DNV GL Joint Industry Project: Decision Support for Dynamic Barrier Management

IADC/DEC Tech Forum "Data Acquisition & Cybersecurity"

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DNV GL Joint Industry Project: Decision Support for Dynamic Barrier Management

Challenge

- Knowing the continuous status of barriers and confidence that they will function when needed
- Lack of common risk language for communication
- Lack of practical decision support tools for operations

Benefits

- Continuous knowledge of barrier health status
- Real time decision support and risk management
- Common language for communication and consensus among engineering, operations, maintenance, and management

Delivery

- The JIP participants will develop and test:
  - Methods, best practices, data sources, and tools
  - Standardized bow tie diagrams, response trees, and decision protocols
  - Pilot-scale decision support systems

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Region:
United States

Background situation

- Continued occurrence and recurrence of major accidents across many industries
  - Three Mile Island
  - Columbia
  - Macondo
  - Fukushima
  - Pipeline spills
- Effective decision support is needed to continuously manage the barriers for preventing and mitigating accidents

Ungraded

Background for the DNV GL research on decision support for dynamic barrier management

Nuclear Power and Aerospace Concepts

- Critical safety functions and success paths
- Information requirements analysis
- Simulator testing of decision support
- Mission success framework

2011 Offshore Technology Conference

- Combine critical safety functions with barrier management
- Identify Post-Macondo human factors issues

2012 DNV Internal Research Project

- Decision support for well control and blowout prevention
- Development of industry partnerships

2013-2016 Projects with Industry Partners

- Erosion integrity management for offshore production installation
- Barrier management for well control

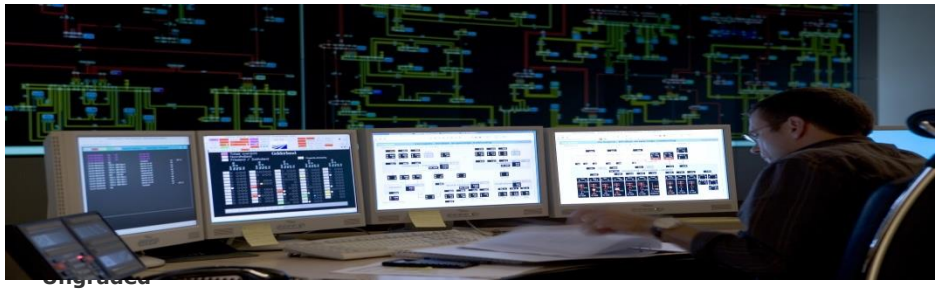
- The approach has also been applied in other projects for offshore operators, pipeline companies and a major nuclear utility.

Insights for managing risks of offshore operations

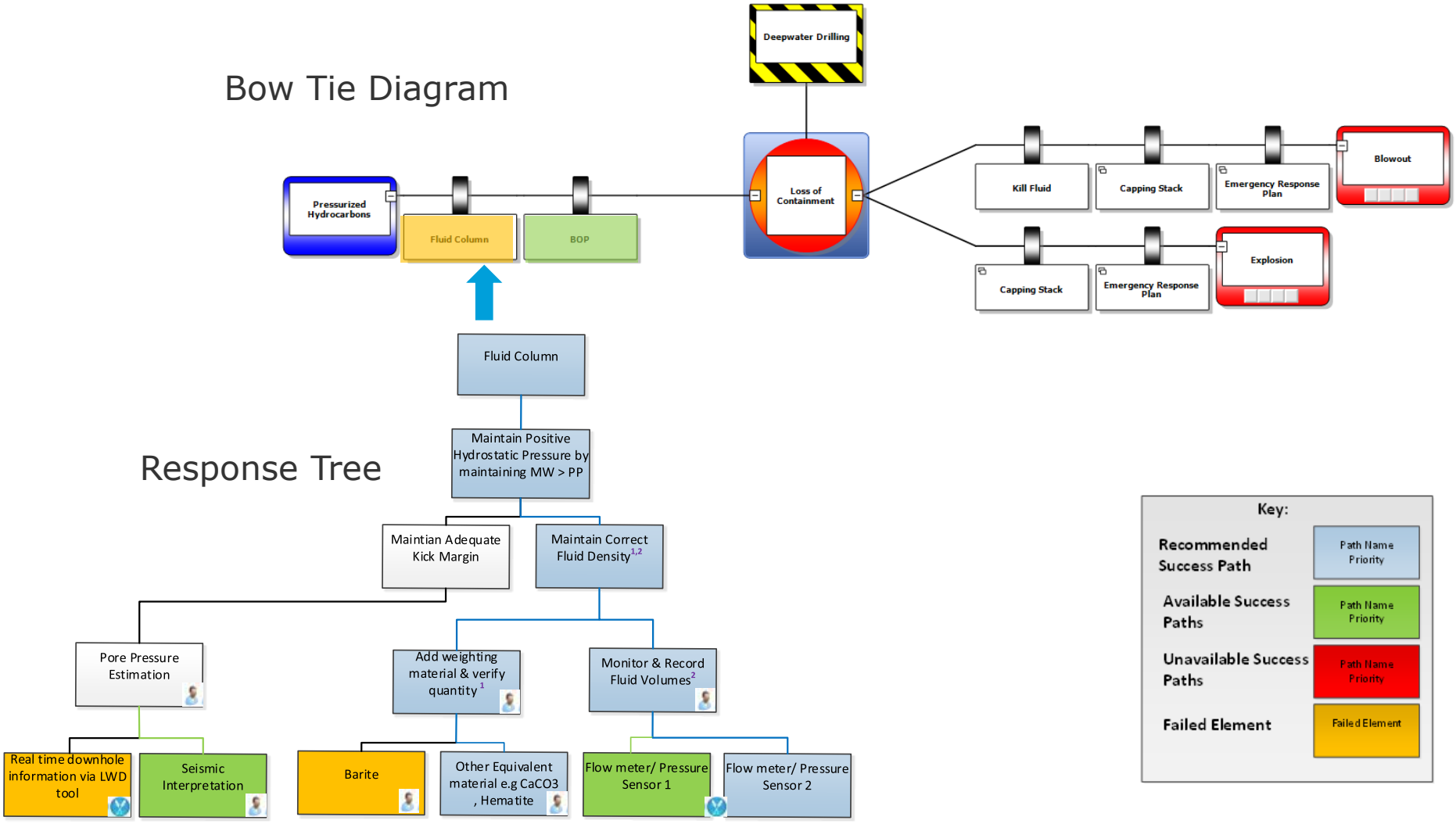
- Offshore operators need two types of information - (1) condition of barriers and success paths and (2) practical decision guidance - to effectively manage risk.
  - *Barrier: Physical or non-physical means to prevent the occurrence of an accident or mitigate its consequences*
  - *Success Path: Combination of equipment and processes (hardware, software, and human actions) necessary for the barrier to perform its intended function*
- An intuitive "common language" is needed to combine information for effective decision support
- **Proposed Solution - Combine barriers and success paths to:**
  - Systematically identify information and instrumentation requirements
  - Provide **decision guidance** to restore degraded barriers or implement alternate success paths
  - Develop an information architecture for communication, consensus, and action among:
    - Offshore operators
    - Industry groups
    - Regulatory bodies
    - External stakeholders

Some key questions are…

- Do you know the **current status** of your barriers and success paths?
- Are you able to **continuously monitor and assess** barrier and success path performance?
- Are you able manage your operational risks by providing **clear guidance** and **decision support** for restoring degraded or failed barriers?
- Are you aware of **multiple success paths** and **actions required** to restore barriers so as to continue operations?
- Do all involved parties have a **common understanding and language** for risk communication?



Bow tie diagrams and response trees form the foundation for decision support for dynamic barrier management



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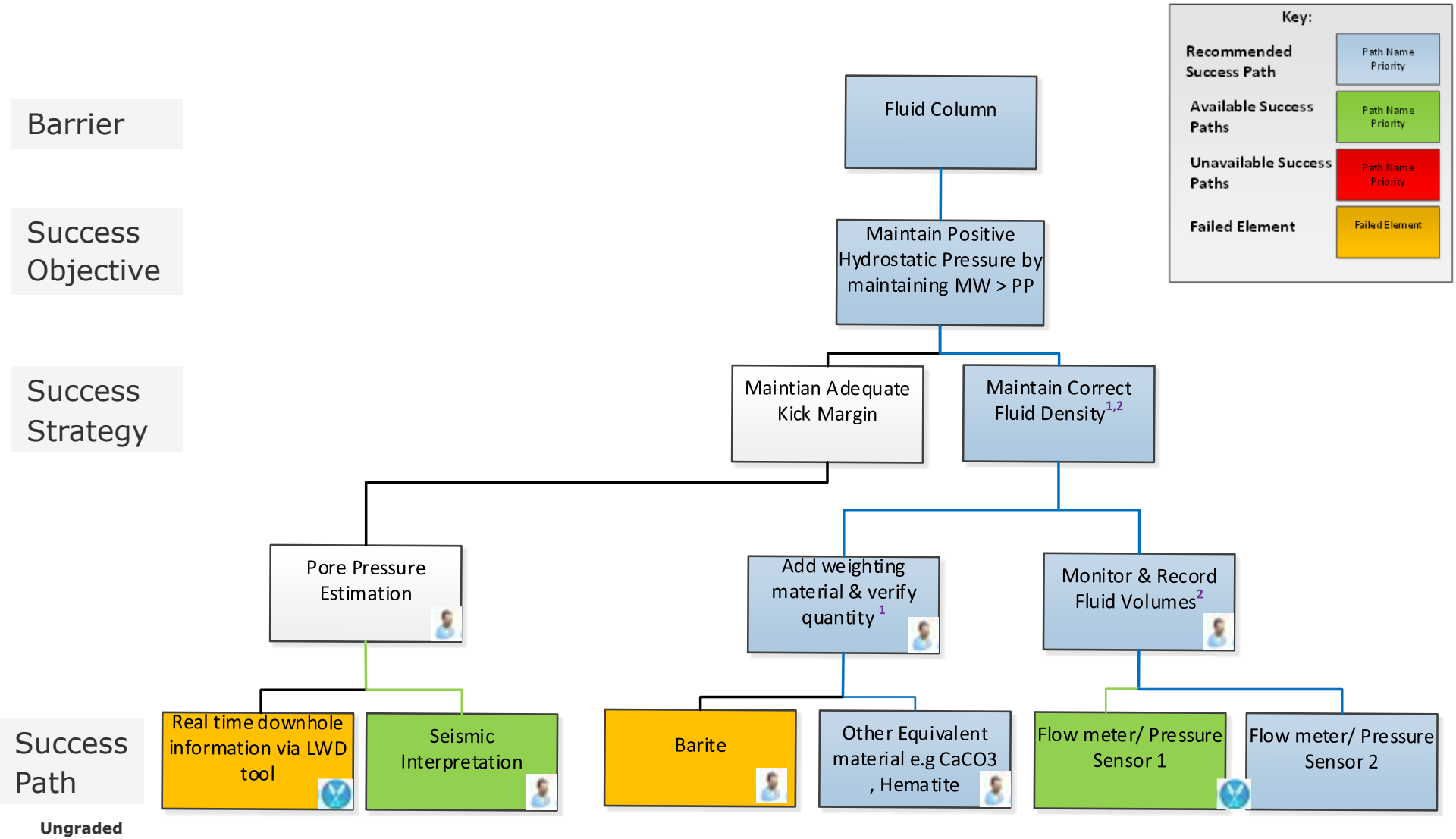
Simplified response tree for the fluid column barrier



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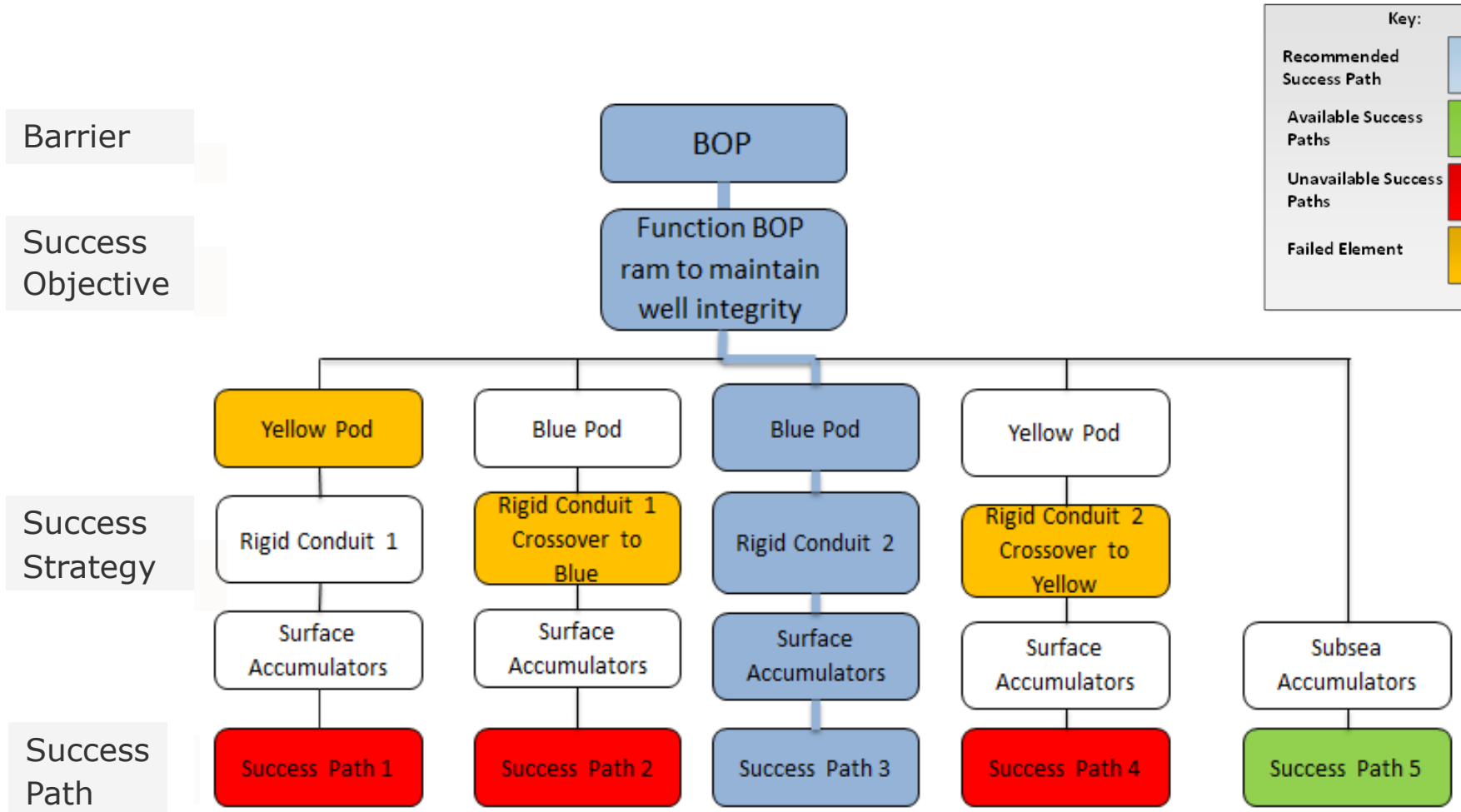
Simplified response tree for the BOP barrier



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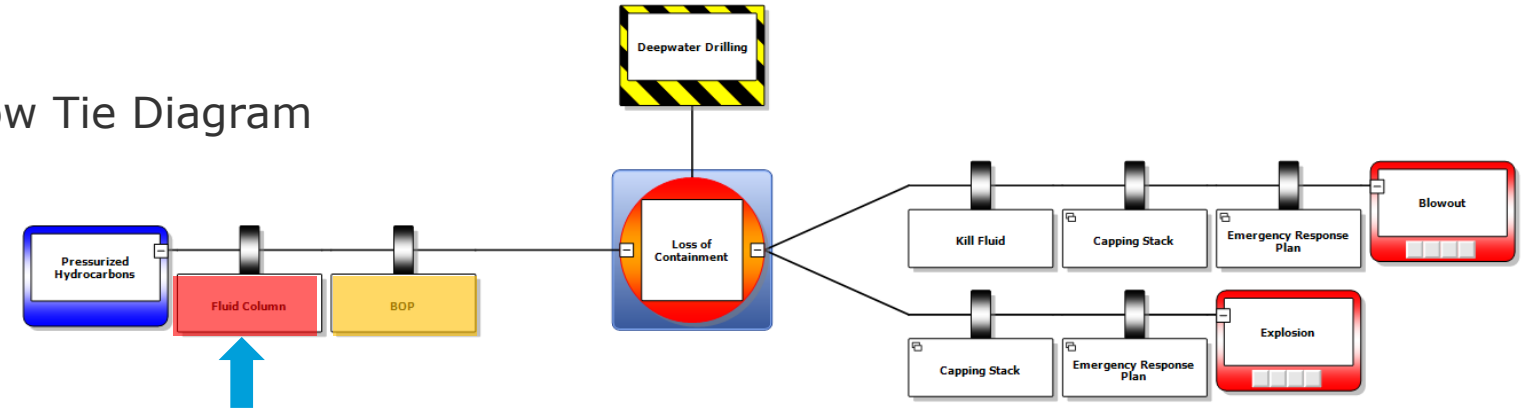
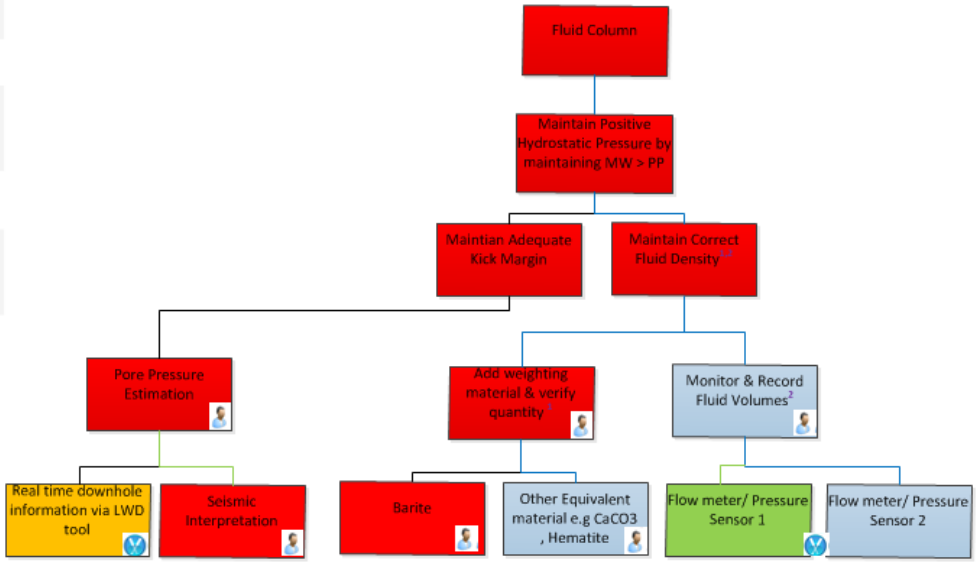
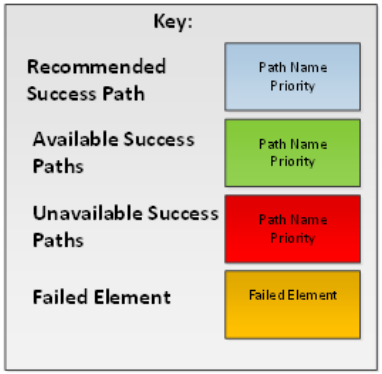
Application of dynamic barrier management: If the fluid column barrier is degraded or fails…

Bow Tie Diagram



Response Tree





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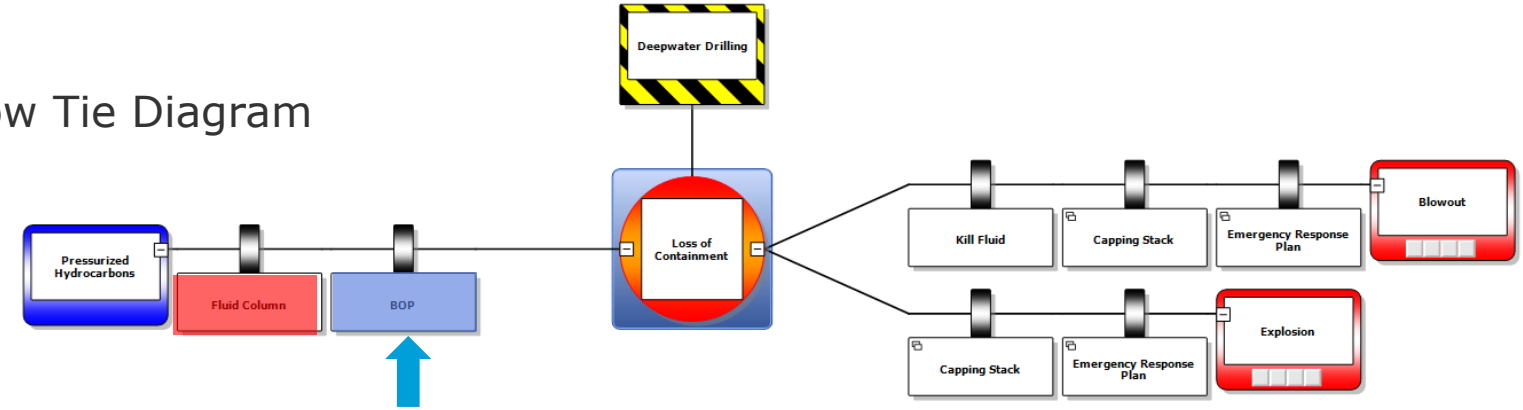
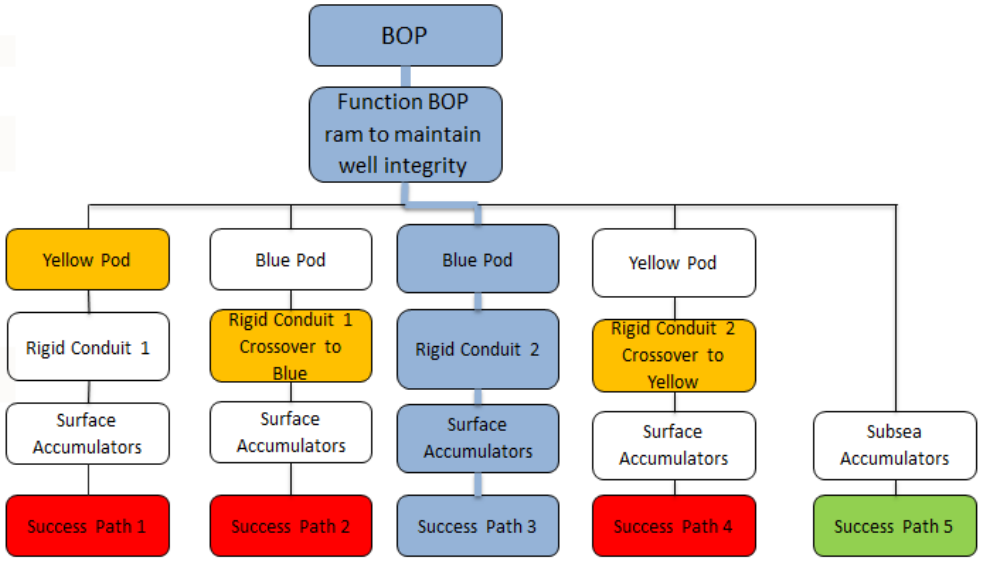
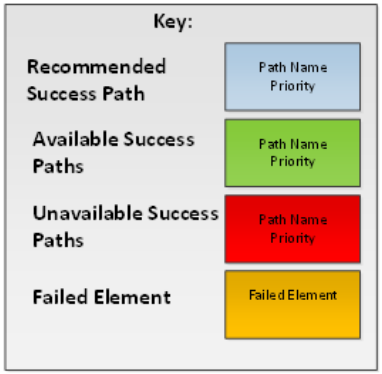
If the fluid column barrier is degraded or fails, then the BOP barrier is activated using an available success path

Bow Tie Diagram



Response Tree





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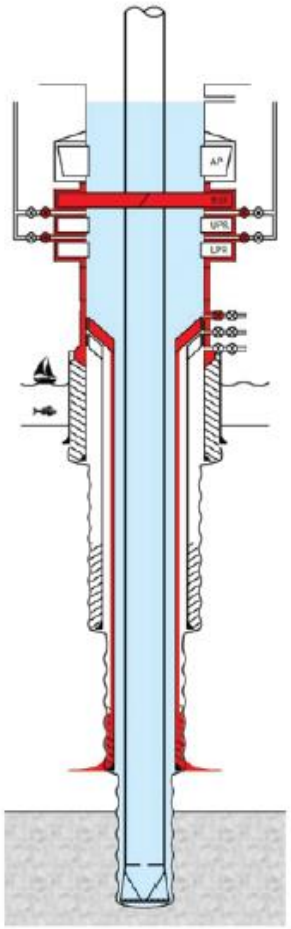
Framework for defining information needs and decision guidance for dynamic barrier management

Elements of the Bow Tie Diagram and Response Tree	Information Requirements	Source of Information	Decision Criteria (IF)	Response Guidance (THEN)
Consequence : Oil Spill	Occurrence of oil spill	Visual observation	Oil on surface confirmed	Implement Emergency Response Plan
Mitigation Barrier Success Path: Inject kill fluid	Initiation criteria for kill fluid injection	- Volume and pressure of kill fluid source - Availability and position of valves in flow path	Uncontrolled well flow	Inject kill fluid
Mitigation Barrier: Kill Fluid	Functionality and Availability of Kill Fluid Flow Paths	- Availability of kill fluid source - Availability and position of valves in flow path	Loss of containment has occurred	Implement kill fluid success path
Top Event: Loss of Containment	Uncontrolled well flow	- Mud pit levels - Wellbore flow conditions	Uncontrolled well flow	- Function BOP ram to control flow if possible - Inject kill fluid
Prevention Barrier Success Path: Function BOP ram to shear pipe and close well	Initiation criteria for BOP activation to shear pipe and close well	- Wellbore conditions - Kick margin	Underbalanced fluid column	Function BOP ram to shear pipe and close well
Prevention Barrier: BOP	Availability of hydraulic fluid pathways to function BOP rams	- Volume and pressure of hydraulic fluid source - Availability and position of valves in flow path	Availability of hydraulic fluid pathways does not meet operational and regulatory requirements	- Suspend drilling operations - Maintain BOP control system to restore required capability
Threat: Underbalanced fluid column	Hydrostatic pressure	Comparison of fluid column pressure to formation pressure	Inadequate kick margin	Restore kick margin

Visualization concepts for application of dynamic barrier management to well integrity

Dynamic Well Barrier Schematic



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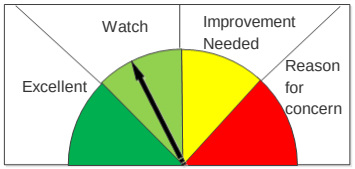
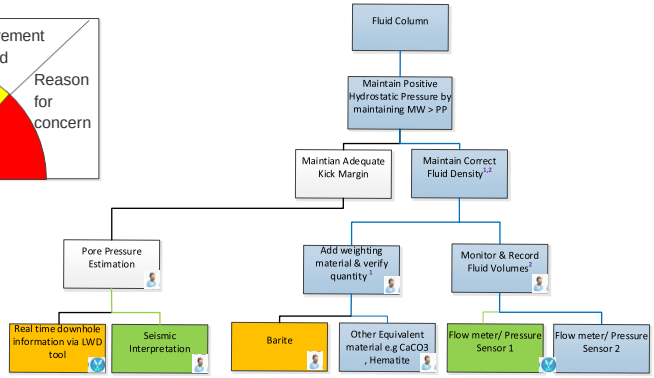
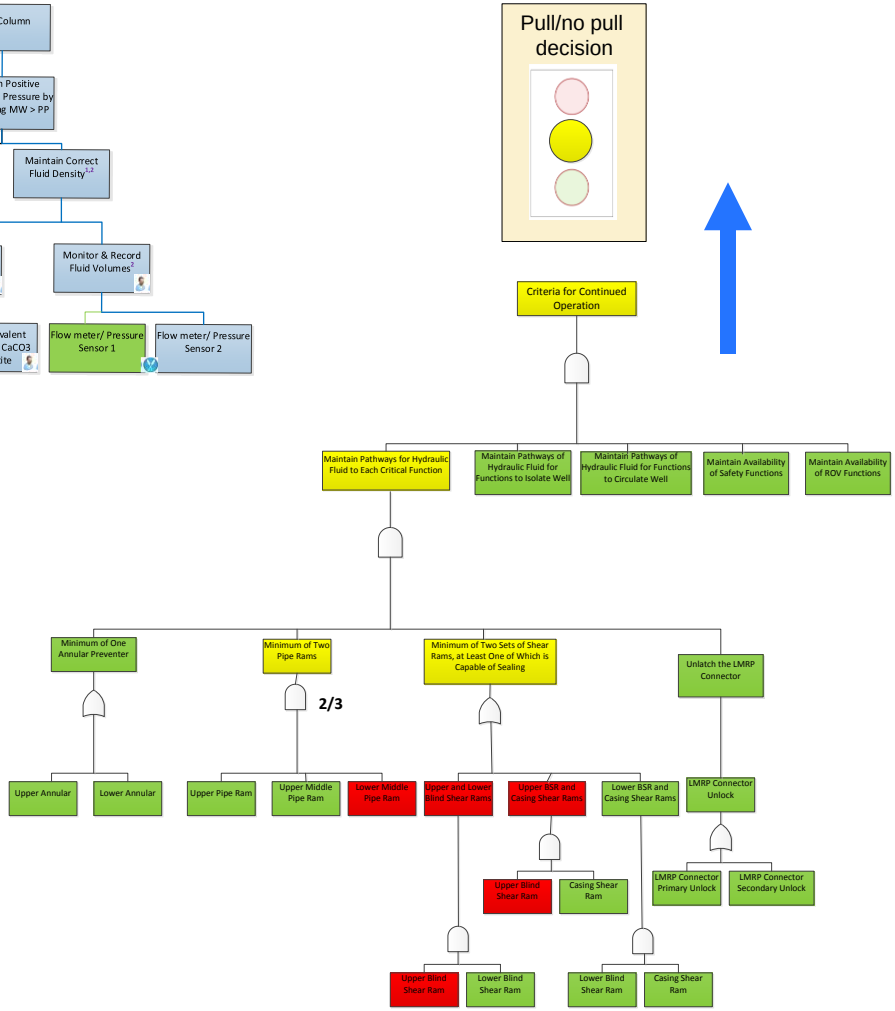
Barrier Status



Success Path Status



Compliance Level



Decision support for dynamic barrier management addresses the entire spectrum of offshore operations

	Standby Conditions		Event Conditions		
Progression of the event → **Elements of the bow tie diagram ↓**	**Continuously Monitor During Standby Conditions**	**IF: Degraded Barrier Conditions are Present**	**IF: Threat Conditions are Present**	**IF: Top Event Conditions are Present**	**IF: Consequences Conditions are Present**
Consequence	Consequence Precursors				Consequence Assessment and Response
Mitigation Barriers	Mitigation Barrier and Success Path Health	Restore Mitigation Barriers		Assess and Implement Mitigation Barrier Success Paths	
Top Event	Top Event Precursors			Top Event Assessment and Response	
Prevention Barriers	Prevention Barrier and Success Path Health	Restore Prevention Barriers	Assess and Implement Prevention Barrier Success Paths		
Threats	Threat Precursors		Threat Assessment and Response		

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Long-range vision: Dynamic barrier management supports communication and decision making at all levels of operation and across the industry

Decision
Consensus
Communication
Insight
Interpretation
Visualization
Data
Sensors

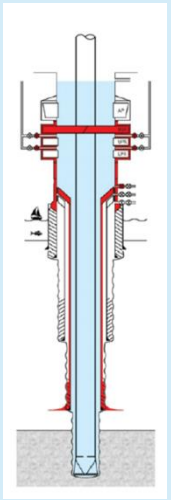
Component

- **Design**

- Component specification
- Performance data
- 3D model

Process /System

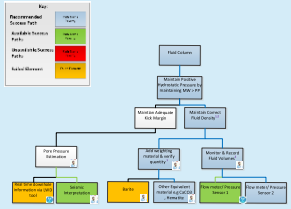
- **Engineering**



- Process diagram

Barrier Health

- **Operations**
- **HSE**



- Response tree

Installation

-**Management**

- Bow tie diagram

Industry

- **Public**
- **Regulators**
- **Industry groups**

Decisions and Actions
- Industry Standards
- Regulatory Processes

Common Language
- Risk Informed Interpretation

Data
- Industry Process Data
- Industry Incident Data

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Steps for Forming the Decision Support for Dynamic Barrier Management Joint Industry Project

- Obtain feedback from potential industry partners, BSEE, and industry groups
  - Focus on human decision making for well integrity barriers
- Identify Phase 1 sponsor organization and establish contract
- Convene launch meeting of potential JIP participants - Spring 2016
- Conduct case study workshop with a "core group" of industry SMEs as a "laboratory" for developing an application and assessing the value of the approach
  - Identify success paths
  - Identify information requirements for barrier and success path health
  - Identify decision criteria and decision guidance
  - Identify visualization concepts
- Conduct case study reporting meeting to brief JIP participants on lessons learned by the workshop core group and their assessment of value of the approach
- Develop formal plans for JIP Phase 2 and beyond

Questions?

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SAFER, SMARTER, GREENER

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