Return to session menu

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RISK SESSION

DP S.A.F.E.

Risk Management and Awareness Training for Project Engineers

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Introduction: Making the case for DP risk training in the project engineering community

The exponential growth in the number of DP vessels, coupled with the number and complexity of construction portfolios, introduces a large number of challenges to the industry. Finding the right vessel to perform necessary tasks, manning the vessels with qualified and competent crews, and meeting aggressive schedules and project deadlines are just a few of those challenges faced regularly.

Process safety and dynamic positioning

Process safety is a key focus of middle and senior management, which includes project engineers, foremen, "company men", and EMs (Engineering Managers). Station keeping risks fall squarely in this category. Given the right sequence of failures, a loss of position is capable of triggering a major process safety event with undesirable consequences and exposure to people, asset and environment. The regulatory community has recognized this and is taking steps to address it.[1]

Dilution of skills

The exponential growth in the industry has resulted in a work force that has limited or no industrial mission specific experience. In the recent past, DPOs and Captains had the requisite knowledge, skills and experience to manage the risks associated with station keeping. These personnel had accountability to manage personal safety and with their experience understood and managed the process safety elements, possibly without recognition of the difference. The current situation is different and it is not unusual to find that vessels are manned with Captains who may not hold a DP certificate and even if he or she does, may not have the requisite experience with execution of the industrial mission. A similar situation exists with DPO's experience with the industrial mission. This is particularly true in the MODU and project construction vessel communities.

While dilution of industrial mission skills among DPOs, Captains, and other watch standing personnel is an often discussed and acknowledged issue, there is scant recognition of a similar dilution of skills with the other segments of the offshore industry, such as the vendor community, engineering and technical disciplines.[2] In many instances the project/well engineering/well operations engineers are contract holders and are responsible for delivery of projects. They are expected to own and proactively manage all risks. Where station keeping risk is concerned, it was not unusual for project engineers to naively assume that specifying a DP equipment class notation of 2 or higher was adequate risk mitigation. The limited experience levels of project engineers with field execution further compounded the lack of understanding of key issues around station keeping that needed to be managed.

Front end loading (FEL) failures affects risk

In addition to the issues caused by the dilution of skills, upstream projects are challenged by cost and schedule impacts.[3] As a result of this pressure, front end engineering is often truncated and some effective barriers which could have been imposed by thoughtful design are not realized. This issue is further compounded by an evolution of turnkey projects where the design is focused on achieving a class notation with insufficient focus on the robustness to be able to maintain the principles of redundancy as well as executing the industrial mission. These issues have manifested themselves during acceptance and subsequent startup phase of the vessels. These shortcomings lead to project engineers inheriting a tremendous responsibility to manage DP risk, often without an understanding of the inherent vulnerabilities.

The problem is compounded by dilution of skills. If a DP vessel has managed to achieve its notation and pass trials, but significant vulnerabilities remain, it is unrealistic to expect inexperienced operators to be cognizant of these issues at the right level. Being trained to react is important, but operator intervention to prevent escalation of a station keeping event is not a substitute for good front end design and engineering practices.

Compliance alone is inadequate

In order to obtain equipment class notation, DP vessels have to comply with the class society rules. Operations are normally carried out under guidance provided by trade organizations (e.g. IMCA). Competency and training of personnel is managed by the certification schemes. A gap has been identified in the above processes as the industrial mission and the specific requirements of the industrial mission have seldom been addressed. The MTS DP Technical Committee recognized this and provided guidance on design and operations and DP personnel which address the industrial mission.

In order to deliver incident free DP operations during execution of the industrial mission, owners and operators must move beyond a compliance mindset in order to manage station keeping risk.

DP Systems Activity Framing Exercise (DP SAFE) course

In order to enhance the ability of the project engineering community to manage the successful delivery of incident free DP operations, the DP System Activity Framing Exercise (DP SAFE) course was developed. It is designed to enhance awareness of DP risks and introduce engineers to the tools available in managing the risks. This enhanced awareness has enabled the project engineers to be effective in delivering their responsibilities as informed stakeholders. Development of the DP SAFE COURSE was led by Shell in conjunction with Kongsberg Maritime.

The goal of DP SAFE is to make project engineers aware of station keeping risk and the different tools available to manage them. This is achieved by providing them a systematic overview of the risk profile, the guidance documents published by the MTS DP Committee, and the development, delivery and use of Well/Activity Specific Operating Guidelines (WSOG/ASOG) to manage station keeping risk.

The target audience for this course was the Shell project engineering community (construction projects and wells). However, during development a conscious decision was made to design the course so that it could be adapted to be delivered as a generic course for the wider industry. The publication of the MTS DP guidance documents enabled the shift of focus from the internal Shell DP DEP (DEP = Design Engineering Practice) to the externally available MTS documents.

The course is not intended to make the participants DPOs, but rather to enable them to ask the right questions from a position of awareness as they evaluate and manage their execution risks.

Delivery method

The course is interactive. It consists of eight modules and encompasses a combination of lectures, simulations, discussions and anecdotes. The course is designed with the flexibility to be adapted, modified, updated, and improved to maximize the value to the participants. The key components to enable effective delivery are a well rounded and diverse team of presenters, utilization of various teaching methods, and ability to capture the needs of the participants and adapt the course appropriately.

The course brings together experienced operators, technical and operational experts from the consultant community, and professional trainers from the system manufacturers. This is a combination which provides experience from numerous years of project planning, execution of DP and marine operations, a variety of vessel types, engineering disciplines, and management. The instructors are knowledgeable of the industrial mission and requirements for various DP activities. They are well versed in MTS and other industry guidance documents.

In addition, because of the interactive nature of the course, the experience and teachings are bidirectional between the participants and instructors. In pilot sessions it was found that the interactive nature of the delivery enhanced the value and enabled continuous improvement of the course. The instructors were able to learn from the participants who provided insight into specifics of their planning and execution of projects.

Effective use is made of simulators. During the design of the course, it was recognized that the objectives of the course did not require using up valuable simulator time. The audience needed to be aware of the consequences and this could be achieved by running the simulations and capturing the outcome in video clips that could be replayed in varying speeds. This enabled maximizing the time available to disseminate information. Specific exercises are carried out on the simulator with a view to enhance the learning experience of the participants.

Module 1: Introduction

The first module introduces the course objectives and builds the case for action.

- Increased awareness for delivery of incident free operations
- Address dilution of skills with introduction and use of decision support tools (DSTs)
- Provision of DSTs and implementation to mitigate risk

This module sets the stage by bringing to the fore the dilution of skills amongst personnel. It emphasizes the significance of station keeping and its impact on process safety, and the importance of conducting work with a clear and definitive understanding of the capability of the vessels. A number of station keeping incidents experienced by industry are re-created and utilized to illustrate consequences and the severity of the impact upon the assets.

Module 2: Introduction to DP

Very few personnel in the offshore industry are required to have formal DP training. Most learn by exposure or as needed for particular projects. Since DP SAFE is focused around enhancing awareness of the risk associated with DP vessels, operations, and incidents, module two is dedicated to broadly introducing what makes up a DP system. It covers the relevance and integration of the DP controller, human machine interface, position reference system, sensors, power system, thrusters, and the operator.

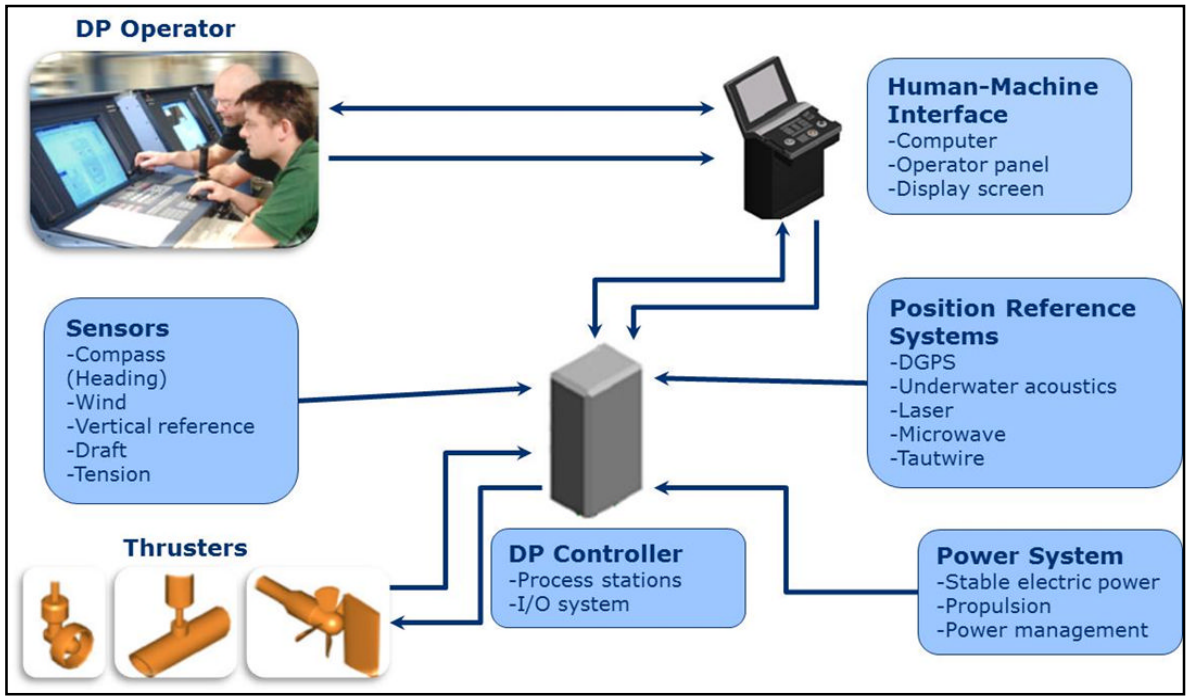

Figure 1. Elements of a dynamic positioning system

Also, to help participants understand the significance of DP classification given to vessels, there is brief discussion of the three equipment classes. Sample topology drawings are used to illustrate that not all similarly classed vessels are of the same complexity or layout. Later modules refer to classifications, their requirement, and how they are determined in more depth, so early discussion lends for better understanding.

Next, due to the reliance on computers and software of DP systems, the mathematical vessel model is introduced and comparisons made between Kalman filter-based and three term (proportional-integral-derivative) controllers. To fully appreciate the capability of the vessel beyond just its classification, differences amongst DP systems are discussed. Items include type of control, sensor input handling, position reference system handling, hardware arrangement, and the various modes and features of DP.

Additionally, the module discusses a vessel's station keeping capability and how it can be affected by external forces acting on the vessel during operations and how these risks are amplified if operators do not give the DP system time to account for changes. To ensure project engineers understand the risks, an overview of the model update and calculation of unknown forces is discussed. This emphasizes the necessity of updates with respect to the models position and heading accuracy and the significance of speed limitations during operations.

Availability, type, and number of position references are vital factors during critical operations. Each type, their varying limitations, and fundamentals for determining position are discussed to ensure an understanding of the different systems used.

Finally, there are a number of scenarios presented during the remaining modules utilizing displays from both DP and automation systems. A brief discussion of the main displays the DPOs and other watch standers may use are explained in enough detail for participants to understand not only what the DPO is experiencing during operations but also the importance of alarm management when limits of the systems are reached and failures occur.

Module 3: Incident analysis

Referencing IMCA's analysis of incident reports from 1994 through 2003, causal factors for incidents were attributed to four initiating factors: environmental forces, equipment (power and thrust fault), equipment (DP system and reference fault), and operator error. After an in depth review, it was determined that 98% of the reported 371 loss of position incidents could have been mitigated by attention to human factors.

To provide some illustration to this concept, reported and analyzed loss of position incidents were recreated based on reports or actual experience and shown using DP and automation display screens, simulated demonstrations, and graphics. Each incident focuses on specific risk involved, learning objectives, and mitigating factors that may have prevented the incident or escalation. A few examples of the incidents involved enabling or loss of tension sensors, operating outside the post failure capability of the vessel, power plant casualties, inaccurate position reference systems, and operator error. The scenarios are played at different speeds to maximize discussion points and replayed for further explanation.

Following in later modules, a few of the incidents are discussed further to illustrate the effectiveness of ASOGs.

Module 4: Oversight bodies

In varying ways, the number of organizations that have oversight in marine and DP operations can be quite large. Whether a trade organization, coastal state, flag state, or classification societies, they all have specific but varying roles, stakes, and interests.

This module identifies the different bodies, explains their role, and identifies gaps and challenges. The main focus of the module is to illustrate that there are a great deal of good standards, guidance, and regulations put forth dealing with design and equipment requirements but they do not address operational requirement or planning of DP operations. The reliance on audits, class notations, and standards are not adequate to understand and mitigate exposure.

Also, with the increasing role of contractors and subcontractors in numerous facets of industry, the operators must close the gap between the minimum standard to fulfill contracts and the necessary robustness to ensure incident free operations. Project engineers must be able to identify and understand the gaps in order to implement a plan for addressing them.

Lastly, the MTS DP Operations Guidance is introduced and the need to focus on the vessel and activity it is performing. This puts focus on the goal of incident free operations and moves beyond reliance upon the audit based and compliance approach.

Module 5: Myths versus reality

Without years of experience and taking a detailed look into the requirements, it may seem that vessel classification and certification of DPOs may be sufficient for risk mitigation. Module five focuses on the reality of some common misconceptions of the industry. The objective for the module is to encourage project engineers to become engaged early and ask the right questions. Examples of myths discussed are:

- Vessel classification alone adequately addresses risk
- All similarly classed vessels are equal
- FMEAs are equal in content and quality
- Crews are familiar with FMEA and understand the impact of failures
- DPO certification is a guarantee of competency
- Operators understand the vessel systems and limitations
- Capability plots reflect vessel's true capability
- Safety of closed bus tie breaker operations
- Multiple GPS receivers meet redundancy requirements

At the conclusion of module five, project engineers have a better appreciation of the potential risk if selection of vessels is done merely by equipment classification and DPO certification.

Module 6: Project engineer's guide to the DP DEP

With the challenges, risks, and myths of DP operations now identified, the next two modules provide an overview of how to best address the challenges and implement a proven process for reducing incidents.

Module six guides the project engineer through the Shell DP Design and Engineering Practice (DP DEP). In Shell, the DP DEP mirrors the MTS DP Operations Guidance as well as the DNV Recommended Practice (DNV-RP) E307. This module can be adapted to be generic using the MTS DP Guidance Documents, or customized to cover their company's own internal standards.

Brief explanations of the requirements for DP vessels (e.g. manning, bus tie configuration, documentation, etc.) and ASOG implementation process are discussed. It is stressed that the ASOG implementation is not an audit, but is instead a technical review that results in enhanced awareness of vessel capability, focuses on the activity being performed, and provides an incredibly useful decision support tool to manage station keeping risk.

Due to the additional risks inherent in simultaneous operations (SIMOPS) and critical activities, there is specific guidance related to the communication and interaction of all vessels involved, and discussion of the potential need for project specific simulator training that will increase awareness and competency of the crews involved.

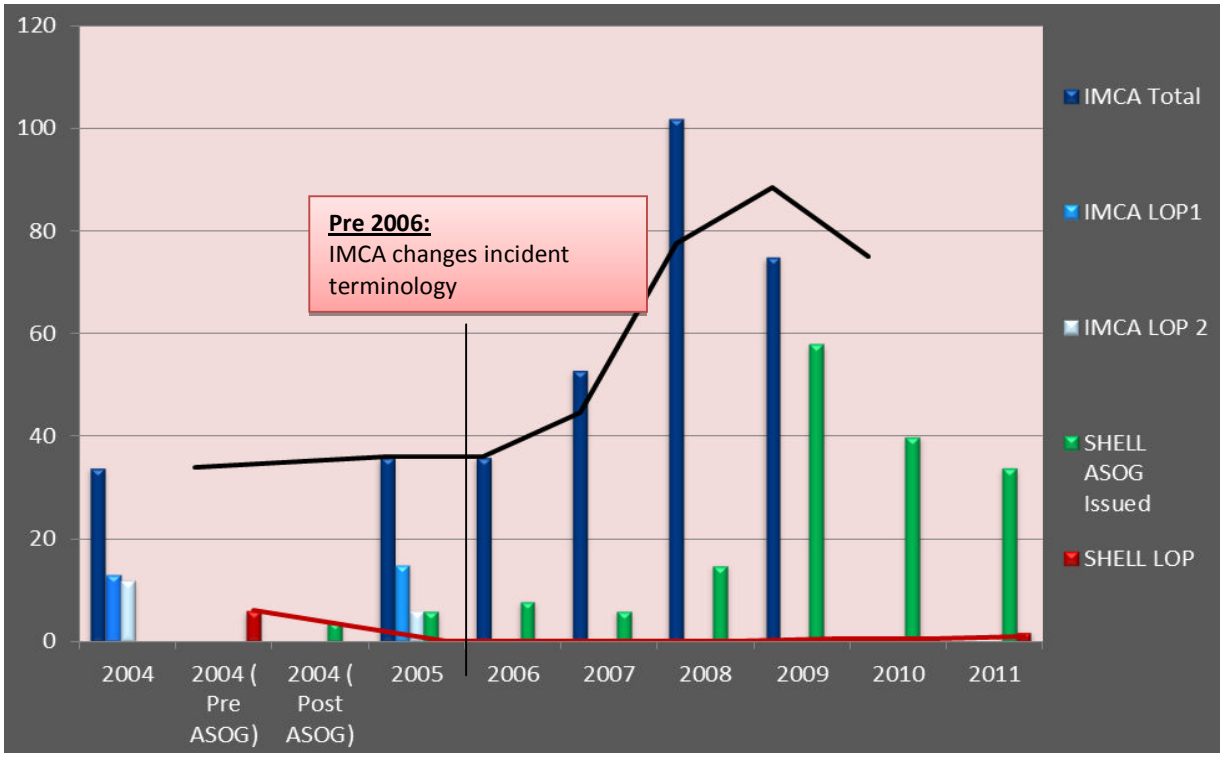

Figure 2. Graphic representation of incidents before and after ASOG process

Module 7: Activity Specific Operational Guidelines

Module seven focuses on specific attributes of the ASOG, such as the inputs required (e.g. FMEA), the cost and scheduling benefits that result from early engagement, and the positive results of a robust process.

As an example of the early engagement benefit, the project engineer is shown how to use the MTS guidance to select appropriate position references and special features so that they can figure these factors into their project plans (i.e. the “no surprises” approach).

Further, several examples of genuine IMCA reported incidents are shown, with corresponding examples of how controls within an ASOG can address and prevent such incidents.

Finally, simulator videos are used to graphically illustrate the benefits of using the MTS guidance. In the example below, one vessel was pre-configured with external force compensation by the project engineer, based on tables in the MTS guidance. The other vessel was merely assumed to be capable of carrying out the operation, and the proper special modes were not identified in advance. Both make identical 30 degree heading changes to starboard at 10 degrees/minute with tension acting on the stern. The improperly managed vessel suffers a loss of position.

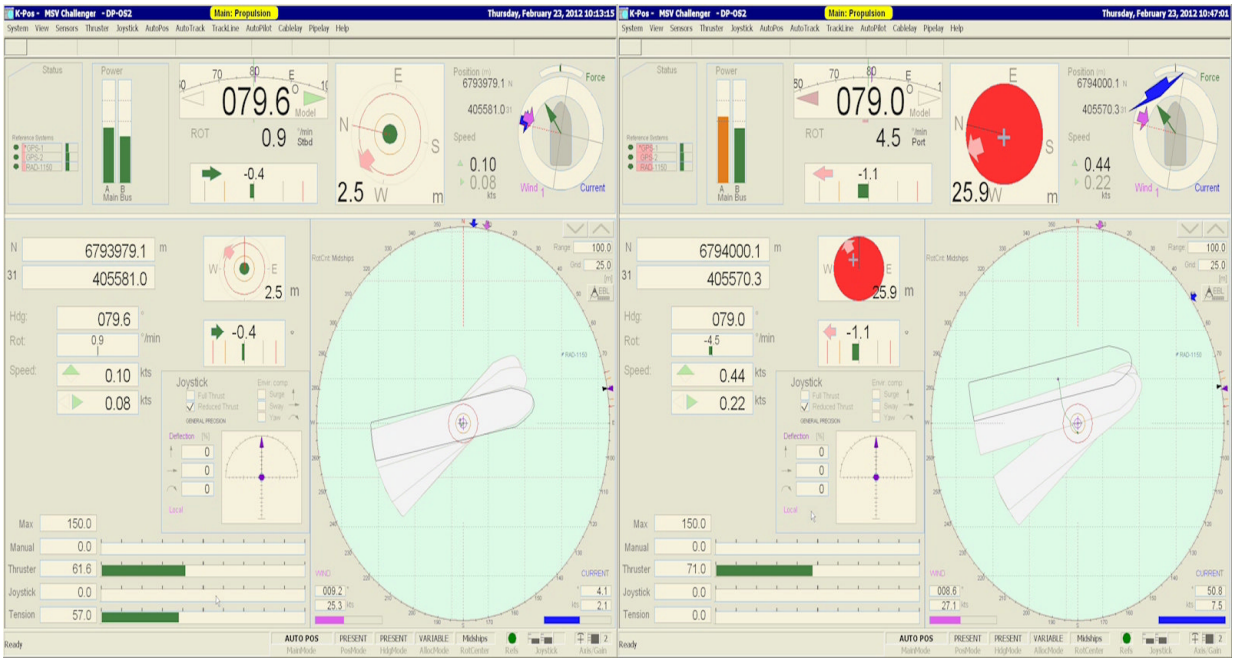

Figure 3. Illustration of vessel properly configured vs. improperly configured, with consequences

Module 8: Wells delivery

Wells delivery engineers have additional considerations due to the nature of work performed by MODUs. There are unique regulatory requirements, extended periods of station keeping, and potentially difficult constraints upon inspection, repair, and maintenance. Module eight addresses these issues.

The topics covered in the module are

- Maintenance related issues (Inspection, repair and maintenance, permit to work, and management of change)
- Critical activity mode vs. task appropriate mode examples
- Positioning standby examples and impact on people, schedule and post-failure capability
- Riser analysis (inputs to WSOG, impact on station keeping, common gaps)
- Emergency shutdown (ESD): blackouts attributed by, design concept, human factors
- Emergency disconnect sequence (EDS): input to WSOG, riser analysis, watch circles, point of disconnect
- Power generation : design considerations and philosophy, distribution vulnerabilities, blackout prevention and recovery, UPS, bus tie configuration, propulsion system
- Positioning systems: GNSS challenges and acoustic challenges, INS and HAIN improvement
- Industrial mission
- OSV and SIMOPS
- Decision support tools (Hardware in loop testing, OPMT, SIMOPS, and WSOG)

Valued delivered and reciprocated

DP SAFE's target audience are the engineers who are responsible for using contracted DP vessels. The course's focus on process safety will enable them to understand the risk and manage them appropriately and thus minimize incidents.

External stakeholders requested invitations to participate in the course and provided feedback. Delivery of the six courses to date this year has highlighted the potential for this course to be effective across the industry. For example, the consultancy community is of strategic importance to the industry to aid delivery of incident free DP operations. The course will introduce them to effective and useful incident analysis and intelligent application of industry guidance. As participants, their own depth of experience brings value back into the course and provides continuous improvement of the material. The first pilot versions of DP SAFE illustrated this very well.

The contractor community, as vessel builders and manning bodies, can benefit greatly from attending the DP SAFE course. It will enable them to offer superior services to their customers and position themselves as leaders in the upstream sector.

Process safety events have widespread industry impacts. DP SAFE is designed to bring fresh rigor to managing DP operations and spread lessons learned to a broad audience which has the accountability to deliver safe projects.

Finally, the course is adaptable for any audience. The success and effectiveness of the course is dependent on a commitment from the providers to make a conscious effort to stay current with the latest developments in the industry and the latest effective guidance documents.

Summary

Offshore construction is a complex business. Equipment and process elements may be manageable via regulation, but the people element requires constant face to face engagement, information sharing, and decision support. DP SAFE attempts to address this people element. It raises risk awareness and introduces tools available for managing station keeping risk. It exhorts participants to consciously go beyond a compliance mindset and focus on delivery of incident free DP operations while executing the industrial mission. It emphasizes the importance of understanding the use of the Activity Specific Operating Guideline as an effective decision support tool to execute and manage station keeping operations.

Way forward

DP SAFE is consciously structured around the MTS guidance documents. It is believed that the DP SAFE course could be effectively adapted to deliver the intent of guidance for the professional development of personnel engaged in DP operations using the Mapping Delivery Ability Tool (MDAT). Such an adapted course with the emphasis on the industrial mission could augment the required basic and advanced DP operator's course and the optional power simulation course.

It is expected that industry's ability to deliver incident free DP operations consistently will be enhanced by such a course. Kongsberg Maritime and other training institutions see the value in delivering courses which are based on the MTS documents. DP SAFE is case in point.

[1] Federal Register / Vol. 77, No. 87. *Mobile Offshore Drilling Unit Dynamic Positioning Guidance*. May 2012
[2] *Mind the Gap: Experienced Engineers Wanted*. AXA Investment Managers. March 2012
[3] *Oil and Gas Industry Megaprojects: Our Recent Track Record*. Edward W. Merrow, Independent Project Analysis, Inc. April 2012