

Advancing Understanding of  
Offshore Oil and Gas Systemic  
Risk in the U.S. Gulf of Mexico

**Current State and Safety Reforms Since the  
Macondo Well–Deepwater Horizon Blowout**



Consensus Study Report

# A Report on Progress and Opportunities Toward Decreasing the Risk of Offshore Energy Operations

## Discussion with the Marine Board of The National Academies

November 14, 2023

**Richard A. Sears, on behalf of the  
committee and staff**

# The Committee

**Richard A. Sears** (*Chair*), Stanford University **O, S, C**

**Norman A. Abrahamson**, University of California **S, C**

**Paul G. Bradley**, Health and Safety Executive, UK **S, R**

**Manson K. Brown**, U.S. Coast Guard (retired) **S, H, C, R**

**Paul S. Fischbeck**, Carnegie Mellon University **S, R**

**Dwight Johnston**, Independent Consultant **O, S, C**

**Ulku G. Oktem**, Near-Miss Management **S, H, C**

**S. Camille Peres**, Texas A&M University **O, S, H, C**

**Kathy A. Seabrook**, Global Solutions, Inc. **S, H, C**

**Charles R. Williams**, Independent Consultant **O, S, C**

**O** – Oil and Gas Industry

**S** – Holistic Risk Management

**H** – Human Systems

**C** – Organizations and Culture

**R** – Regulatory Affairs

# Summary Points From Statement of Task

- Define the current profile of systemic risks of offshore oil and gas operations in the Gulf of Mexico.
- Assess the impact of technological, regulatory, environmental, organizational, and process changes on systemic risk since Deepwater Horizon.
- Specifically consider the impact of the regulatory structure on systemic risk.
- Assess the impact and potential of GRP for understanding and reducing risk.

# Important Definitions

***Systemic risk:*** The overall risk of catastrophic failure associated with the entire system. It includes design, operations, and regulation throughout the life cycle of offshore oil and gas facilities.

***Systemic risk profile:*** The temporal description of systemic risk. Real world operations are characterized by a risk profile that can change daily, hourly, and sometimes by the second.

***Systemic risk management:*** The design and operation of controls to ensure the integrity of physical barriers and that the responsible people have the appropriate competence and organizational support to manage system control barriers appropriately in planned and unplanned conditions.

# Total Injury and Illness Incident Rates 2003 - 2020

## U.S. Oil and Natural Gas vs. Private Industry

### Occupational Safety

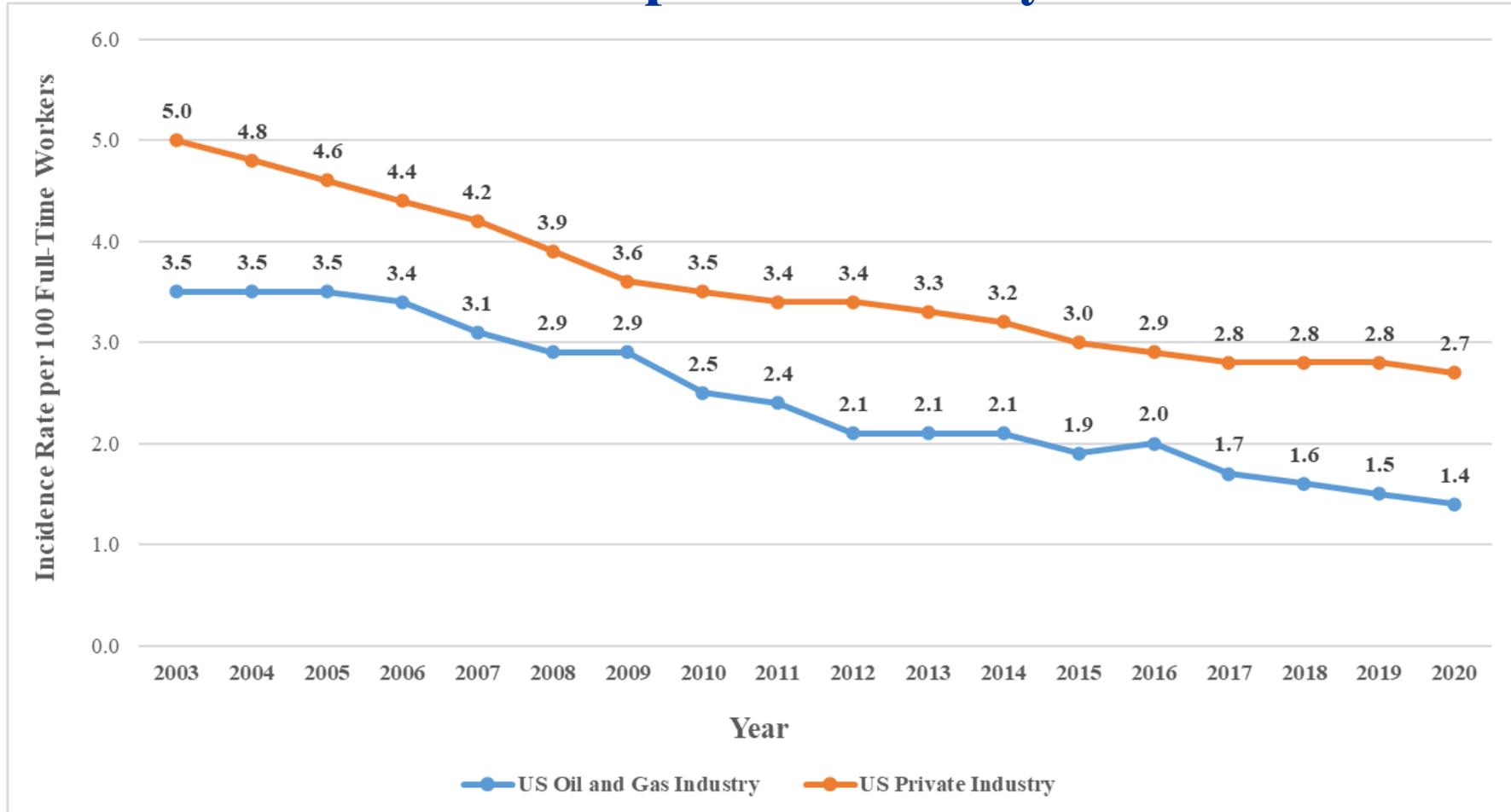
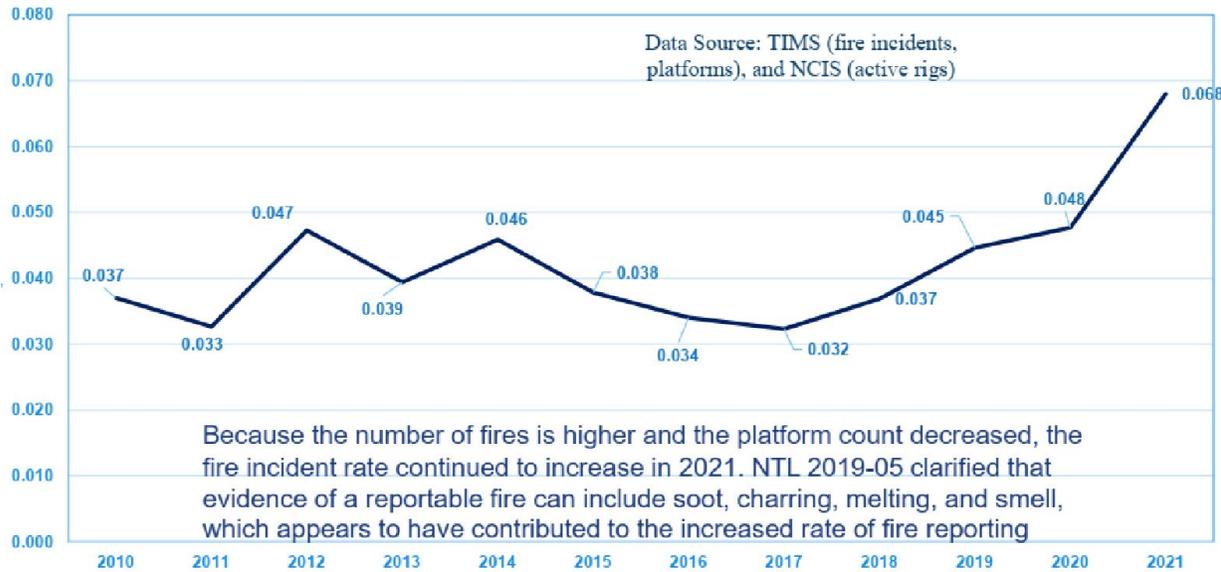
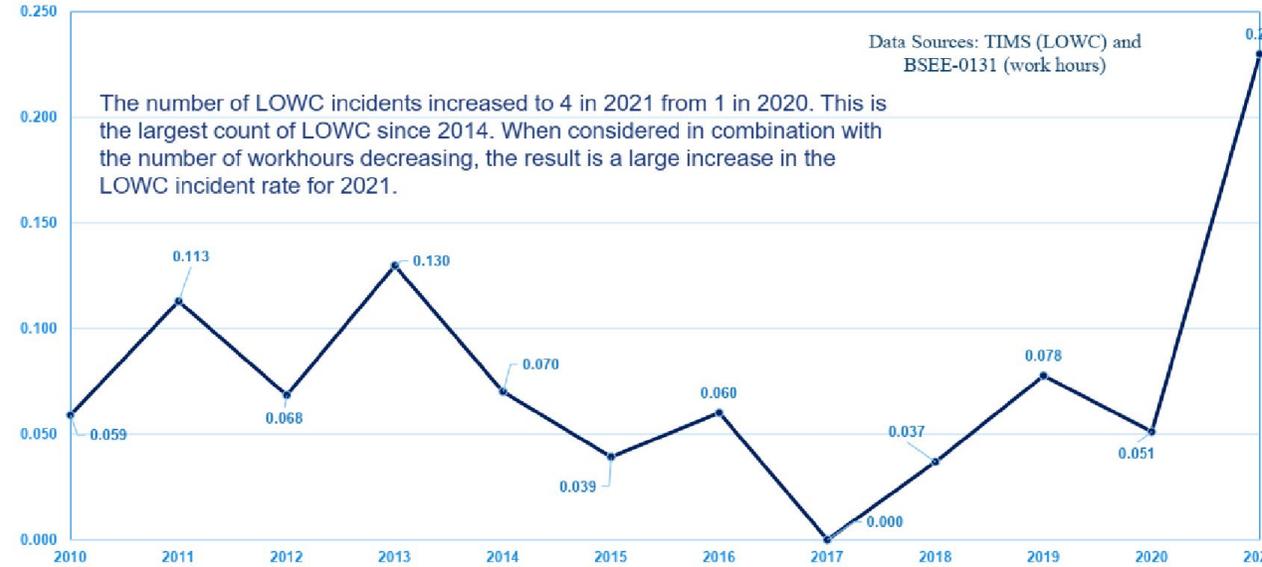


Figure 1-1

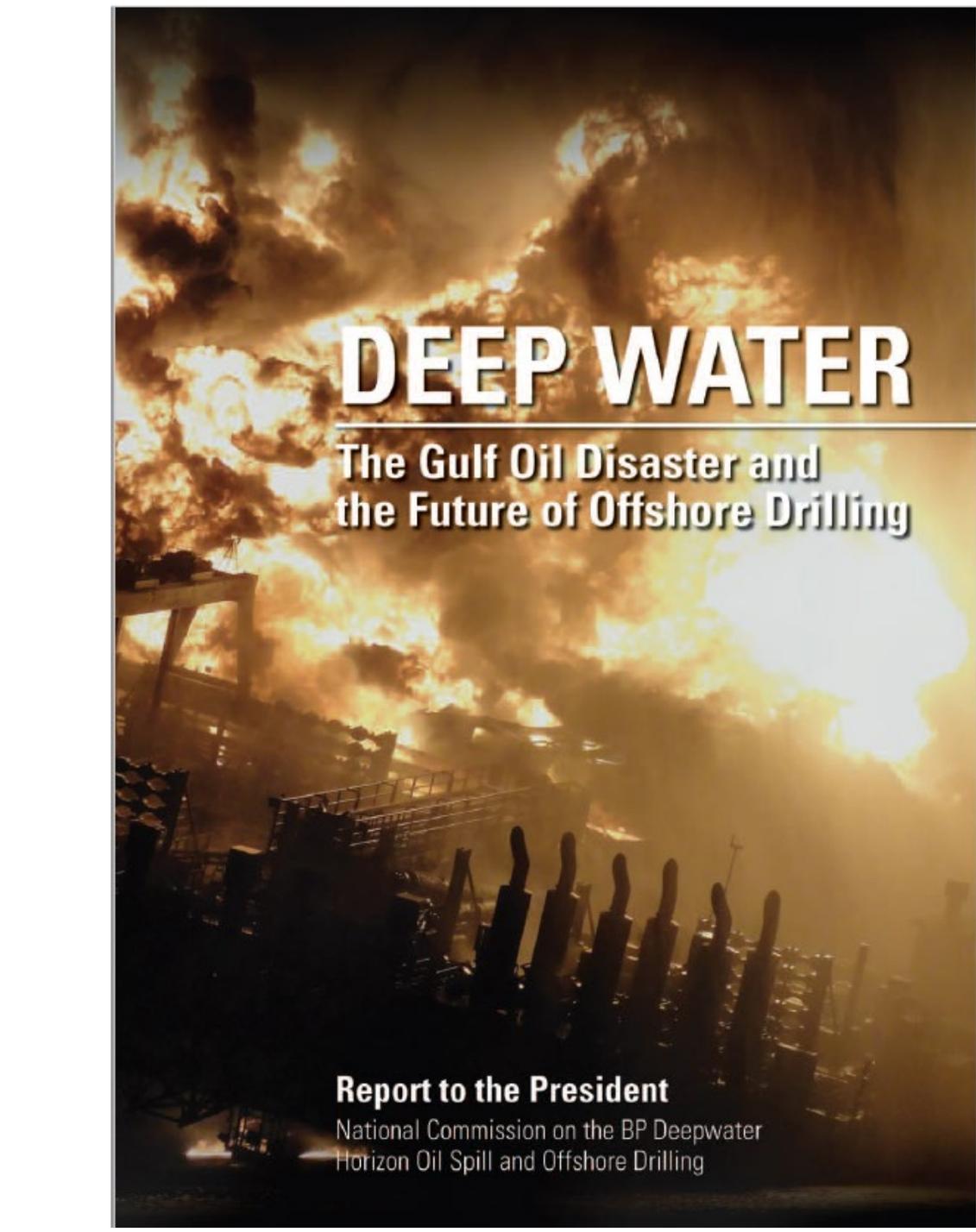
# OCS Process Safety Metrics 2010 - 2021



**Figure 3-2, Rate of reported fires**



**Figure 3-3, Loss of well control event rate**



# DEEP WATER

## The Gulf Oil Disaster and the Future of Offshore Drilling

### Report to the President

National Commission on the BP Deepwater  
Horizon Oil Spill and Offshore Drilling

As a result of our investigation, we conclude:

- The immediate causes of the Macondo well blowout can be traced to a series of identifiable mistakes made by BP, Halliburton, and Transocean that reveal such systematic failures in risk management that they place in doubt the safety culture of the entire industry.

Forward, page vii

## **Risk Profile for Offshore Oil and Gas**

**Risk Profile for Offshore Oil and Gas**

**System**

**People**

**Human-Systems Integration**

**Systems**

**Risk Profile for Offshore Oil and Gas**

**System**

**Risk Controls**

**People**

**Human-Systems Integration**

**Systems**

**Culture That Supports Safety**

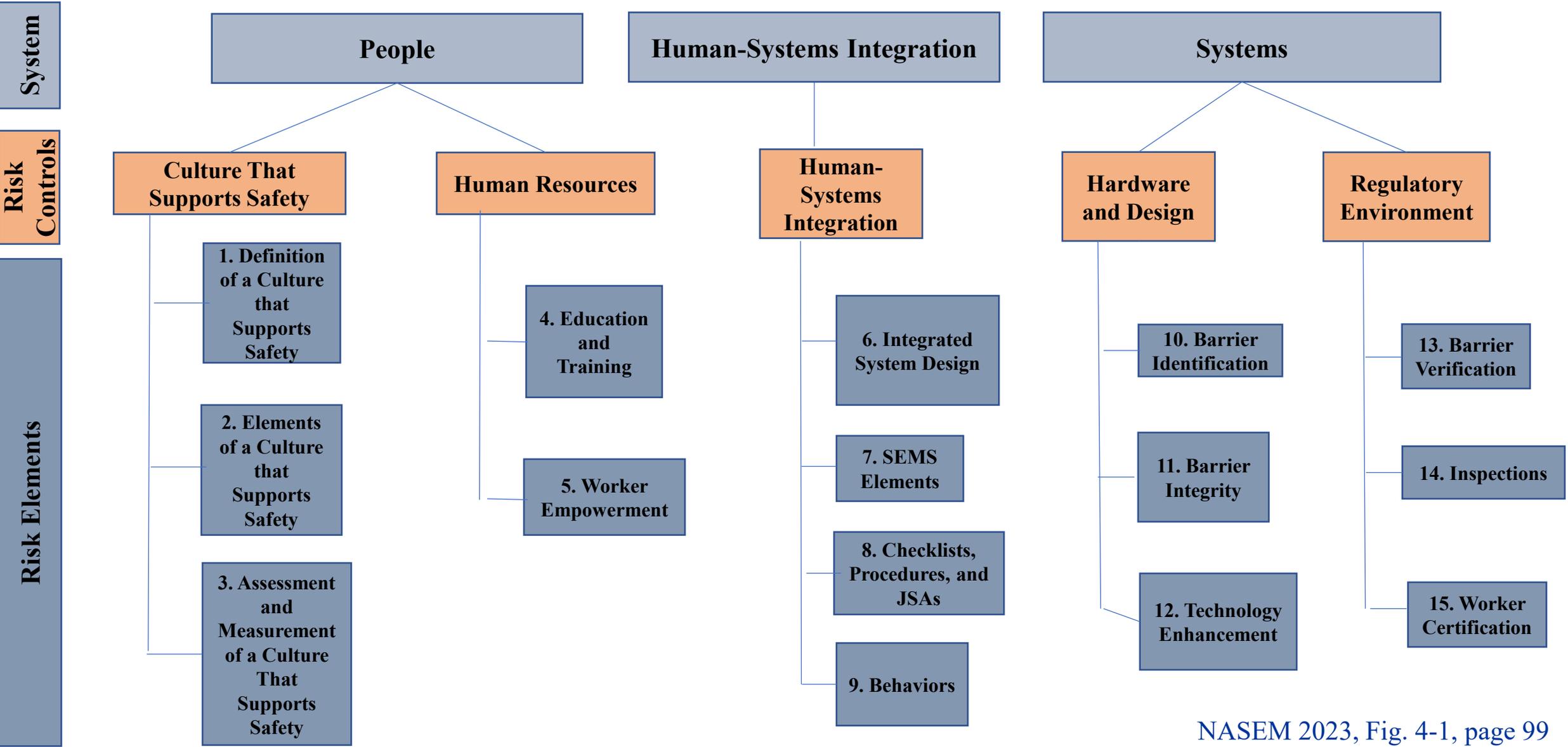
**Human Resources**

**Human-Systems Integration**

**Hardware and Design**

**Regulatory Environment**

# Risk Profile for Offshore Oil and Gas



# Understanding Systemic Risk

## 15 Risk Elements Evaluated Across 5 Lenses

**Risk Elements**

**Definition of Culture**  
**Elements of Culture**  
**Assessment and Measurement of Culture**

**Education and Training**  
**Worker Empowerment**

**Integrated System Design**  
**SEMS**  
**Checklists, Procedures, JSAs**  
**Behaviors**

**Barrier Identification**  
**Barrier Integrity**  
**Technology**

**Barrier Verification**  
**Inspection**  
**Worker Certification**



**Maturity Lenses**

**Culture**

**Technology**

**Human Resources**

**Barriers**

**Regulatory Environment**

# Maturity Evaluation

## Maturity Levels

### Maturity Lenses

Culture

Technology

Human Resources

Barriers

Regulatory Environment



**Level 1 – Unacceptable: Inconsistent management practices, reactive organization.**

**Level 2 – Concerning: Management processes exist, but siloed organization with poor communication.**

**Level 3 – Neutral: Process awareness and an organization working toward consistent performance, but with a compliance mentality.**

**Level 4 – Good: An organization using processes and capabilities to achieve reliable results. Possible issues of consistency across the organization.**

**Level 5 – Mature: A learning organization focused on full engagement and continuous improvement. This is an aspirational goal that is always moving.**

# Conclusions in Brief and Critical Research Gaps - I

- Significant improvements in risk and hazard management have been implemented by industry and regulators.
- The model for disaggregating systemic risk into systems, risk controls, and risk elements provides a framework for understanding the complexity of systemic risk and for catalyzing actionable statements and discussion. The 15 risk elements were most commonly assessed to be at a maturity level of 2 and 3, but industry complexity and heterogeneity results in specific aspects of the elements being at all five maturity levels.
- Process safety management has in general lagged behind offshore technology development. Safety and Environmental Management Systems (SEMS) lack modern thinking on barrier management and human factors, and precursor data are not widely shared. An industry-wide culture that supports safety is lacking.
- Data for assessing offshore risk are now being captured through voluntary and mandatory reporting to SafeOCS and COS. The data are however limited and there are large differences in the commitment of specific companies to SEMS.
- The industry lags other safety-critical industries in developing best practices and guidance in use of checklists and JSAs.

# Conclusions in Brief and Critical Research Gaps - II

- The operator-contractor interface remains of particular importance in assessing and managing systemic risk.
- The legal mandates provide regulators with policing authority which could discourage open sharing and collaboration with industry.
- Education and training standards lack requirements for demonstrating competence in safety critical positions.
- The committee sees value for GRP to consider its role in addressing the critical gaps through funded research and GRP's convening capabilities.
- Industry has evolved significantly since the Macondo incident. The energy transition will put new pressure on regulators.

# Questions and Discussion

# Back-up



Consensus Study Report

# Current State: People

Risk System	Risk Controls	Risk Elements	Assessed Level
People	Culture That Supports Safety	Definitions	2
		Elements	3
		Assessment and Measurement	2
	Human Resources	Education and Training	2 - overall, 3 - well control training and competency
		Worker Empowerment	3



# Current State: Human Systems Integration

Risk System	Risk Controls	Risk Elements	Assessed Level
Human-Systems Integration (HSI)	HSI	Integrated Systems Design	2 - overall 4 – physical hardware and systems
		SEMS Implementation	3
		Checklists, Procedures, JSAs	3
		Behaviors e.g., competence, situation awareness	3 - overall 2 - contingent barriers, data sharing



# Current State: Systems

Risk System	Risk Controls	Risk Elements	Assessed Level
Systems	Hardware and Design	Barrier Identification	2 - overall 3 - physical elements
		Barrier Integrity	3
		Technology Enhancement	3
	Regulatory Environment	Barrier Verification	3
		Inspections	3 - overall 4 - BSEE
		Worker Certification	3 - overall 4 - BSEE

Level	Training is on responsibilities for	Action may occur relative to Well Control Assurance *	What training this person needs	Learning Outcomes	Certificate for	Repeat Frequency	Learning Method	Formal Assessment	Guide to Typical Roles (Titles can vary between different companies, locations or facilities). The Level may need to be adjusted depending on responsibilities. This list is not exhaustive; the principle is that operator and employer review what training is required to manage the risks.
1	All personnel contributing to the well project	For individuals who need an awareness of what well control is and those who could perform an action that might indirectly impact Well Control Assurance (WCA)	Awareness of the processes and terminology of well lifecycle in order to develop adequate knowledge to provide the required support	Have relevant awareness knowledge of the Key Topics to provide effective support	A general overview of the lifecycle of a well with emphasis on how everyone's role can affect well control	None (No repeat)	Online modules or classroom. Include self-assessment questionnaires.	None	<ol style="list-style-type: none"> <li>The following non-well-site office-based staff in an oil and gas operating company drilling or well operations department:               <ol style="list-style-type: none"> <li>Logistics coordination personnel and logistics supervisors</li> <li>Subsurface staff/geologists involved with well planning and well scheduling personnel</li> </ol> </li> <li>Offshore installation managers (OIMs) that do not have a primary function for drilling and/or well intervention (i.e., production OIMs)</li> <li>Roustabouts, deck crew, and platform and site location crane operators</li> <li>Rig move captains or rig move offshore installation managers (OIMs)</li> <li>Oil and gas installation supply and support vessel watch officers and captains</li> <li>Other non-critical well-site personnel responsible for downhole and surface well equipment repair, inspection and operations such as:               <ol style="list-style-type: none"> <li>Remotely operated vehicle (ROV) personnel (non-supervisory)</li> <li>Other well-site non-supervisory and non-critical drilling or intervention personnel</li> <li>Tubular and rig inspection personnel</li> </ol> </li> <li>Maintenance personnel not working on pressure control equipment</li> </ol>
2	Operations team support personnel	Well-site based position whose action or inaction that could directly influence (WCA) <sup>a</sup>	Skills to act under guidance	Have knowledge and skills to effectively act under guidance (monitor, observe, detect, report)	Attention to Well Control Prevention and Response for the appropriate equipment scenarios (surface / subsea): <ol style="list-style-type: none"> <li>Drilling</li> <li>Intervention</li> <li>Support services</li> </ol>	Every 5 years	Online modules or classroom. Include self-assessment questionnaires.	Examination	<ol style="list-style-type: none"> <li><b>Drilling, Workover and Completions</b> <ol style="list-style-type: none"> <li>Well-site operations engineer</li> <li>Well-site and office-based operations geologist</li> <li>Roughneck</li> <li>Derrick-man</li> <li>Drilling contractor maintenance personnel working with pressure control equipment (e.g., maintenance supervisor, rig mechanic)</li> <li>BOP equipment installation, re-work, repair or maintenance personnel</li> </ol> </li> <li><b>Intervention</b> <ol style="list-style-type: none"> <li>Well-site operations engineer</li> <li>Intervention services crew members</li> <li>Well-site based wireline or slick-line crew members</li> <li>Coiled tubing services crew members</li> <li>Snubbing crew members</li> <li>Well test crew members</li> <li>Pumping and stimulation crew members</li> <li>Well testing crew members</li> </ol> </li> <li><b>Support Services <sup>b</sup></b> <ol style="list-style-type: none"> <li>Dynamic position operator</li> <li>Well-site ROV supervisor and crew</li> <li>Well-site drilling fluids, mud and completion fluids engineer</li> <li>Well-site directional driller</li> <li>Fishing engineer or fishing tool operator</li> <li>Mud logger or well-site drilling data engineer</li> <li>Well-site casing crew supervisors</li> <li>Well-site cementing operator</li> <li>Wellhead engineer</li> <li>Subsea BOP engineer</li> <li>MPD / UBD well-site service personnel (non-supervisory)</li> <li>Casing running personnel (non-supervisory)</li> <li>Directional surveying / MWD / LWD personnel</li> <li>Production staff / supervisors</li> <li>Crane operators suspending intervention equipment</li> <li>Wellhead maintenance crew</li> <li>Well-site oilfield equipment repair personnel</li> <li>Electric supervisor and crew working with EE related to WC</li> <li>Subsea wellhead / Xmas tree engineer</li> </ol> </li> </ol>
3 and 3E	Equipment operator	Has to perform an action to ensure WCA <sup>a</sup> or to respond to well control incidents WCA <sup>a</sup>	Correct actions to take	Be able to perform their role effectively, in particular by identifying anomalies and performing the first actions independently, and recognize that they are empowered to do so. Proactively communicate with all personnel who provide support to maintaining well control (e.g., Level 2 personnel). <i>The Level 3E (Enhanced) is intended to deepen knowledge and can be attempted after having passed Level 3.</i>	Attention to Well Control Prevention and Response for the appropriate equipment scenarios (surface / subsea): <ol style="list-style-type: none"> <li>Drilling</li> <li>Intervention</li> <li>Support services</li> </ol>	Every 2 years  Level 3E can be attempted 2 years after Level 3 has been successfully passed	Online modules or classroom. Include self-assessment questionnaires.	Examination and Practical <sup>d</sup>	<ol style="list-style-type: none"> <li><b>Drilling, Workover and Completions</b> <ol style="list-style-type: none"> <li>Driller</li> <li>Assistant driller</li> </ol> </li> <li><b>Intervention</b> <ol style="list-style-type: none"> <li>Wireline, E-line, Slick-line operator</li> <li>N2 operator</li> <li>Wellhead / tree installation engineer</li> <li>Hydraulic workover (snubbing) operator</li> <li>Coiled tubing operator and equivalent positions in other well-servicing or intervention operations</li> <li>Well Test Operator</li> </ol> </li> <li><b>Support Services <sup>b</sup></b> <ol style="list-style-type: none"> <li>Well testing crew</li> <li>MPD / UBD well-site service supervisor</li> </ol> </li> </ol>
4 and 4E	Supervisor	Specifies and has oversight that correct actions are carried out	Skills to anticipate, plan, oversee and verify	Be able to establish consistent practices to assure continued primary well control and well integrity. When anomalous situations occur, or conditions escalate, they will be able to analyse the situation, develop plans to minimize the impact and recover the situation to the norm. <i>The Level 4E (Enhanced) is intended to deepen knowledge and can be attempted after having passed Level 4.</i>	Attention to Well Control Planning, Prevention and Response for the appropriate equipment scenarios (surface / subsea): <ol style="list-style-type: none"> <li>Drilling</li> <li>Intervention</li> <li>Support services</li> </ol>	Every 2 years  Level 4E can be attempted 2 years after Level 4 has been successfully passed	Facilitated virtual/online or classroom-based using instruction, simulation, desktop exercises, presentations and discussions, possibly complemented by online prework for knowledge content and practice. <sup>c</sup>	Examination and Practical <sup>d</sup>	<ol style="list-style-type: none"> <li><b>Drilling, Workover and Completions</b> <ol style="list-style-type: none"> <li>Drilling, workover and completions well-site supervisor, superintendent or company man (day and night)</li> <li>Tool pusher</li> <li>Drilling contractor rig manager</li> <li>Office-based operational staff (e.g., senior well engineer, operational well engineer)</li> </ol> </li> <li><b>Intervention</b> <ol style="list-style-type: none"> <li>Completion / workover / intervention supervisor or superintendent</li> <li>Well-site completions / workover supervisor</li> <li>Supervisors or crew chiefs for special service operations such as wireline, slick-line and coiled tubing operations, which provide specific well control equipment for these activities</li> <li>Office-based operational staff (e.g., senior completions / well interventions)</li> <li>Engineer, operational completions / well intervention engineer)</li> <li>Well test supervisor</li> </ol> </li> <li><b>Support Services <sup>b</sup></b> <ol style="list-style-type: none"> <li>Offshore installation manager (OIM) for offshore units with a primary function for drilling or well intervention</li> <li>Well-site personnel supervising managed pressure drilling (MPD) operations or under-balance drilling (UBD) services</li> <li>Hydraulic workover (snubbing) supervisor</li> </ol> </li> </ol>
	Well control in design and lifecycle management <sup>a</sup>	Deliver the correct design and develop the normal operating envelope. Identify actions with the agreed design envelope and manage risk.	Skills to design the well and well activities, including subsurface/geological knowledge. Skill to identify and to specify actions to be taken when stepping outside of the normal operating envelope. Ability to assess well integrity and associated risks.	Have discipline-specific skills and subsurface/geological/ production knowledge to be capable of planning and performing safe well design and/ or intervention operations. Be able to evaluate technically on deviations to the well operations plan and advise accordingly. Be able to support operational teams when assessing critical well situations.	One discipline-specific training course or programme for all operations, environments and rig types	None (Continuous learning refreshers recommended) <sup>f</sup>	Facilitated classroom or equivalent facilitated distance learning, self-study using simulation, desktop exercises, presentations and discussions, possibly complemented by online prework for knowledge content and practice. Modular training programmes over a longer time period (maximum 2 years) as part of a career development programme is encouraged.	Industry Examination, or auditable alternatives as deployed in some company programmes.	<ol style="list-style-type: none"> <li>Drilling engineer / senior drilling engineer</li> <li>Completion engineers / senior completion engineer</li> <li>Petroleum engineers / senior petroleum engineers</li> <li>Well service engineer / senior well service engineer</li> <li>Intervention engineer / senior intervention engineer</li> <li>Drilling / intervention superintendent (if involved with well design)</li> <li>Drilling manager (up to first line drilling management)</li> <li>Drilling project managers (up to first line drilling management)</li> <li>Well operations managers</li> <li>Well services managers</li> <li>Office-based design personnel</li> <li>Senior wells personnel, e.g., team leader and general manager wells</li> </ol>

Chart excludes Well Integrity Assurance (WIA) during production use of the well.

<sup>a</sup> Well Control Assurance. WCA (I). The assurance that primary well control is maintained. WCA (II). When this is not the case that the situation is properly contained and the status of the well returned safely to normality.

<sup>b</sup> Well Support Service providers (for their training partners) are to identify and deliver appropriate well control training to their staff requisite for services provided.

<sup>c</sup> Could be a fully auditable alternative. The Classroom is a Standard. The full capability should be demonstrated to meet or exceed the learning environment of the classroom.

<sup>d</sup> For Drilling (and for D/W/C). Written examination and simulator assessment. For Well Intervention: Written examination and simulator assessment or approved alternative (e.g. scenario-based paper exercise).

<sup>e</sup> Approving Authority is the individual providing technical oversight for the design and for deviations.

<sup>f</sup> Refreshers recommended because technologies, practices, designs, standards, etc. change with time.