Section 4, Results Presentation and Interpretation

- **How to quantify the model, including uncertainty, reviewing results**

#	Prob/Freq	Total %	Cut Set	Description
Total	4.18E-04	100	Displaying 5 Cut Sets. (10551 Original)	
1	3.70E-04	88.6		
	1.00E+00		INIT-EV_DRILLING	Well Kick While Drilling
	3.70E-04		BOP-HUM-ERR-KICKDET	Operator fails to realize a kick has occurred or does not take timely action
		End State	LIMITEDRELEASE	
2	3.70E-05	8.86		
	1.00E+00		INIT-EV_DRILLING	Well Kick While Drilling
	1.00E-01		BOP-CYL-JAM-BSRDP	BSRs fail to close and seal when drill string is in the hole
	3.70E-04		BOP-HUM-ERR-KICKDET	Operator fails to realize a kick has occurred or does not take timely action
		End State	CAPPINGSTACKCONTAIN	
3	5.92E-06	1.42		
	1.00E+00		INIT-EV_DRILLING	Well Kick While Drilling
	1.60E-01		BOP-HUM-ERR-HANGOFF	Driller fails to position drill pipe properly before activating BSR
	3.70E-04		BOP-HUM-ERR-KICKDET	Operator fails to realize a kick has occurred or does not take timely action
	1.00E-01		DP_TOOLJOINT_PRESENT	Drill Pipe Tool Joint is Present
		End State	CAPPINGSTACKCONTAIN	

Cut sets



Uncertainty

PRA Guide Status

- Second draft is on the BSEE website (and link for this meeting)
- Third draft planned for late 2018, updated, new examples
- The PRA “white paper” (also on the BSEE website and link for this meeting) is a high level overview of PRA