SPE Technical Report

Getting to Zero and Beyond:
The Path Forward

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Forward

Following Lord Cullen’s review of this report he provided the following message to the oil and gas industry:

“Operations in the oil and gas industry necessarily have to rely on the actions of members of the workforce. Their actions may be influenced – with implications for safety – by a number of things such as the design of equipment, the organisation, the working environment, and the competence and attitude of individuals. It follows that the management of safety has to include assessing human factors and taking them into account. The implications of human factors for safety must be fully realised”.


Lord Cullen of Whitekirk KT conducted the Public Inquiry into the Piper Alpha disaster. He continues to share guidance, wisdom and support for safe and reliable operations across the global oil and gas industry. His insights and contributions are valued and respected amongst the industry, its leaders, and oil and gas workers. The authors wish to convey appreciation to him for his leadership and contribution to the understanding that human factors is a necessary element to achieving zero harm.
# Table of Contents

1.0 Executive Summary ................................................................................................................................. 4  
2.0 Introduction............................................................................................................................................... 6  
3.0 How did we get here: The road to Stavanger ........................................................................................... 8  
4.0 It’s all about us: Human Factors ............................................................................................................ 10  
5.0 Achieving a culture of perfection led from the top .................................................................................. 20  
6.0 Where do we go from here? Next steps ..................................................................................................... 25  
7.0 Appendices...............................................................................................................................................  
   7.1 Acronyms............................................................................................................................................. 32  
   7.2 Participant Demographics for SPE “Getting to Zero” - The Road to Stavanger Sessions................. 34  
   7.3 The ABC Model................................................................................................................................. 35  
   7.4 Afterword........................................................................................................................................... 36  
   7.5 References.......................................................................................................................................... 38  
   7.6 Author and Contributor Biographies .................................................................................................... 41
1.0 Executive Summary

Between 2009 and 2016, the Society of Petroleum Engineers (SPE) facilitated a series of global sessions to develop ideas for the future advancement of health, safety and the environment (HSE) in the industry. These sessions brought together over 850 leaders from across the oil and gas industry, government, and academia representing diverse disciplines to discuss a simple question: How can the oil and gas industry achieve zero harm?

The diverse group of participants generated many valuable ideas for a “step change” in performance, and they precipitated alignment around a vision of safety, specifically the expectation of zero harm. The participants agreed achieving zero harm was possible but given the oil and gas industry’s varied cultures and risk tolerance it was necessary to collaboratively identify the methods for attaining zero. It was widely agreed the effort must begin with the industry’s most valuable resource, its people, and particularly the elements of human factors. This includes the factors that influence the interaction of people with each other, the facilities and equipment and with the management systems and working practices used to organize and manage the way work is carried out within the industry.

This report is a compilation of the discussions of the SPE sessions, and expands on the discussions to identify and evaluate elements that may aid the industry in removing obstacles to achieving zero harm as an expectation by: exploring current thinking and views; understanding experiences and learnings from other industries that are mature in the application of human factors; and suggesting next steps that will enable the oil and gas industry to meet an expectation of zero harm.

Specific recommendations for the industry discussed in this report include:

- Define a safety vision in which zero is an attainable expectation today – not a future goal.
- Learn from other industries mature in human factors with the expressed intent to progress the application of human factors across the oil and gas industry.
- Achieve the right balance between leading and lagging indicators to ensure a progressive and preventative focus on expected behaviors rather than outcomes of the process.
- Establish a no-risk-to-sharing culture – a commitment of collaboration – across the industry with the expressed intent to overcome perceived risks and competition barriers.
- Remove barriers to open sharing of lessons learned from major incidents, high-potential near misses and projects where, although complex and with considerable risk, the work was executed without incidents.
- Work with regulators to ensure they can match the best minds in industry so competent discussions about the risk-management strategies are occurring.

For individual companies the recommendations include:

- Realize an interdependent HSE culture demonstrated by a commitment to a collaborative environment and consistent safety culture at the worksite regardless of company position (operator, service company, specialty contractor).
- Achieve operational ownership of HSE.
- Ensure sustainable HSE leadership programs.

This report is an output of the previously approved Technical Report; Assessing the Processes, Tools, and Value of Sharing & Learning from Offshore E&P Safety-Related Data (SPE-182847-TR) and it also builds

Additionally, this report serves as a catalyst to “jump start” SPE’s recently approved Safety & Environment Strategy. Specifically, it supports the strategic objective of “Strengthen[ing] HSSE-SR integration into other SPE disciplines” as well as SPE’s 2013-2017 Strategic Plan goal:

“Promote safety and environmental protection as high priorities with our membership. Over the past two decades, industry has become far more cognizant of the far-reaching environmental and social consequences of its activities. While many companies have very strong safety and environmental programs, several recent incidents have reinforced public and government skepticism of industry’s focus on these issues. SPE should emphasize safety, the environment, and sustainability to its members as a complement to current corporate efforts. Ensuring that environmental and social responsibility is part of SPE programming may provide opportunities to improve awareness and perception.”
2.0 Introduction

“For me, the idea is to shun the incremental and go for the leap.”

The oil and gas industry was started by visionaries and wildcatters who foresaw a brighter future and were willing to scrap the status quo and take steps to achieve their vision. For the industry to reposition itself today for the future it needs an injection of the same willingness to cast aside some strongly held legacy beliefs and practices and take the next leap forward – achieving zero harm.

Rod Gutierrez Ph.D., Global Leader – Culture and Change Management for DuPont Sustainable Solutions, has written that the concept of zero has encouraged industries to move away from simply minimizing risks through engineering out hazards, towards actively engaging people for an overall improvement to workplace health and safety outcomes.

“But however positive this advancement, it is important to consider what comes next. What if we are to shift our point of reference, so that zero harm was no longer the goal, but rather simply the beginning of sustained workplace health and safety? By reconfiguring the scale that we apply to workplace health and safety, by no longer considering zero as a final objective but rather a starting point, a minimum standard, we allow for the opportunity to initiate comprehensive and meaningful outcomes” (Gutierrez 2015).

The oil and gas industry has for more than two decades set HSE goals that are focused on reducing incidents with the ultimate intended outcome that no one is hurt and no releases occur. Therefore, the concept of zero harm is not a new one in the industry. However, what has been a challenge for decades is aligning on an effective pathway to achieve these goals. To attain zero harm a step change in thinking, performance and alignment around HSE is required across the industry. Nathan Meehan, 2016 SPE President stated, “This trend in performance improvement over the past decade has plateaued. We need a breakthrough” (Meehan 2015).

It is acknowledged that some believe directing attention towards achieving zero harm can lead to a detrimental focus on incidents and injuries that may lead to under-reporting of incidents, gaming of statistics, manipulation of incident definitions, and overly aggressive injury case management. Sidney Dekker has argued against zero being a goal. However, his explanation of it as a vision perhaps best illustrates what it can represent:

“A zero vision is a commitment. It is a modernist commitment, inspired by Enlightenment thinking, that is driven by the moral appeal of not wanting to do harm and making the world a better place. It is also driven by the modernist belief that progress is always possible, that we can continually improve, always make things better” (Dekker 2013).

Between 2009 and 2016, the SPE facilitated a number of global sessions to develop ideas for the continued improvement of HSE in the industry. These sessions brought together leaders from across the industry, government, and academia representing diverse disciplines to discuss a simple question: How can the oil and gas industry achieve zero harm?

What the participants identified, and the authors emphasize in this report, is that the industry must unequivocally set an expectation of zero harm and urgently commence with the required breakthrough in thinking, collaboration and an approach to achieve zero.
The participants of the SPE sessions identified achieving and sustaining zero harm relies on the industry’s most valuable resource, its people, and the factors that influence the interaction of people with each other, the facilities and equipment and with the management systems and working practices used to organize and manage the way work is carried out within the industry. These criteria are described as human factors; identified by the SPE session participants as the priority element for the industry’s success in meeting an expectation of zero harm.

In addition, ensuring an industry-wide commitment to the expectation of zero harm and integrating elements of human factors to improve human performance were recognized as important steps for oil and gas companies’ evolution to becoming High Reliability Organizations (HROs) (Weick and Sutcliffe, 2001). An evaluation of the principles of HROs applied to oil and gas drilling organizations found numerous HRO attributes, including elements of human factors, that readily align with challenges that exist in drilling operations and that impact performance (Thorogood 2012).

There was agreement among the session participants that the output from the SPE “Getting to Zero” sessions should form a part of the continuing dialogue within the industry around an industry-driven expectation of zero harm. To this point of the discussions, achieving zero has included both personal and process safety. It is recognized that there are different applications required for each and as the discussions continue delineating application of the discussed principles will occur as appropriate.

In keeping with the agreement and expectations from the sessions, this report includes information and decisions from the SPE sessions and aims to continue the dialogue around the participants’ prioritized items identified as essential for the industry to achieve zero harm as an expectation.
3.0 How did we get here: The road to Stavanger

千里之行，始於足下 (The journey of a thousand miles begins with a single step.)
*Tao Te Ching*, Lao Tzu, Chinese philosopher, 604-531 BC.

Many in the oil and gas industry today recognize HSE as adding business and shareholder value. Likewise, leaders in HROs recognize HSE as essential and fundamental to short-term and long-term sustainable success. In fact, the impact of poor HSE practices can drive companies out of business. HSE performance becomes an integral part of our ethical, legal and social responsibility to our employees, customers, contractors, the communities in which we work and to the future of our planet.

In 2009, while HSE performance in the industry was improving, it was recognized that a step change would be needed to achieve noticeable improvement and to better align the industry toward eliminating incidents and unplanned events. The concept of “Getting to Zero” was suggested as a focus and in 2010, SPE sponsored a Forum Series entitled: “Getting to Zero – An Incident-Free Workplace: How Do We Get There?” in Park City, Utah. The forum was attended by 43 participants from six countries representing 37 organizations. The discussions included:

- Defining zero;
- Discerning the role of management systems and metrics;
- Understanding and developing an effective safety culture to support zero-harm;
- Identifying stakeholders and their roles; and
- Mitigating risk from work processes.

The forum stimulated considerable interest and discussion within SPE and across the industry. To encourage further dialogue, in 2011 a SPE Workshop entitled “Continuing the Journey to Zero” was held in San Antonio, Texas; 90 attendees from 10 countries representing 55 organizations participated. The workshop focused on sharing of information and expanding the discussion beyond traditional HSE topics and the oil and gas industry.

The workshop highlights included:

- *Learning from outside the oil and gas industry* is a significant opportunity - specifically from nuclear, aviation, and aerospace industries that are regularly recognized as HROs.
- *Human factors engineering* is an essential component for creating an incident-free workplace.
- *Behavior of senior leaders* is crucial to revealing critical lessons.
- *Self-reporting* where an individual can make notification about errors or mistakes without fear of retribution, is essential.
- *Removing blame, and absolute honesty and openness* are critical success factors in investigation and identification of root causes of incidents.
- *Leading indicators* remain an elusive but much sought after component of an incident-free workplace. There remains no one solution and continued work is needed to develop universally accepted leading indicators.
- *Lagging indicators* still play an essential role in understanding the overall performance of an entity by providing critical information in dissecting the causes of systemic failures.
- *The general public’s view of oil and gas industry* is driven by its worst performer. Therefore, the implications of poor performance affect all industry participants.
Workshop participants developed and endorsed “Getting to Zero” vision and mission statements (Fig 1) that introduced a human factors approach to safety and sought to be both understandable and inspiring.

![“Getting to ZERO”
A Vision Statement
As a member of SPE, “Safety IS my way of Life” at work, home and in my community. Safety is fully integrated into work knowledge, skills, and abilities, regardless of my position or responsibility in the organization.

As a core value, I am accountable for my safety and the safety of my co-workers, family and friends. Indeed, I believe every employee associated with the Petroleum Industry is equally accountable for their own safety as well as the safety of those with whom they work and live. I passionately believe ZERO injuries/incidents is achievable because “SAFETY IS MY WAY OF LIFE.”

A Mission Statement
The success of our business depends on my Safety Ethic to properly plan my work; to ensure my tools are available, maintained, and safely utilized; to know the hazards of my work and control or eliminate exposure to them; to follow all procedures safely; to “STOP WORK” when I deem it is necessary; to immediately report all near-misses and accidents; and to make safety improvement suggestions when warranted.

Fig.1 - SPE “Getting to Zero” session participants’ Vision and Mission statements generated as a work product from 2010 “Getting to Zero – An Incident-Free Workplace: How Do We Get There?” SPE Forum Series.

Following these two events, the SPE Health, Safety, Security, Environment and Social Responsibility (HSSE-SR) Advisory Committee accepted responsibility for further broadening the discussion. In preparation for the 2016 SPE International Conference and Exhibition on HSSE-SR in Stavanger, Norway a series of interactive sessions was conducted. These sessions began in 2015 and were held across the globe (including North America, South America, Europe, Asia, and the Middle East) with the last session organized in Stavanger in conjunction with the April 2016 SPE conference.

More than 750 participants from numerous disciplines and organizations joined the global sessions. See Appendix 7.2 for information on the participants’ organization affiliation and employment demographics. The sessions’ format integrated both in-person and live-webinar, encouraging active participation including question and answer sessions and real-time polling of participants. The discussions focused on three questions:

- Is getting to zero achievable?
- What are the most critical (organizational) values to achieving zero?
- What issues to achieving zero exist that require additional effort and time to understand and resolve?

Nearly 70 percent of the participants agreed achieving an expectation of zero harm was possible for the industry, with approximately 20 percent recognizing it may be possible. Additionally, participants identified that the current HSE culture and risk tolerance across the industry were likely the most significant factors in positioning the industry to regard zero as an achievable expectation.
Participants prioritized five organizational values, that define culture and impact the ability of the industry to achieve an expectation of zero harm (Fig. 2).

![Top 5 Prioritized Values for Achieving Zero](image)

*Fig. 2. SPE “Getting to Zero” session participant responses to survey question: Select five values which you believe are critical to achieving a Safety Vision of “Getting to Zero”.*

Participants also identified five obstacles that require attention in the near term if the industry is to achieve an expectation of zero harm. Listed in priority as defined by the participants:
- Insufficient alignment and application of human factors.
- Misalignment and confusion on the expectation of zero harm.
- Ineffective leadership development.
- Inaccurate identification and management of risk.
- Market pressure and recent industry downturn.

Participants overwhelming agreed that the evolution of the industry’s HSE culture and risk tolerance maturities were driving forces in the recognition that human factors is pivotal and a required pathway for the industry to achieve an expectation of zero harm.
4.0 It’s all about us: Human Factors

A person who never made a mistake never tried anything new.
Albert Einstein

Across industries the efforts to improve safety performance or achieve a state of operational excellence has followed a generally consistent path. The initial reaction to reducing incidents was to focus on needed improvements in engineering designs. For example, improving drill rig designs, engineering blast proof control rooms, and/or incorporating process safety engineering into the design of offshore platforms. Once there was better designed and built equipment, the focus was on how the equipment was operated and managed, thus the development and evolution of management systems.

Management System: The framework of processes used by the managers and the workforce at all levels in a company’s organization to plan, direct and execute activities (IOGP-IPIECA 2014).

Initially designed as an internally focused framework of processes and procedures, over time management systems evolved to also include an external focus, integrating supplier and customer networks.

The progression to improve safety performance does not stop there. HROs and forward looking oil and gas companies and services providers have embarked on the third critical component “People”.

Consensus at the SPE “Getting to Zero” sessions was that to ensure a safe work environment requires not only technical and procedural improvements, but also close consideration of cultural and behavioral aspects, including human factors.

Poor and inconsistent human performance continues to be an issue that impacts the oil and gas industry safety performance. Similar incidents occur across the industry with familiar root causes labeled as human error. This “cause” aligns with the simple cause-effect relationship the industry has historically relied upon, but which has not achieved the desired outcome, lack of recurrence. A genuine step change in HSE performance is not going to occur until the industry catches up with the thinking and commitment found in other high hazard industries and HROs. In the case of incidents, investigations and root cause analysis must include evaluation and explanation of the conditions or events that led to human error. Often human error is mistakenly categorized as human factors when, in fact, the application of human factors – understanding why people do what they do – is essential to the creation of a safe workplace. This includes elements of human factors inclusive of neuroscience and social science.

As was identified by the SPE “Getting to Zero” session participants, the oil and gas industry needs to demonstrate a consistent commitment regarding human factors. Part of the struggle has been the multiple definitions of human factors presented within the industry. These multiple definitions have led to misunderstandings of core issues that lead to the inability to design processes and “tools” that make a difference for the frontline worker. The concepts and discussions of the SPE “Getting to Zero” sessions and the authors of this report rely on the International Association of Oil and Gas Producers (IOGP) definition of human factors:

The interaction of individuals with each other, with facilities and equipment, and with management systems (IOGP 2005).

If the oil and gas industry is to achieve the needed step change in culture, risk management and performance to embrace and realize an expectation of zero harm it is worthwhile to understand more about human factor elements (Fig. 3). Specifically, how they may and are being applied across the oil and gas industry; and how HROs and other industries changed, learned and worked together to fulfill the expectation of zero harm in their operations.
1. Human/Equipment Interaction
Addressing Human/Equipment Interaction requires mastering three categories:
- Identification of human actions that are critical to safety;
- Review of legacy equipment incident data with proper human factors causal analysis to identify opportunities to improve equipment design; and
- Incorporation of “error reducing” strategies and questions during risk assessments.

Identifying human actions that are critical to safety places emphasis on operating activities that, if not performed in accordance with the procedure, could result in a major loss. The nuclear industry, through the Nuclear Regulatory Commission (NRC), handles this category through their Human Factors Engineering (HFE) programs. The “major loss” concern includes damage to the nuclear reactor core. The goal of the programs is to minimize the likelihood of human error and ensure that personnel can detect and recover from any errors that may occur.

The NRC conducts a review for every plant design application to verify that the applicant has:
- Identified specific important human actions tied to human factors; and
- Considered error mechanisms for important human actions in designing the human factors aspects of equipment and the facility.

Through a combination of probabilistic and deterministic risk analyses, the HFE programs identify which human actions are most important to safety for a specific facility design, and uses the information to prioritize and assign efforts and resources on developing solutions to prevent human error.

It is important to recognize the nuclear industry is a highly regulated industry with consistent approaches used world-wide and where the industry and regulators share and communicate on best practices. Although not a perfect alignment to the oil and gas industry, there is much to learn from the human factors programs the nuclear industry has developed and implemented for critical tasks. To this end, research has been done to bridge the nuclear industry’s Human Reliability Analysis (HRA) methods to oil and gas operations (Boring and Øien, 2014). This research illustrates how the concepts and learnings about human factors can transcend industries and operational boundaries.
Identifying opportunities to improve equipment design involves determining causal factors that can be traced back to sub-optimal equipment design or user/equipment interfaces. Initial emphasis is placed on thorough reviews and analyses of lessons learned from legacy predecessor or comparable equipment to help identify and eliminate characteristics in the new equipment that:

- Require excessive cognitive, physical or sensory skills, or high aptitudes;
- Involve complex fault location or workload-intensive tasks;
- Necessitate excessive training; or
- Result in frequent or critical errors.

The nuclear industry, commercial aviation and the U.S. Department of Defense (DOD) have extensive human factors user-centered equipment design requirements focused on physical human performance considerations, human cognitive behavior, and industrial design.

The Three Mile Island Commission, the Federal Aviation Administration (FAA), and the Deepwater Horizon Commission are resources for recommended equipment design improvements from major incidents. Examples from these include:

- Equipment reviews from the point of view of providing information to operators to help them avoid making human factors errors that escalate a situation and to cope with accidents when they occur (President’s Commission 1979).
- Provide monitoring instruments and equipment to record continuously all critical plant measurements and conditions (President’s Commission 1979).
- Computer technology that clearly displays for operators and shift supervisors key measurements relevant to potential conditions, together with diagnostic warnings of conditions (FAA 1995).
- Grouping of key measurements, including distinct warning signals, on a single panel should be available to the operator, and a duplicate panel in the shift supervisor's office (Presidential Commission 2011).

It is not without awareness that some of the reports above are nearly four decades old. The relevance of which illustrates why and when other industries (and HROs) expanded their understanding of the people/equipment element of human factors and in some cases embarked upon a commitment to integrate human factor elements across their industries.

The analysis of incidents and equipment downtime focused on human factors can reveal important clues for opportunities to improve equipment design and eliminate future human error. However, determining a causal factor regarding human factors from an incident is only one step. Other contributing factors must be identified to comprehend the total complexity of the breakdown in human and system performance.

Incorporating human-error-reducing questions and strategies into early risk assessment activities is the third category in the Human/Equipment Interaction element. HROs employ error-reducing design questions and strategies during quantitative and qualitative risk assessments. For example, DOD Standard Practice “Human Engineering Requirements for Military Systems, Equipment, and Facilities” provides the foundation for asking such critical questions during the early design stages. Their questions require specificity in the answers beyond just yes and no and include the following.

- Have human roles, interfaces, and workloads been fully identified and analyzed?
- Are tasks designed to be within human capabilities and limitations?
Will the design provide adequate decision support to minimize situations where humans may rationalize away information or data that is problematic, unclear, or ambiguous, or which does not meet with what the team believes (or wants to believe) is the actual state of an operation?

Are job aids, training, or references required? Is their availability timely?

Have human/system interface design incompatibilities been corrected by changing the design or restructuring the tasks to ensure that degraded human performance does not result in degraded system performance?

Have critical tasks and steps been thoroughly defined? Are they understood? Can these tasks be performed reliably? (For example, avoidance of distractions or ensuring alertness - lack of fatigue).

Has equipment been designed to support performance of critical tasks in terms of use of automation, user interface design and equipment layout?

Has equipment design considered increasing sensitivity to weak signals and enabling a culture that rewards mindfulness when performing any critical activity?

Have lessons learned regarding operability and maintenance from similar equipment designs been considered in the design of the new equipment?

Organizations often begin by defining tasks that have fatality or serious injury potentially in advance and put prevention or mitigation elements in place prior to performing the task. The oil and gas industry has examples of where these strategies are being implemented. A global integrated oil company utilized human factors to address human errors in potential major accident hazard events. High risk tasks were identified and prioritized to include significant safety, environmental and/or operational risks. The prioritized tasks were part of an initial effort and once the process was implemented benefits were noted leading to expansion of the process across the company. In addition, educating the workforce in human factors resulted in operating sites having significantly more robust work instructions that were better understood. Therefore, hazard awareness was improved and personnel were more confident in challenging activities that they were unsure of and quicker to identify potential anomalies (Petrie and Rosbrook 2015).

Further efforts towards improving human performance includes identification and discussion of types of errors based on performance modes: skill-based; rule-based; and knowledge-based (Rasmussen 1983). Organizations that are advanced in human factors consider how an individual’s traits and characteristics further impact performance mode behaviors. Recognizing each personality has a different risk awareness and tolerance level and applying necessary adjustments is providing notable results in performance for many organizations. As an example, a global drilling company utilized a personality identifier process to enhance communication, applied leadership, personal and team development, and risk awareness and mitigation. The impact in safety performance was notable and from a pilot application a global implementation was planned (Barakat et.al. 2010).

These examples represent the beginning stages of how human-error reducing strategies are effectively being implemented in the industry. The obvious next step is to begin the process of integrating these efforts across the industry and not just within individual companies.

2. Human/Management System Interaction

The second of the three key relationships is between the worker and the management system (operating or safety). Management systems provide direction and guidance for people, the organization, and contractors on how to operate. When the effectiveness of a management system fails, the results can be catastrophic.
In 1996, 110 people were killed when their DC-9 aircraft, flown by ValuJet, crashed shortly after takeoff from Miami International Airport. The National Transportation Safety Board (NTSB) concluded that a fire had started in the cargo hold of the DC-9, cutting through the flight controls and rendering the aircraft uncontrollable by the flight crew. The fire was linked to hazardous cargo that the contract service company had not properly prepared or presented to ValuJet before it was loaded onto the aircraft. The NTSB determined that contributing to the incident was ValuJet’s failure to oversee its contract maintenance program to ensure compliance with maintenance, maintenance training, and hazardous materials requirements and practices.

In the oil and gas industry, Piper Alpha had a similar effect setting in motion the evolution of the safety case and safety management systems. In 2010, Transocean and the Deepwater Horizon management systems were rendered ineffective in preventing or responding to the flow of hydrocarbons in the riser and subsequent explosion and fire. The United States Coast Guard (USCG) accident report stated:

“The Safety Management System failed to provide proper risk assessment, adequate maintenance and material condition, and process safety adherence. The Flag State and USCG did not identify these system failures in time to ensure the safety of the vessel” (USCG 2011).

These fatal incidents highlight the importance of the relationship between management systems and human factors. Safety management systems, in and of themselves are not the answer, but the discipline of human factors helps to uncover gaps in management systems, helping to ensure their effectiveness.

One of the key elements within a management system is a detailed set of specific and mandated operating procedures. These procedures indicate to the human operator the way the organization intends to have various tasks performed. The intent of operating procedures is to ensure the following, and ultimately to deliver a predictable outcome:

- Provide guidance to the worker to ensure logical, efficient, safe, and predictable means of carrying out work;
- Reduce the variability of work;
- Deliver clear expectations; and
- Define boundaries of acceptability of work.

HROs have procedures that are designed to prevent errors, that are standardized in format, and function to ensure that they are followed by workers throughout their industries, regardless of company affiliation. Performance mode thinking, as an aspect of human factors, helps to create procedures that consider the reasons that produce errors and attempt to eliminate them when procedures are created.

In the oil and gas industry differences exist in contractors’ operating procedures that sometimes exhibit little consistency. Such non-standardized work processes lead to deviations by individuals and crews, as well as difficulty in training people as they move from one location or company to another. These deviations continue to occur in the oil and gas industry and typically they are masked on a contractor’s mishap report labeled as “not following procedures”, which does not cite proper corrective actions other than “follow the procedures” to prevent similar incidents. Furthermore, the more routine the work becomes for a worker, the more apt the worker is to drift from the original/mentored way of conducting work. This effect is known as procedural drift an adaptation of Practical Drift (Snook 2000), the search to establish why formal safety procedures may not assure system safety.

There is a concern that the industry is exposed to workers who learn their craft and reapply knowledge from each other more than from formal/procedural training (Caldwell and Hinton 2015). This approach to
conducting work has left a large variable in the output of the work and highlights the development of workers as the single point of failure in the management system.

The nuclear and commercial aviation industries provide an interesting counterpoint to this approach. These industries developed detailed, standardized, step-by-step operating procedures to help prevent human error during routine work – where most incidents occur in the oil and gas industry. These highly detailed operating procedures became the foundation of the safety or operational management system for each organization in their industry and created a step change in safety. Today, operating procedures are the cornerstone of any corporate management system throughout these industries because they are used for training, investigation, quality control, auditing, continuous improvement, and organizational learning.

There are efforts underway within the oil and gas industry to change the course. An oil and gas service provider designed a system of checklists for operating perforating guns with a goal of lowering their misfire rate. Although the project was initially identified as an operational enhancement and not specifically a safety improvement, the focus on risk (misfire) reduction provided improvements in safety, reliability and operations. Perforating gun checklists were designed to catch human-errors during the process of rebuilding the guns. Three months after crews were trained on how to use the checklists and with over 1,600 gun runs, the results were staggering. With a measured operational improvement of 74 percent within a few months and a quarterly savings of over $18 million, the service provider declared the project a tremendous success. Three years later the teams that received the checklists and training realized reliability improvements of over 300 percent (Dingee 2015).

The importance of the worker to their management system cannot be understated. Company management systems in the oil and gas industry have been in a constant state of overhaul and revision over the last 20 years to improve safety culture and organizational performance. This is because humans govern and accomplish all the activities necessary to control the risk of incidents. Not only do humans unintentionally make errors in executing a process that can result in an incident, but they also make errors by creating deficiencies in the design and implementation of management systems. We are prone to making errors in all areas of management systems such as authorities, accountabilities, procedures, feedback, proof documents, and continual improvement provisions. Ultimately, human factors is a means to systematically validate the efficiency and effectiveness (quality) of our management systems.

3. Human Interface/Performance
An important characteristic of HROs is their recognition of the importance of human performance and decision-making. The nuclear, aviation, and medical industries and the DOD continue to invest in the understanding of human performance concepts. They apply how people make decisions and implement practices to consciously identify where opportunities may exist to reduce human error. They accomplish this by ensuring effective procedure guidance or engineering features are in place to mitigate deficiencies in human performance and decision-making. While the research and applied literature on this topic is extensive, going back many years, a detailed review of the literature is beyond the intent of this paper. Some key examples and learnings for the design of equipment and practices that consider human performance and decision-making include:

- Where critical equipment and operations support the human decision-making process.
- Examination of past incidents and development of specific learnings that are then fed back into the design of doctrine, equipment and standards, including better incident reporting and investigations.
- Assuring competence on decision-making strategies for teams and within the organization.
 Opportunities where critical equipment and operations support situational awareness and decision-making are regularly found in HROs. Nuclear power plants have numerous alarms and indicators to communicate operating parameters that are out of limits or need attention. In commercial aircraft, ground warning proximity alarms are present to warn pilots when they are too close to the ground. Ideally, the design of warning and alarms are thoughtfully integrated into the overall systems that support operator’s situational awareness. Ideally, these alarms are meant to increase the operator’s situational awareness, but depending on the number of alarms, an alarms’ level of reliability, and whether the alarm can be deactivated by the operator, alarms are not well integrated with the mental processing of the operator (Jones and Endsley 2004).

An example of poor alarm integration is the 1987 Northwest Airlines Flight 255 that crashed on takeoff from an airport in Detroit, killing all but one person onboard. The investigation revealed that the automated takeoff configuration and warning system had failed (NTSB 1988). The pilots, having become distracted by air traffic control communications, were unaware that they had misconfigured the flaps and slats for takeoff. The automated system, designed to detect and prevent exactly this type of problem also failed. The crew was unaware of both the state of the aircraft and the state of the automation. Design of warnings and alarms needs to be thoughtfully integrated into the overall systems that support situational awareness.

In the oil and gas industry proximity alarms or detectors are in place as an alert to high hazard, “red zone” conditions (for example potential exposure to hydrogen sulfide, or alerting a driller of the potential interference with the traveling block). Thus, the industry is not starting from scratch in introducing this type of technology. However, the challenge is to ensure the desired outcome to increase an operator’s situational awareness is occurring and, to improve the human interface with these tools.

The second category involves further examination of past incidents and development of specific learnings that are then fed back into the design of doctrine, equipment, and standards. All too often, safety investigations begin and end with the individual who committed the “unsafe act” and unless a high potential event or one that attracts external attention, the rigor to go beyond “who committed the unsafe act” is not consistently done. Safety investigations must go beyond typically stated causal factors such as employee incompetence, failure to follow procedures, failure to recognize risk, failure to maintain situational awareness, failure to maintain vigilance, or just human error. HROs conduct investigations to determine why or how the human made the decision that preceded their action (the error). Understanding why the team or the individual made certain decisions is critical to learning how to prevent human error.

As an example of how learnings from industry incidents are leading to improvements, a drilling company in consideration of the role human factors has had in oilfield incidents, revised their well-control manual. Well-control presents complex and diverse challenges that can create a high-stress environment, therefore the company decided to introduce human factors into the management of well-control incidents. Their journey of development included identifying the specific human factor elements relevant to well-control processes and tasks and consideration of how to successfully implement significant change in an industry generally resistant to change (Odgaard and Morton 2017).

The third category addresses training on decision-making strategies for teams and within the organization. The DOD, commercial aviation, and other industries have been conducting training in this area including:

- Training for individuals and teams on how to improve workers’ situational awareness.
- Decision-making strategies are being taught and communicated across organizations. The purpose is to improve awareness that human decision-making is impacted by cognitive biases. Further, the learning environment helps teams and individuals consider the need to be cognizant and to look for mitigations and improvements.
Simulators and virtual environments are being used increasingly to help improve situational awareness and decision-making by the crew.

Crew resource management (CRM) training is a recognized tool for improving team decision-making. Within CRM, the emphasis is on human interpersonal behavior. These are the personal and social resource skills that complement technical skills that contribute to safe and efficient task performance (Flin, et.al. 2008).

The commercial aviation industry is viewed as an industry leader in recognizing the importance of interpersonal skills or CRM training to assure its safety record. CRM training covers skills such as leadership, communication, assertiveness, team-building and cooperation, and conflict resolution that are central to optimizing inter-personal effectiveness. The goal of this training is to increase situational awareness that aids in making better team decisions. Most programs include scenario-based training within flight simulators to enhance effectiveness of the learning experience.

In the oil and gas industry follow-up reports from multiple incidents in the petroleum industry have included indications that inter-personal factors contributed to individuals either:

- Not sharing and using information that was available to them; or
- Not effectively challenging decisions that they believed were wrong.

Therefore, the industry has started considering training for their workers regarding decision-making and cognitive bias in courses typically called “non-technical skills training”. In 2014 IOGP released two publications – OGP 501, OGP 502 – that identify a training syllabus and instructor guidance for CRM customized to the needs of well operations teams who are performing drilling, completions, intervention and work-over operations.

The impact of non-technical factors to HSE performance and operational execution was evaluated by a global oil company’s drilling team. The 14-month, two rig program was designed to assess and improve human factors awareness and modify team behaviors using the application of CRM and other methods used by HROs with a goal of achieving perfect or near perfect operations – hurt free and spill free - while improving performance efficiency. The application of CRM principles was reported to produce significant days of perfect HSE and improved operational execution (Morris, et.al. 2016).

Continuing the application of CRM for all job categories will enable the industry to address yet another element of human factors - the engagement and interpersonal skills we rely on as we achieve the expectation of zero harm.

As was identified at the SPE sessions, human factors is an important element in the evaluation and management of risk within the industry. The United States Department of Energy (USDOE) sums it up best.

“It is not easy to anticipate exactly how trivial conditions can influence individual performance. Error-provoking aspects of facility design, procedures, processes, and human nature exist everywhere. No matter how efficiently equipment functions; how good the training, supervision, and procedures; and how well the best worker, engineer, or manager performs his or her duties, people cannot perform better than the organization supporting them. Human error is caused not only by normal human fallibility, but also by incompatible management and leadership practices and organizational weaknesses in work processes and values. Therefore, defense-in-depth with respect to the human element is needed to improve the resilience of programmatic systems and to drive down human error and events” (USDOE 2009).
5.0 Achieving a culture of perfection led from the top

“Oil and gas companies will never be ‘High Reliability Organizations’ if they rely on campaigns to change hearts and minds on the operational frontline. Instead, they must identify the obvious precursors to catastrophe and get serious about eliminating them – led firmly from the top.”
Andrew Hopkins, 2014.

Zero harm as an expectation will require a cultural adjustment for the industry. Patrick Hudson’s Safety Culture Maturity Model (Hudson 2001) is a recognized framework used by organizations to assess and understand their culture. For the 2015-2016 SPE “Getting to Zero” sessions the Hudson Model was adapted to evaluate HSE culture and risk tolerance (Fig. 4).

![Fig. 4. Culture/Risk Tolerance adaptation of Hudson’s Safety Culture Maturity Model.](image)

Participants at the SPE “Getting to Zero” sessions identified that an evolution to a generative mindset is emerging within their companies, for both HSE culture and risk tolerance (Fig 5). Specifically:

- Two-thirds (69%) identified their organizations to have a proactive/generative HSE cultural mindset – 50% Proactive / 19% Generative.
- Three-quarters (78%) identified their organizations to have a risk tolerance mindset of being naturally proactive/generative – 72% Proactive / 6% Generative.

Although the over 750 session participants represented a diverse cross-section of the industry the authors are not concluding the survey unequivocally defines where the oil and gas industry is on its evolutionary journey to a generative mindset. Rather the authors attest that the results represent insight into the desire and direction the industry is moving on attributes that are essential for achieving zero as an expectation.
Fig. 5. HSE Culture and Risk Tolerance survey results from SPE “Getting to Zero” sessions.

Also, indicative of the culture across the industry being able to achieve an expectation of zero harm is the present attention and action that is being given to incidents. As a frame of reference, incidents are categorized as fatalities, lost time injuries, medical cases, first aid, hi-potential and near miss. When asked what level of safety incidents trigger their company’s incident analysis and attention the participants reported the following: (Fig 6.)

- Over a third of the session participants identified that in their organizations all incidents receive analysis and attention regardless of outcome severity.
- For nearly half of the participants, hi-potential incidents initiate action in their organizations.
- The small remainder of participants limit their analysis and attention to traditional incident metrics (that is, fatalities, lost time, medical cases and first aids).

Fig. 6. Management of HSE incidents - survey results from SPE “Getting to Zero” sessions.
When session participants were queried regarding their company’s state of cultural readiness to embrace zero as possible, the results were notable.

- Two percent expressed no desire to pursue and just sixteen percent cited a present lack of leadership commitment or limitations in their present means to manage HSE as what was holding them back.
- Thirty-three percent indicated it may take some time and clarity as to “how” they would embrace zero as possible.
- Nearly half (49%) responded they are actively working now or are ready to join others in the pursuit.

Most encouraging are the organizational behaviors, cited during the SPE “Getting to Zero” sessions, that underpin these positive percentages. More organizations now genuinely believe safety is critical to business success and that their safety systems are essential; using effectiveness methodologies to ensure their efficacy. For many, safety is a fundamental part of who the organization is, not a discretionary add-on, or someone else’s responsibility.

Organizational and personal accountability mindsets are now more prevalent, causing preemptive challenge of conditions and behaviors, because the recognition and perception of risk has increased and tolerance for risk has decreased. This supports Patrick Hudson’s research that organizations shift their tolerance/perception of risk as they evolve upwards on his culture ladder (Hudson 2001).

To continue this cultural evolution across the entire industry, the critical component to instilling and ensuring the necessary change rests with leadership behaviors. Andrew Hopkins states, “a company may expend huge resources trying to change the way operators, foremen, and supervisory staff think and feel about safety, but a far more effective approach is to instill a culture of ‘This is the way we do things around here’. This approach focuses on what people do, not on what they think.” And, says Hopkins, “what people do is something company leadership can indeed control, while what people think is neither here nor there” (DecomWorld 2014).

“Organizational culture reflects the shared, tacit assumptions that have come to be taken for granted and that determine members’ daily behavior. The subset of assumptions about safety in an organization can be loosely labeled safety culture, encompassing the organization’s values, beliefs, attitudes, social norms, rules, practices, competencies, and behaviors regarding safety.” (National Academy of Sciences 2016).

The 2016 National Academy of Sciences “Strengthening the Safety Culture of the Offshore Oil and Gas Industry” report identified that safety culture is elusive, both conceptually and empirically because safety itself presents many distinct challenges for organizations including the following:

- Issues that negatively impact oil and gas production are perceived by the organization as an acute problem that needs to be addressed immediately, while safety is viewed as a more chronic concern that competes, often unsuccessfully, with production for resources, attention, and real commitment.
- Safety demands seeing and preventing an incident in the making. Therefore, a strong safety culture is often difficult to manage and sustain because people have difficulty knowing the mistakes they did not make but could have.
- Feedback on system safety is often discontinuous because recorded accidents, incidents and even near misses are relatively rare. Further, it is indirect because the data reflects a system only at a moment in time without necessarily indicating its intrinsic resistance to operational hazards.
Members of senior management have been identified as critical drivers in setting the priorities within an organization (O’Dea and Flin 2003). The higher the individual is in an organization, the greater their potential to influence organizational outcomes through their behaviors and actions. Managers have a direct effect on establishing the culture of the organization and the safety climate - employees’ behaviors - in the workplace. The model described by O’Dea and Flin (2003) demonstrates that senior managers have a direct impact on the HSE attitudes and behaviors of middle managers and middle managers in turn have the same impact on supervisors. Because of this influence, the importance of effective HSE leadership by senior managers and middle managers becomes apparent. They have a critical role in creating positive HSE attitudes and behaviors throughout an organization. It becomes very clear how important HSE Leadership by senior managers is in ensuring safety remains on a par with other business priorities such as profitability and productivity.

Some error prone behaviors can become self-reinforcing if leaders don’t continually emphasize the importance of safe behaviors and practices. For example, if a procedural shortcut or using an incorrect tool saves time and does not result in an incident or near miss, the positive consequence of the error prone behavior can easily reinforce the behavior and over time this type of occurrence can become part of the culture of the organization.

A tragic and memorable lesson in cultural deviation resulting from commitment to schedule and delivery are the tragedies at the National Aeronautics and Space Administration (NASA) – the loss of Challenger and Columbia crews. These failures were defined as examples of “normalization of deviance”, meaning people within the organization become so accustomed to a deviant behavior that they do not consider it as deviant even though they far exceeded their own rules for safe performance (Wilcutt and Bell 2014).

As explained by Diane Vaughan, “In many cases the various pieces of hardware and systems that ultimately fail, ‘talk’ to us in some manner before the failure. As leaders, we need to decide whether to listen to the hardware and fix it (or control it), or rationalize the risk and continue operations. Before Challenger’s fatal flight, NASA had seen erosion of the Solid Rocket Booster O-rings on previous flights. Likewise, before the loss of Columbia NASA had seen multiple pieces of foam liberated from the external tank and strike the vehicle. In both cases, the decision was made to accept the risk of flying with these failure modes. For a short time, the flights were successful, and so we congratulated ourselves on making the right decision. Unfortunately, the risk still existed and we paid the consequences” (Vaughan 2016).

Finding ways to translate learnings from other industries into action in the oil and gas industry has not been easy. An oil and gas service provider enlisted leaders as HSE owners by developing an HSE leadership program for senior managers (Breitsprecher et al. 2014). The program used findings from previous psychological research on the role of managerial leadership in determining workplace safety outcomes, and applied the antecedent-behavior-consequence (ABC) model (see Appendix 7.3). The aim of the program was to increase HSE leadership by senior and middle managers and thereby accelerate the development of a strong HSE culture. The scope of the HSE leadership program was to increase managers’ and senior managers’ operational ownership of HSE and provide ‘line of sight’ as to what effective HSE leadership is and how to apply it to daily activities.

The first phase of success was commitment from senior management outside the HSE function to endorse the HSE leadership program. If this commitment was not present and the training was not perceived to be integral to the business, the participants in the course would not recognize the importance of the training. Further the goal of achieving a strong culture through operational ownership of HSE would be undermined.
To assure this critical aspect of success, a series of executive sessions were conducted for the executive leadership teams of the organization to ensure their commitment and involvement in the program. Members of the executive leadership team were active participants in the sessions and defined their expectations for participants following their completion of the program.

The program’s effectiveness was realized at various levels of the company. The executive leadership awareness and commitment drove an increase in their level of accountability and ownership. The direct reports of those attending the leadership sessions reported an increased awareness and improved HSE behaviors. The participants themselves were the instigators of the cultural change of their supervisors and their subordinates. In summary, the results demonstrated that the HSE leadership program had a positive impact on the operational ownership of HSE.

Programs like the one described above have been implemented with varying levels of success in several oil and gas companies. In each case, the impact/success of the program was directly related to the level of senior operational management involvement in the process. In short, effective and engaged leadership matters.
6.0 Where do we go from here? Next steps

“If a problem is too difficult to solve, enlarge it.”
Dwight D. Eisenhower

The takeaway from President Eisenhower’s words is that we should be thinking about managing HSE as a subset of a larger human factors question that can then be enlarged to become part of the organizational development of HROs. Or, seen another way, as we get HSE and human factors right, we move closer to managing risk throughout our organizations—and our industry—to get everything right.

Despite year-on-year improvements in personal injury rates, fatal incidents in certain areas continue at unacceptable levels. In 2016, IOGP members reported 29 fatal incidents resulting in 50 employee fatalities (IOGP 2017).

High-profile incidents such as Exxon-Valdez, Deepwater Horizon, and the Lac-Mégantic rail disaster, have led the industry to focus increasingly on process safety and systems engineering. While needing to maintain high investment in occupational safety programs, the industry also is investing more than ever in the prevention of “low-frequency, high-severity” incidents – those rare, but disastrous events that can cause devastating harm to people, communities and ecosystems. With this investment, focus on “high-frequency, low-severity” incidents sometimes suffer.

So, when faced with these challenges the industry’s alignment on an expectation of zero harm must encompass managing its risks as a high reliability industry, and given this goal there are many opportunities for companies to focus their efforts to drive them towards implementing generative characteristics common to HROs.

In generating next steps for continuing both the discussions and actions required to achieve an expectation of zero harm, the authors considered the output of the SPE “Getting to Zero” sessions and developments that have ensued since the sessions. These recommendations are provided below. In addition, during the peer review of this paper the reviewers provided additional topics for consideration by the industry. The authors believe the reviewers’ recommendations are additive to the discussion and have included them in the Afterword found in Appendix 7.4.

What do we do as an industry?

1. **Shift from “Zero as a Goal” to “Zero as an Expectation”**. In the 1990s leading companies in our industry defined a goal of zero harm (for example, Exxon’s “Nobody Gets Hurt”, Shell’s “Goal Zero”, and BP’s “No accidents, no injuries and no harm to the environment”); the ultimate outcome of these efforts would be that no one is hurt and no releases occur. These goal driven visions drove a step change in the reduction of injuries and spills. But despite these improvements, catastrophic incidents—fatal injuries and major releases—occur in our industry at a persistent frequency today.

   To eliminate catastrophic events in the oil and gas industry, we need to revise our vision of zero. Defining zero harm as a goal implies that we can set incremental safety performance targets, it acknowledges that our operations will harm today. Further, this thinking can lead to a detrimental focus on incidents and injuries that may lead to under-reporting of incidents, gaming of statistics, manipulation of incident definitions, and overly aggressive injury case management. A goal of zero suggests an unattainable numerical target of perfection. Rather, we need to think of zero harm as an expectation at each-and-every moment. We need to acknowledge the risks in our industry and at the same time we need to expect that the people working in our operations will go home safe today.
In the 1950’s, the frequency of airplane crashes was so high that many assumed there could never be a market for air transportation to the public. So, the nascent commercial aviation industry did not set a future, ultimate goal of zero plane crashes. Rather, they realized that a single plane crash is one too many and they committed to eliminate catastrophic aviation accidents. They began to expect that every flight could arrive safely. The steep drop in commercial aviation accidents in the 1960s is a testament to this industry’s commitment. In the same way, the oil and gas industry can eliminate catastrophic events when we begin to expect zero catastrophic events.

Perhaps this is a nuanced, subtle shift in thinking—from a goal of zero harm to an expectation of zero harm—but the difference between the two is the difference between focusing on future improvement and focusing on safety in the moment. This shift in mindset is imperative to eliminate catastrophic incidents.

If we can agree as an industry that zero harm is an attainable expectation, then we will commit to undertake the necessary step change to ensure it is attained.

Individual companies and organization such as SPE should review their Safety Visions and the workforce safety messaging to clarify that zero harm is not an ultimate goal, but is an immediate expectation.

2. **Continue to progress the application of human factors.** The cultural shift to being proactive, and ultimately to being generative, is causing healthy questioning of how the industry has managed HSE. SPE “Getting to Zero” session participants characterized:
   - Essentially half (49 percent) of the industry’s efforts to manage HSE performance are still very traditional; specifically, comprised of management systems, standards/procedures and audits/inspections;
   - Only around 11 percent of companies are using Leading Indicators; and,
   - Only six percent are evaluating and using human factors elements.

The realization that our present suite of management and mitigation efforts can only yield incremental HSE performance improvement is profound; particularly when one considers how sacred the traditional approaches have become. The questioning that incremental-thinking must be replaced with zero-thinking is driving the appetite to radically do something else. This is a significant shift in the industry’s culture, and one that is positioning for the acceleration of human factors to get us to zero.

The industry should standardize on a set of leading indicators that measure the degree human factors is being used in our industry. This would necessitate a common view of human factors. During the peer review of this report, it was evident the views of human factors and its successful application in the oil and gas industry varies considerably across the field of human factor technical experts. Continuing the discussion and sharing how human factors elements can be and have been successfully applied across the industry’s operations will benefit the whole industry and improve the likelihood of the industry, not just individual companies, to achieve the expectation of zero harm.

Once we have a common understanding around human factors we can develop a common vocabulary and, we can begin to drive a consistent industry culture that will help all companies with considerations such as resource planning and competencies. We will be able to regularly include human factors assessments in such things as Hazard and Operability Studies/Hazard Identification Studies and equivalent tools/processes so we can identify shortcomings in the understanding of the engineered process. Incident investigations and root cause analysis can include a common set of
human factors attributes that would allow companies to better understand contributing factors in events that go well beyond the often-cited and yet narrow assessment that someone did not follow process or that the event was caused by operator error.

Industry conferences and technical forums provide the opportunity to further the discussion and share broader ideas and actions started by the industry. Examples of these opportunities include:

- 2014 SPE workshop “Getting to Grips with Human Factors in Drilling Operations.” The main point from the workshop presentations and discussions were summarized in a paper that included practical tools and insights that could be applied to day-to-day operations and additional resources for further reading (Thorogood, et.al. 2015).

- A panel discussion at the 2017 Offshore Technology Conference included presentation by a service company about their work in human factors. Their efforts are focused on the underlying organizational and system aspects that support the individual. Using their “What Lies Beneath” approach (Fig. 7) that incorporates human factors elements they are embracing a holistic view that will enable their organization to achieve a step change, not just incremental change, in HSE performance. This will further their cultural advancement towards a HRO (Hinton 2017).

![Fig. 7. “What Lies Beneath” analysis of Human Factors Elements (Harris and Hinton 2017).](image)

3. **Achieve the right balance between leading and lagging indicators.** As an industry, we have become adept at gathering performance on lagging indicators (events that have occurred) versus leading indicators (risk control measures), both regionally and globally. While the emphasis on lagging indicators has brought significant improvement in recordable injury rates, the pressure exerted by focusing on incidents as a performance measure is yielding diminishing returns.
“Injury rates are no longer considered the best measure of a company’s safety program.” David Michaels, PhD – 2009-2017 Assistant Secretary of Labor for Occupational Safety and Health Administration (USOSHA 2012).

In addition to agreeing to target eliminating the worst events, the industry should agree upon an appropriate set of leading indicators. These measures would be the inputs required to get the desired outcome of eliminating incidents. This demands that we look toward the next evolutionary stage of our performance measurement and the need for the industry to focus on expected behaviors rather than outcomes of the process. It is only by collectively setting this expectation that we will establish an industry culture that requires the actions needed to prevent harm, rather than the harm that comes from a potentially flawed system.

4. **Optimize Collaboration Across Companies and Crews**

The oil and gas industry is made up of numerous operating companies, service companies, vendors, contractors and subcontractors—all interrelated and all needing to interface seamlessly to operate safely. With a workforce guided by a myriad of safety management systems and processes and procedures unique to each organization, working in alignment—and working safely—is a challenge. We need to improve how our individual companies collaborate with each other.

Numerous opportunities exist within the oil and gas industry to optimize collaboration. Some believe a rigorous “bridging” process between contract parties remains the single most important tool for collaboration. The process requires the parties to identify, document, and communicate hazards and controls in a bridging document that sets the stage for effective collaboration throughout a project.

Having said that, better standardization of terms will facilitate sharing. Standardization of HSE requirements can help support better collaboration between different companies working together. When the various parties on a job site are using the same rulebook, they are better able to collaborate. Efforts to standardize HSE requirements are already happening in various ways.

- Standardization of requirements within a single enterprise streamlines implementation of safety programs between major projects.
- Standardization of requirements between operators within a single region (such as in the Gulf of Mexico) can simplify training and assurance for vendors working for various operators—including individual workers who may continuously move from platform to platform and operator to operator.
- Standardization of requirements between projects within a single fabrication yard has potential to streamline differences between adjacent projects that share workers, and improve effectiveness of training and assurance efforts.

We need to establish and sustain a no-risk-to-sharing culture across the industry, with the goal of overcoming perceived risk and competition barriers. This is paramount to the identification and management of risk. It has been suggested that perhaps industry associations such as IOGP, International Association of Drilling Contractors (IADC), American Petroleum Institute (API) and the Center for Offshore Safety (COS) need to focus on the barriers to communication rather than more metrics and analysis. Intellectual property boundaries may have to be challenged where advances in HSE technologies could benefit the entire industry, but are used by only a few.

5. **Remove Barriers to Open Sharing of Lessons Learned.** There is no use sanitizing the message to the point of uselessness, and being vague dilutes the personal touch. As every soldier knows, war stories are more effective. The industry should be telling the stories, repeatedly, of the iconic
incidents relevant to the industry. Likewise sharing the success stories from jobs and projects successfully operated will enable learning opportunities from well executed work. Story telling is a powerful way of educating and reinforcing attitudes.

We must create an environment where incident information can be shared across boundaries without fear of unnecessary regulatory reaction and burden, misunderstanding and mistrust by the public, and frivolous and counterproductive litigation.

Michael Bloomfield is currently the vice president and general manager of Oceaneering Space Systems. Prior to that, he was an astronaut, shuttle commander, and vice president of Johnson Space Center Houston operations. He is NASA’s only ex-officio member of the Columbia investigation board. Bloomfield tells an iconic story that still resonates throughout the air traffic control community nearly 15 years after it occurred.

On July 1, 2002, a Russian charter flight and a DSL cargo flight collided in mid-air over Überlingen, Germany, when technical maintenance issues in the air traffic control room, conflicting instructions from European flight regulations and a Russian operations manual, and a stress-related mistake by the sole air traffic controller on duty converged to create a perfect storm of chaos and disaster. The crash killed 45 Russian schoolchildren who were being rewarded for excellent academic performance with a trip to Barcelona. It also ultimately killed the air traffic controller, who was murdered by the father of two of the children (Mayday Air Crash Investigation 2015).

“In air traffic control, the iconic story is still Überlingen. Recently I was doing some work with air traffic controllers in Melbourne, and an event occurred that was recognized as a remote precursor to an incident. Immediately, managers mobilized and the name on everybody’s minds – and I know because it was on people’s lips, as well – was ‘Überlingen’”, says Bloomfield.

“That people were super-sensitive to any hint of similarities in circumstance to that tragedy. It was unforgettable anyway, but its ‘unforgettableness’ had also been intentionally harnessed to useful effect in a way that the oil and gas industry’s unforgettable incidents such as Piper Alpha and Deepwater Horizon, generally, have not been. Stories are so powerful because they convert raw data into pictures and feelings, which our brains are hard-wired to receive.”

Recent progress is being made to remove barriers to sharing, starting with the interagency agreement between the U.S. Department of the Interior’s Bureau of Safety and Environment Enforcement (BSEE) and the Bureau of Transportation Statistics (BTS) to develop a confidential near-miss reporting system for use on the Outer Continental Shelf (SPE Technical Report 2016). As of September 2017, six companies had agreed to participate in the pilot program where it is planned BSEE and the industry will be able to capture essential information about accident precursors and potential hazards associated with offshore operations.

Other industries have committed to and benefitted from the process of sharing lessons learned, one being Formula One racing. Between 1952 and 1994 (43 years) 47 drivers were killed in Grand Prix championship and test races. In 1994 industry leaders came together and decided to suspend racing until a solution to the fatalities could be realized across the industry. With the commitment that safety was paramount and should not be left up to the individual teams in the highly competitive environment, common standards and a common approach to safety were established. The results of this action remarkably reduced driver fatalities with one fatality occurring in Grand Prix championship races in the last 23 years. This tragic occurrence prompted further improvement in track operations and driver safety systems across the industry.
Our industry needs to adopt a more open, transparent approach to sharing lessons learned from major incidents, high-potential near misses and projects where, although complex and with considerable risk, the work was executed without incidents. If we do not share we hamper our ability to learn from each other.

6. **Collaborate with Regulatory Authorities.** Andrew Hopkins summarizes the need to get regulators onboard if continued and sustained improvement is to occur across the industry.

   “Regulators have a crucial role to play because when they say what ‘the way things are done around here’ must look like, the industry has to listen. To get companies to focus on major hazard risk you need to get the regulators to focus on major hazard risk. In some countries they have already pushed behavior in certain directions, by requiring gas releases to be recorded and reported, for instance. That is a step in the right direction, but a gas release is still too close to a catastrophic event. The further upstream in the causal process you set the precursor event, the better.

   Regulators need to be highly skilled and resourced, and must be able to match the best minds in industry in order to have competent discussions about the risk-management strategies of corporations. In the US, they’re not doing that yet. The best practice recognized worldwide is the safety case regime, in use in the UK and Norway” (Decomworld 2014).

   We recognize that the certain legal systems can create an underlying adversarial relationship between industry and its regulators, but within this regulatory environment there is room to improve the collaboration and trust - which will lead to greater partnership.

7. **What do we do as individual companies?** The real power to break down silos and barriers to get to zero ultimately resides with the operating companies because they drive contractor behavior in most of the world. This having been said, some great risk management and organizational development improvements have been driven by individual drilling contractors and service providers.

   A recent SPE paper describes the challenge faced by an oilfield service company expected to deliver high HSE performance on site. “This expectation (is) sometimes easier said than done when variables outside of the service contractor’s control are taken into consideration, such as numerous third parties and their equipment, variances in processes across different companies, and the integrity of well-barriers owned and/or maintained by the operator or other contractors” (Novia and Fernandes, 2016).

   A collaborative environment and consistent safety culture is one in which all workers—regardless of the logo on their coveralls—look out for one another and confront each other as needed to address hazards. Ideally, a low-level laborer at any worksite can exercise Stop Work authority to a supervisor, regardless of company, and be assured of support from the facility owner (operating company representative). Of course, the ideal state is not the real state at many oil and gas worksites.

   a. **Interdependent HSE culture.** If a company has a mature interdependent HSE culture, its employees are more likely to recognize and act on hazardous conditions. The DuPont Bradley HSE Culture model (Fig. 8) describes the journey to an HSE culture in three phases, moving from a dependent phase, through independence, to an interdependent culture. In the dependent phase, HSE is mainly driven through use of control, discipline, rules, and regulations. As the culture matures, it moves through the independent phase, in which employees begin to take personal responsibility for HSE rather than simply relying on rules and regulations to create a safe work environment. The final – interdependent – phase is characterized by a “peer’s keeper” approach.
that is adopted by all. In this phase, employees do not just look out for their own safety; everyone looks out for each other’s safety, and management works collaboratively with employees on HSE matters, feeling comfortable leading or allowing others to lead. People do this because they genuinely care about the safety and well-being of their colleagues. They do it because they want to, not because they have to.

b. **Operational Ownership of HSE.** Interdependence is established by achieving operational ownership of HSE - that is, by employees assuming accountability for HSE performance and maintaining a safe work environment. Operational HSE ownership is characterized by employees looking out for each other, intervening in unsafe acts and conditions, and engaging with HSE to identify and implement risk-mitigating controls and processes. This leads to a collaborative engagement rather than HSE directing and acting as a police force in the organization. Operational ownership must, however, exist at every level of the organization to be successful.

c. **Sustainable HSE leadership programs.** While operational ownership of HSE leads to all employees assuming accountability for HSE performance, it is essential that senior leaders and managers are a continual driving force in embedding this concept throughout the organization. Senior leadership and managers have a direct effect on establishing the “culture” of the organization and employee HSE behaviors in the workplace. The behavior of managers, through their influence on employees, can strongly influence the HSE performance and HSE culture of an organization. Only when senior leadership and managers adopt operational ownership of HSE will the rest of the organization follow.

The oil and gas industry has made great strides in the way we manage HSE. We must continue to evolve our culture so everyone across the industry is empowered and responsible to make the right decisions every time and is supported by the organization and systems to be error free. We must do this in the face of ever changing market conditions that can form a barrier to HSE commitment and making the best decisions. Changing how we manage HSE is the next frontier for our industry. How we go about that change will shape the industry and the world it serves far into the future (Hinton 2016).

Zero harm is the expectation and the industry has the bench strength, the fortitude, the commitment and resources to make it happen. Let’s get going.
## 7.0 Appendices

### 7.1 Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
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<tr>
<td>BSSE</td>
<td>Bureau of Safety and Environmental Enforcement</td>
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<tr>
<td>BTS</td>
<td>Bureau of Transportation Statistics</td>
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<tr>
<td>COS</td>
<td>Center for Offshore Safety</td>
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<tr>
<td>CRM</td>
<td>Crew Resource Management</td>
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<tr>
<td>DOD</td>
<td>Department of Defense</td>
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<td>DOE</td>
<td>Department of Energy</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>HFE</td>
<td>Human Factors Engineering</td>
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<tr>
<td>HRA</td>
<td>Human Reliability Analysis</td>
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<td>HRO</td>
<td>High Reliability Organization</td>
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<tr>
<td>HSE</td>
<td>Health, Safety, and Environment</td>
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<tr>
<td>HSSE-SR</td>
<td>Health, Safety, Security, Environment and Social Responsibility</td>
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<tr>
<td>IADC</td>
<td>International Association of Drilling Contractors</td>
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<td>IOGP</td>
<td>International Association of Oil and Gas Producers</td>
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<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<td>NRC</td>
<td>Nuclear Regulatory Commission</td>
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<td>NTSB</td>
<td>National Transportation Safety Board</td>
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<td>SPE</td>
<td>Society of Petroleum Engineers</td>
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<td>USCG</td>
<td>United States Coast Guard</td>
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7.2 Participant Demographics for SPE “Getting to Zero – The Road to Stavanger” Sessions

SPE “Getting to Zero - The Road to Stavanger” sessions conducted across the globe were attended by over 750 participants. During the interactive sessions participants were asked to report their organizational affiliation and their employment position. The results are illustrated by the graphs below.

**ORGANIZATIONAL AFFILIATION OF PARTICIPANTS**

- Oil Company - 46%
- Service Company - 18%
- Consultant - 14%
- Vendor / Supplier - 8%
- Academia - 3%
- Government - 1%
- Drilling Company - 3%
- Other - 7%

**EMPLOYMENT POSITION OF PARTICIPANTS**

- Safety - 23%
- General HSE - 28%
- Environment - 6%
- Operations - 24%
- Engineering / Technical - 14%
- Other - 5%
7.3 The ABC Model

What does good HSE behavior look like? The ABC model is a methodology well-grounded in empirical research spanning more than 50 years. It is, as its name suggests, made up of three components:

- Antecedents, (events that trigger behavior);
- Behaviors (observable acts); and
- Consequences (events both positive and negative that follow behavior).

The ABC model enables managers to clearly identify and describe desired HSE behaviors. It replaces vague statements such as, ‘I want to improve my employees’ attitudes toward HSE,’ into more observable, behavioral terms such as, ‘I want all my direct reports to review risk assessments before the start of a task.’ These more concrete ways to express successful HSE performance enable managers to be more direct in their HSE leadership. The model also helps managers understand where and how their own behaviors affect HSE behaviors of others. If the managers change their own behaviors regarding setting antecedents and consequences, this changes the HSE behaviors of others, and ultimately leads to a positive shift in the organization’s HSE culture.

By applying the ABC model and setting timely, certain and positive consequences for safe behaviors, the manager can outweigh the positive consequence an error prone behavior might bring the employee. In addition, by setting timely, certain and negative consequences for error prone behaviors, the manager gives the employee the incentive to choose the safe behavior over the error prone behavior. As these safe behaviors are demonstrated and repeated over time by the employee, they are likely to become stronger and more habitual, and as such will assist in creating a strong HSE culture where safe behaviors are chosen over error prone behaviors.
7.4 Afterword

The peer reviewers of this report provided valuable insights and comments. Some of the comments and recommendations were beyond the scope of this report and the authors believe they merit additional consideration by the industry as the conversation about human factors and achieving an expectation of zero harm continues.

M. Sam Mannan, Texas A&M College Station

- Broadening the participation and contribution by all stakeholders, i.e. academia, government, industry and the public.
  - Academia everywhere should make appropriate curriculum revisions to include concepts of process safety, loss prevention, human factors engineering, and risk-based decision making. These curriculum changes should cover all engineering disciplines and extend to other disciplines as well such as the sciences, business, management, industrial psychology, and public policy.
  - Government should make sure that regulations are based on science, data, and risk. And once a regulation is promulgated, there should be a comprehensive plan for assuring compliance. Government can and must drive progress by developing and maintaining a national chemical incident surveillance system.
  - Industry should continue the progress towards adopting new and effective risk-based standards and engineering standards to improve safety performance. In this respect, specific emphasis should be placed on making progress in the Human Factors Engineering area. We should no longer accept or even allow self-defeating arguments such as, “cannot fix stupid.” Other areas of progress include safety culture, appropriate use of leading and lagging indicators, and wide sharing of lessons learned.
  - Public and public-interest groups should play their own role by engaging with industry and other stakeholders in a constructive dialogue based on a deep understanding of ‘hazard’ and ‘risk.’ We must realize that often we do not have a choice but to live with the hazards in our midst (because of the associated benefits); however, we do not have to accept unreasonable risks associated with the hazards.

Ron McLeod, Consultant

- The ideas of Barrier Management that have become current and very widely used across the oil and gas industry in the past 10 years and more. The UK’s CIEHF published guidance on Human Factors in Barrier Thinking in 2016 and CCPS has a new publication soon to be published that is relevant. This must have a critical place in achieving zero, at least for process safety.

John Thorogood, Drilling Global Consultant, LLP

- Expand the discussion to include the current modern thought leaders in human factors: Kahneman, Hollnagel, Dekker, Leveson, Shorrock, and Woods. Including the following concepts:
  - Kahneman: System 1 and 2 thinking: its impact on decision-making and design of procedures
  - Dekker, Hollnagel, Shorrock, Woods:
    - Safety-I vs Safety-II: people create safety in complex systems
    - Re-framing the discussion in terms of human performance as opposed to human error
    - Introducing the essential notion of “Work-as-imagined” vs “Work-as-done”
    - Recognizing local rationality versus situation awareness in post-accident investigation
    - Acknowledging the pernicious influence of hindsight bias in investigations
    - Incorporating the property of resilience
    - Accepting safety is an emergent property of complex systems
  - Leveson: Moving beyond simple linear accident causation models and thinking in terms of systems that consist of interactions amongst hardware, computer software and the operator(s).
The academic debate has moved on from HROs to the broader concept of resilience. Resilience is a topic that is the focus of active debate and development and the subject of multiple conferences and books. Resilience is an essential attribute of safe organization and that safety is the presence of capabilities of team members to recognize boundaries of safe operation, maintain control within them and recover from an excursion if it happens and that these capabilities must be trained and assessed.

IOGP does what it can in terms of sharing, but its efforts are hampered by lack of contributions from all but a few members and legal constraints on what can be published. The situation in our industry stands in complete contrast to that which prevails in aviation where the obligation to investigate and publish accident reports is an integral part of international treaty obligations. The ICAO was established by the 1944 Chicago Convention, ICAO, Annex 13, Aircraft Accident and Incident Investigation incorporated into the nation law of all participating states is the result.

By contrast, there is no such independent investigatory system for the oil industry. Consequently, to this day, the precise events and reports of the Macondo precursor incident that occurred in the North Sea in December 2009 remain a matter of anecdote. When asked for information, the Regulator simply dismisses the request with the remark that the information has been widely shared, the subtext being “amongst those that need to know”. This is hardly a shining example of transparency in an industry that is unloved by the public. This is a major failing in our industry and one that should be recognized as a blocker to safety.
7.5 References


Mayday Air Crash Investigation. 2015. DHL Flight 611 Deadly Mid Air Crash The Überlingen Disaster. Video File. https://www.youtube.com/watch?v=vZixPCeG4ss


7.6 Author and Contributor Biographies

Co-Authors:

Andrew Dingee has worked with the oil and gas industry since 2010 where his airline industry experience has guided him to successfully implement aviation style checklists and procedures that reduce risk and increase efficiency - saving hundreds of millions of dollars for his clients.

Dingee is a 27 year veteran (Lt Col) of the US Marines where he flew AV8Bs. During his tours, he received over a dozen awards for outstanding recognition with regards to standardization and safety. In 1999, he was hired at United Airlines and held a variety of safety leadership positions including Manager of Human factors. For his accomplishments, he was nominated for the Flight Safety Foundation Brownlow award. He conducts accident investigations with an emphasis on the human factor element, designs and delivers courses on threat error management, reviews CSB accident reports and develops standardization programs that consists of procedures and checklists which prevents and traps human error.

He was the former Chairman of SPE Human Factors Technical Section and a regular speaker at international events.

Dingee holds a degree in economics from the University of Illinois.

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Colette M. Glencross is Director, True North Concepts, Inc and serves as an executive advisor to global industries including energy, chemicals, maritime, aviation and law enforcement. Her areas of focus include enterprise risk management, operational excellence, organization effectiveness. She has 25 years in the global oil and gas industry serving as a registered lobbyist with the American Petroleum Institute, Strategic HSE Manager for Texaco, Senior HSE Director for Baker Hughes and global advisor. Prior to her work in the oil and gas industry she worked in state and local government and in manufacturing.

Glencross holds a MSPH degree in environmental science and a BS degree in biology both from the University of South Florida. She is a published member of SPE.

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Phil Grossweiler is a Principal Consultant at M&H Energy Services consulting to corporate clients on LNG business strategy, LNG projects, and managing risk in offshore oil and gas operations. Grossweiler first served as a U.S. Coast Guard officer on ships operating in North Atlantic and Greenland and Russian Arctic regions. He worked at Exxon for 25 years with assignments in Exxon’s U.S. and Norwegian production companies and Exxon’s Upstream Research and Upstream Development companies. His recent government service included assignments as Chair, Ultra Deepwater Advisory Committee for the U.S. Secretary of Energy on $200M Deepwater R&D Programs and on the staff of Congresswoman Heather Wilson (R-NM) for support on energy and science policy issues.

Grossweiler graduated from the U.S. Coast Guard Academy and holds MS degrees in mechanical engineering and naval architecture from Massachusetts Institute of Technology and a MBA degree from Houston Baptist University. He is Chairperson of SPE’s Human Factors Technical Section.
J. Jack Hinton is Chief Health, Safety and Environment (HSE) Officer for Baker Hughes, a GE company. With 40 years of oil and gas experience, he is widely known across the industry for strategic insights that are industry leading and yield step changes in how HSE is managed and integrated into the culture of organizations. Prior to joining Baker Hughes in 2005, he was a dean and professor at the Kazakhstan Institute of Management, Economics, and Strategic Research for two years. He previously spent 26 years at Texaco serving in leadership roles that included Director of HSE; and Vice President of International Petroleum.

Hinton presently sits on the Management Committee of the International Association of Oil and Gas Producers, is a member of the Kazakh-British Technical University Business School Advisory Board, sits on the Board of the Center for Offshore Safety, and serves as Chairman of the Board of Advisors for the Southwest Center for Occupational and Environmental Health. He is a member of the SPE HSSE-SR Advisory Committee, serving as Chair of its Safety Sub-Committee and a published SPE member. He is a distinguished speaker within the Oil & Gas Industry and within the HSE profession.

Hinton holds a DrPH degree in occupational health and a MS degree in environmental science, both from the University of Texas, and a BS degree in biology and chemistry from Trevecca Nazarene University.

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John M. Karish has held senior level HSE positions with Ensco plc and BP Exploration during the past 15 years. Prior to that, he held various operational drilling, technical auditing, organizational development and drilling safety positions with BP and its legacy companies in the US, and various international assignments. He is now pursuing similar interests in a consulting role.

Karish has been very active in both IADC and SPE HSE Conferences during the past 15 years, as an author, moderator, panelist and Program Committee member.

Karish holds a BS degree in petroleum engineering from the University of Pittsburgh.

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Tom Knode, is the Director of HSE for Athlon Solutions, LLC. He previously worked for Statoil on contract, with Contek Solutions, and spent 25 years with Halliburton. In his last position with Halliburton he was the Director for HSE Standards and Performance with global responsibility for health and safety technical experts and the HSE management system documentation. He has developed several HSE leadership workshops for operations leaders, introduced improved means of investigating incidents and sharing lessons learned, and established leading indicators to improve the balanced view of performance.

He has been active with industry and was the Technical Director of HSSE-SR for SPE from 2008-2011, has co-chaired five SPE HSE conferences and co-authored upwards of 20 technical papers and articles, including in the JPT. He was Chair of OGP Safety Data Task Force for two years and also worked on the rewrite of API RP 76 on contractor management.

Knode holds a MS degree in geology from University of Texas Arlington and a BS degree in geology from Texas Christian University.

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Tony Zamora is Director for the consulting firm, ERM. He has worked for over 25 years in safety and environmental leadership roles for the oil & gas industry - including Chevron, BP and Alyeska (the Alaska Pipeline). He has been responsible for HSE operational programs for offshore and onshore operations as well as delivery of corporate initiatives for safety improvement. His professional interests include safety culture, environmental protection, communication effectiveness and business management systems.

Zamora holds a BA degree in biology from the University of California at Santa Cruz. He has been an active member in SPE for 10 years.

Contributors:

Michael Bloomfield is VP and GM of Oceaneering Space Systems, a division of Oceaneering that provides space flight hardware and space suits to NASA. Bloomfield served 26 years in the Air Force as a fighter pilot, test pilot and NASA astronaut. While at NASA, he made three trips into space, serving as the commander on his final flight. He also held several management positions at NASA, including Chief of Safety for the Astronaut Office, Chief Instructor Astronaut, and Deputy Director of Flight Crew Operations. In this role, Bloomfield represented the Astronaut office for the critical go, no-go decisions prior to each shuttle launch. Bloomfield also served as the ex-officio member of the Columbia Accident Investigation Board, providing technical and operational expertise to board members as they investigated the reasons for Columbia’s loss.

Bloomfield is a 1981 graduate of the United States Air Force Academy, and holds a BS degree in mechanical engineering.

Lord Cullen of Whitekirk KT. In 1986, after 25 years at the bar, he was appointed a judge in the Supreme Courts in Scotland He held office as the most senior judge from 2001 until his retirement in 2005.

During the time when he was a judge he conducted three public inquiries – into the Piper Alpha Disaster in 1988; the shootings at Dunblane Primary School in 1996, and the Ladbroke Rail Crash in London in 1999.

He is a Privy Counsellor, a life peer, and a knight of the Order of the Thistle. He is a Fellow of the Royal Society of Edinburgh and an Honorary Fellow of the Royal Academy of Engineering.

Judy Feder is senior writer and content manager for Baker Hughes, a GE Company, responsible for creating and managing content for the company’s communications with external audiences. She has over 30 years’ experience and has won numerous awards for papers, articles, speeches, and marketing and education materials for the oil and gas and medical industries.

Feder holds a degree in journalism from The University of Texas at Austin and has pursued graduate studies in education and writing at Rice University and is a member of SPE.
Rob Fisher is President and Director of Operations for Fisher IT, Inc. a Native-American (Cherokee) and veteran owned business. Prior to his current role, Fisher spent almost ten years in the US Navy and twelve years at the South Texas Nuclear Project where he owned the Human Performance Improvement initiative and the Procedure Program through a difficult plant recovery time.

Fisher has extensive experience in performing event investigations, designing performance improvement systems, designing and improving corrective action programs, designing and running procedure programs, and educating staff. He is a sought-after trainer, and is routinely invited to speak at international, national and regional conferences on safety, procedures, performance improvement, human performance and event investigation. Fisher IT has most recently been recognized internationally as instrumental in reducing fatalities and serious / life-altering injuries in high hazard industries using human performance and procedure concepts.

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Mary Morahan former senior HSE manager at Chevron-Texaco, is a Partner in the consulting firm of Hire Standard, Inc. in Denver, Colorado. She has consulted in the global oil and gas industry since 2003 with primary focus on HSE leadership development, incident investigation, management system development and HSE performance improvement. She is the co-author of “Never and Never Again - Lessons from the Frontline.

Morahan holds a MBA degree from the University of Colorado, and bachelor degrees in mathematics, education and communications from Gustavus Adolphus College in St. Peter, Minnesota.

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Trey Shaffer is a Senior Partner with ERM based in Houston, Texas. He helps clients with a broad range of sustainability, environmental and safety challenges.

In 2014, Shaffer was elected to the SPE International Board of Directors as the HSSE-SR Technical Director and will complete his term in October 2017 at the SPE Annual Technical Conference and Exposition in San Antonio, Texas. In 2016, he was elected as Vice Chair of the SPE Gulf Coast Section and will begin his term as Chair in August 2017. In 2010, he was recognized by the SPE Gulf Coast Section and received the Award for Distinguished Contribution to Petroleum Engineering in the area of HSSE-SR. He was the co-chair of the SPE International 2016 HSSE-SR Conference in Stavanger, Norway. Shaffer supports numerous SPE activities globally and is a frequent speaker on environmental and sustainability topics.

Shaffer holds a Bachelor degree in environmental design from Texas A&M University in College Station, Texas.