

THE HUMAN ELEMENT IN SAFE SHIPPING: ABS INITIATIVES

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SUMMARY

The maritime industry recognizes the important role of the human element in maritime safety and is responding accordingly with effective design practices, standards and associated management systems. With increased attention to human element concerns by organizations such as the IMO, with recent Goal-Based Standard (GBS) requirements for ergonomic considerations in vessel design, and with requirements for increased focus on crew habitability and safety contained in the International Labor Organization's Maritime Labor Convention (ILO MLC), it is expected that the application of ergonomics, human factors engineering (HFE), and habitability data and principles to maritime systems will expand. As a result, it is important to identify and directly apply relevant HFE/ergonomics-related guidance.

This paper presents information reinforcing the continued need to address human element concerns in maritime systems as well as how the American Bureau of Shipping (ABS) is tackling these concerns. The ABS Ergonomics Model for addressing human element concerns and current ABS activities to help improve mariner safety, crew task performance, and shipboard quality of life are presented. ABS human element-related topics include crew habitability, the assessment of safety culture, the identification of potential leading indicators of safety, mariner personal safety, and the application of ergonomics in a maritime environment.

1. INTRODUCTION

The importance of the human element in maritime safety is suitably recognized by the shipping and offshore communities and continues to receive significant attention due to the efforts of organizations such as the United States Coast Guard (USCG), the United Kingdom's Health and Safety Executive (HSE), the International Labor Organizations (ILO) and the International Maritime Organization (IMO). Classification societies have also responded, generating guidance and rules for the application of ergonomic data and principles to the design of marine structures, their maintenance, and to the readiness and skills of the people who operate and live on those structures.

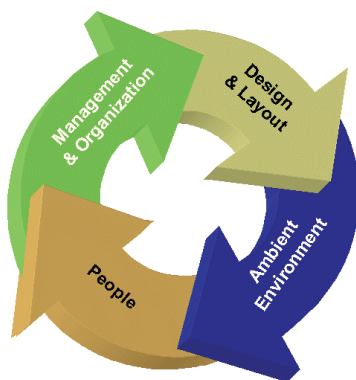


Figure 1: ABS Ergonomics Model

The ABS Ergonomics Model (See Figure 1, "ABS Ergonomics Model") encapsulates important elements that influence safety and efficiency in job performance: ship, workboat, or offshore installation design and layout; workplace ambient environment; management and organization, and the capabilities of the people who operate the vessel or offshore installation. Insufficient

attention to any of these elements can adversely affect safety, productivity, and efficiency.

1.1 DESIGN AND LAYOUT CONSIDERATIONS

It is the design and layout aspect of the ABS Ergonomics Model that considers the integration of personnel with equipment, systems, and interfaces. Examples of interfaces include: controls, displays, alarms, video-display units, computer workstations, labels, ladders, stairs, and overall workspace arrangement.

1.2 AMBIENT ENVIRONMENTAL CONSIDERATIONS

The ambient environmental aspects of the model address the habitability and occupational health characteristics related to human whole-body vibration, noise, indoor climate, and lighting.

1.3 CONSIDERATIONS RELATED TO PEOPLE.

Personnel readiness and fitness-for-duty are essential for vessel or offshore installation safety. This is particularly so as tasks and equipment increase in complexity, requiring ever greater vigilance, skills, and experience. The following factors should be considered when selecting personnel for a task:

- Knowledge, skills and abilities that stem from an individual's basic understanding, general training and experience
- Maritime-specific or craft-specific training and abilities (certifications and licenses), and vessel or offshore installation-specific skills and abilities

- Bodily dimensions and characteristics of personnel such as stature, shoulder breadth, eye height, functional reach, overhead reach, weight, and strength
- Physical stamina; capabilities, and limitations, such as resistance to and freedom from fatigue; visual acuity; physical fitness and endurance; acute or chronic illness; and substance dependency
- Psychological characteristics, such as individual tendencies for risk taking, risk tolerance, and resistance to psychological stress.

1.4 MANAGEMENT AND ORGANIZATIONAL CONSIDERATIONS.

Management's attitude and organizational processes impact safety throughout a system lifecycle. The effective implementation of a well-designed safety policy that includes ergonomics creates an environment that minimizes risks and reflects a positive corporate safety culture. Commitment of top management is essential for a safety policy to succeed.

ABS activities and projects use the ABS Ergonomics Model as a guide for addressing the human element. The following describe the ABS Safety and Human Factors Group's current efforts related to the human element and the ABS Ergonomics Model.

2. MARINER PERSONNEL SAFETY PROGRAM

Ship owners, ship managers and ship crews are chiefly responsible for providing safe living and working conditions on-board ship. The Mariner Personal Safety (MPS) project is a collaborative effort among ABS, Lamar University and numerous industry partners. The objective of the MPS project is to gather a worldwide database of maritime incident, injury and close call (near miss) reports. The goal of MPS is to create a searchable database of these incidents, injuries and close calls in order to identify trends and possible causes, potential corrective actions, potential lessons learned, and to create close call benchmarking indicators. The above are intended to be shared with the maritime community.

With confidentiality agreements in place, the collected data from each industry partner are sanitized to remove specific references to company names, ship names, people, vessel locations or any other item that could reveal sensitive information. This prevents individual records being associated with a specific industry partner. A unique username and password to access the secure searchable database are assigned to each industry partner.

To date, the MPS project has collected over 59,000 injury and close call records from twenty-seven (27) industry partners. The established database undergoes

continual revision based on the needs identified and accommodates the addition of new industry partners.

One of the primary challenges of establishing a cross-industry injury and close call database is that in many instances the injury/close call information is in multiple formats with company-specific coding mechanisms. This is particularly true with close call records, where intra-database inconsistencies are often difficult to reconcile.

2.1 DATABASE

Industry partners have access to the injury and close call databases, as well as the Mariner Safety Document Center that contains a growing number of safety toolbox talks, ergonomic discussion papers (white papers that discuss the underlying science of ergonomic principles and criteria) and "safety spotlights" (safety discussion papers of greater length and detail than safety toolbox talks).

Database revisions and improvements are based on user (industry partner) feedback. Examples of revisions and improvements include the use of: (1) stemming techniques that use the roots of words as part of a search, for example, searching for the string "colli" can return results containing "collide," "collided," "collides" and "collision", (2); search synonyms (similar to a web search engine), and (3) aided searches by incident cause, type, location (e.g., bridge, engineering control room, anchor windlass), and searches by vessel type.

2.2 INJURY DATA

To date, nine (9) different industry partners have provided injury data, summing to over 15,000 reports. Though the data provided varies with regard to specific content, commonly re-occurring data fields include injury type, potential, root of or cause for the incident, equipment involved, location on the vessel (engineering, deck, accommodations, etc.), vessel type/trade, tasks being performed at the time of a reported event, and demographic characteristics of the crewmembers involved. From this data, injury causes, types, locations, and their corrective actions and lessons learned have been communicated back to the industry partners.

2.3 CLOSE CALL (NEAR MISS) DATA

To date, twenty-seven (27) different industry partners have provided close call data, providing approximately 44,000 reports. Though the data varies, commonly reoccurring data fields include close call type, potential, root of or cause for the incident, equipment involved, location on the vessel, vessel type/trade, tasks being performed at the time, and demographic characteristics of the crewmembers involved. From this data, close call causes, types, locations, and their corrective actions

and lessons learned have been shared with the industry partners.

2.4 BENCHMARKING CLOSE CALL RATE

Benchmarking allows for some amount of organizational or vessel level type comparisons to be made. Close call occurrences are normalized per 200,000 employee work hours, to create close call rates, allowing for the establishment of benchmarks. For an industry partner's close calls to be included in the benchmarking analyses that organization must provide hours worked over the same period. Currently, the close call rates range from 12 to 67 per 200,000 employee hours for the 23,000 close calls reported to date. A review of the benchmarking data raises several questions:

1. Does a lower benchmarking number of close calls, eleven (12), mean a safer environment?
2. Does a higher benchmarking number of close calls, fifty three (67), indicate a safe environment?
3. Could there be a more or less mature safety program?
4. Could there be a proactive safety management system?

Similar benchmarking is planned for injury data.

2.5 USES OF PROJECT RESULTS

The data generated from the MPS project has been used to:

- Help in directing safety auditing efforts by identifying hazards for specific spaces on board
- Identify potential hazards related to crew activities
- Identify the more hazardous tasks and task performance locations (not surprisingly, using ladders and stairs, and working from heights continue to be among the more hazardous tasks)
- Identify the industry need for an ergonomic Guide related to seafarers interfaces with structures such as ladders, stairs, and work platforms
- Identify the industry need for an ergonomic Guide related to the design of engineering spaces to support human access and maintenance activities
- Identify the need for the generation of safety toolbox talks (TBTs) for ABS surveyors and office workers. Dozens of these have been generated based on the analyses of the accident and close call data.

The MPS data can also help direct safety intervention efforts, prioritization and resource allocation, provide input into safety measurements (metrics), support corporate safety management systems, provide industry access to database (or request) queries, create a database of interventions and corrective actions, identify the more common accidents and close calls, identify potential new training areas, and support the

development or guidance related to JHAs, JSAs, HAZIDs, operating and working procedure development.

2.6 NEXT STEPS

The next steps of the MPS project include:

- Continued data analysis
- Develop repositories for injury and close call data and corrective actions and interventions
- Further development of data-driven training aids (e.g., toolbox talks)
- Analyze data for potential leading indicators of safety
- Enlist more industry partners
- Create a Mariner Safety Research Center.

3. ERGONOMICS GUIDE AND GUIDANCE NOTES

Based largely on findings stemming from analyses of the MPS database, an ergonomics Guide has been created to offer ergonomic (**ERGO**) notations for selected working areas on vessels, including topsides design, enclosed space design (e.g., on or below the main deck on the interior of the vessel), design for operability and maintainability, and design for valve access and use.

The *ABS Guide for Ergonomic Notations* has been developed with the objective of promoting an ergonomically-focused design. This Guide offers the following ergonomic notations:

- Ergonomic Topsides (**ERGO TOP**), which establishes a level of ergonomic design promoting human performance and safety when working with topside structures exposed to the weather
- Ergonomic Enclosed Space (**ERGO ES**), which establishes ergonomic design when working within enclosed spaces (not exposed to the weather)
- Ergonomic Valve (**ERGO VALVE**), which establishes ergonomic design when accessing and operating valves
- Ergonomic Maintenance (**ERGO MAINT**), which establishes ergonomic design for accessing maintenance items.

The Guide and its notations are directed at enhancing industrial safety at sea. The requirements imposed in using this Guide address the structural design of the following human interfaces:

- Stairs
- Walkways and ramps
- Vertical and inclined ladders
- Guard rails and climber safety devices

- Fall protection from secondary fall points
- Work platforms
- Handles
- Hatches
- Doors and scuttles
- Manual valve operation, access, location, and orientation
- Maintenance access

In addition to requirements imposed on the design of structures, the Guide requires the conduct of a maintenance criticality analysis to identify, on a three point scale, which requirements apply to specific equipment. The more frequently maintained and critical equipment (Category 1 and 2 maintenance items) have additional and more strict design requirements imposed compared to category 3 items which have few requirements to be satisfied. In addition, a valve criticality analysis is similarly required to identify specific requirements applicable to more frequently accessed and critical manual valves, also on a three-point scale.

It is anticipated that achieving compliance with the requirements of the Guide, leading to these notations, will help reduce the number and severity of accidents, injuries, and close calls to people working at sea. In addition to this Guide, the Guidance Notes on the Application of Ergonomics to Marine Systems (ABS 2013) has been revised to update the guidance provided and to better target that guidance to the safety and performance concerns revealed from the MPS database. These Guidance Notes introduce important ergonomic principals and criteria that should be considered during the design of a vessel or offshore installation. Applying the ergonomic principles and criteria contained in these Guidance Notes, within the context of engineering design processes, allows for improved safety, productivity, and efficiency.

4. HABITABILITY AND COMFORT

There is clear evidence that suitable habitability design practices influence the safety, productivity, morale, and overall sense of well-being of seafarers. To recognize and promote habitability, ABS has produced four *Guides for Crew Habitability* in order to provide a single source for habitability criteria suitable for ships, workboats, offshore structures and Mobile Offshore Drilling Units (ABS, 2012). These Guides have been developed with the objective of improving the quality of crew life-at-sea by improving working and living environments in terms of accommodation area design and ambient environmental qualities.

The Guides are applicable to new and existing vessels for which an optional Habitability notation has been requested. The habitability criteria are a measure of the acceptability of crew accommodation areas and workspaces for living and working.

The habitability Guides focus on five habitability aspects of vessel design and layout that can be controlled, measured, and assessed. These five aspects are broken into two categories in the Guides, (1) accommodation area design and (2) the characteristics of the ambient environment.

Accommodation area criteria pertain to dimensional and outfitting aspects of spaces and open deck areas where crew members eat, sleep, recreate and perform routine daily activities.

The ambient environmental aspects of habitability pertain to the environment that the crew is exposed to during periods of work, leisure and rest. Specifically, the Guides provide criteria, limits and measurement methodologies for the following:

- Whole-body vibration (separate criteria for accommodation areas and workspaces)
- Noise
- Indoor climate
- Lighting

The criteria provided in the Guides are based on currently available research data and standards for the purpose of improving crew performance and providing a base level of habitability and elements of safety related to habitability.

5. ASSESSMENT OF SAFETY CULTURE AND LEADING INDICATORS OF SAFETY

The Safety Culture and Leading Safety Indicators (SC/LI) project is a collaborative effort between ABS, Lamar University and several industry partners. The central premise of the Safety Culture (SC) assessment is that improvements in organizational safety culture can lead to enhanced safety performance. The first step is an assessment of the existing safety culture to identify areas of strength that can be built on, and weaknesses that afford opportunities for improvement against operational incidents, personal injuries, etc.

The purpose of a Leading Safety Indicators (LI) assessment is to identify which safety metrics are most strongly associated with safety performance in a particular organization. This information can be used to guide actions to improve future safety performance. Though related, the Safety Culture assessment and the Leading Safety Indicator assessment are two separate activities. These findings are only shared with the participating organization and are treated as confidential.

To date, the SC/LI project has been completed on six organizations, and numerous others in various stages of planning. An automated process for collecting and analyzing the LI/SC data has also been created.

5.1 CHALLENGES

There are challenges that should be considered during the decision-making process of determining whether or not to proceed with a safety culture (SC) survey. Undertaking a survey can be costly, so the costs and benefits should be carefully appraised before proceeding. Once the decision has been made to carry out a survey, the details of the questionnaires should be completely finalized, the distribution format needs to be determined, and employees should be prepared well before beginning the survey. The choices of distribution are paper-based, electronic or a mixture of both (e.g., a web-based electronic distribution for shoreside staff and spreadsheet or paper-based for vessels). There are numerous considerations that need to be addressed before a web-based survey for shipboard personnel can be a viable option. Some of these considerations include web access of crewmembers, bandwidth, security and confidentiality.

The primary challenge of the Leading Safety Indicators (LI) approach to improving safety performance is that it is only appropriate for organizations that are industry leaders in completely addressing all of the technical aspects of safety. For an organization to successfully utilize the LI approach, they should meet the following criteria:

- The organization is compliant with all relevant regulations
- Human error or organizational factors are causing the majority of operational incidents or personal injuries
- The organization has a genuine desire to prevent operational incidents and personal injuries and is not solely driven by the avoidance of prosecution
- The organization is relatively stable, not in the middle of mergers, acquisitions or significant reorganizations
- An objective leading indicators assessment of the organization requires that safety metrics must have been collected for some time: at least five years for an organizational level analysis, and at least one year for the business unit level, or across the fleet

If an organization does not meet these criteria, then it is not ready for a Leading Indicators assessment. In this case, a subjective leading indicators assessment may be selected after a Safety Culture survey is performed and the results utilized as subjective leading indicators. For an organization to be ready for a subjective LI assessment, safety metrics must have been collected for at least five years for an organizational level analysis, and at least one year for the business unit level, or across the fleet. Also, as with the SC survey, a LI Program also needs adequate resources.

5.2 SAFETY CULTURE

The ABS Safety Culture questionnaire contains 40 statements that respondents (crews and shoreside staff) are asked to rate according to their level of agreement (Agree=5, Slightly Agree=4, Neutral=3, Slightly Disagree=2, Disagree=1, and Don't Know). These statements are categorized into 8 aspects of safety culture, called safety factors:

1. Communication (COM)
2. Empowerment (EMP)
3. Feedback (FDB)
4. Mutual Trust (MTR)
5. Problem Identification (PID)
6. Promotion of Safety (POS)
7. Responsiveness (RSP)
8. Safety Awareness (SAW)

There are two questionnaires, one for the shoreside staff and one for shipboard staff. Each questionnaire contains forty statements that are identical or equivalent. Respondents indicate their level of agreement to a statement on a five-point scale, known as a Likert scale.

5.3 LEADING SAFETY INDICATORS

The central premise of the ABS Safety Culture and Leading Safety Indicators Model is that improvements in organizational safety culture can lead to enhanced safety performance. The first step is an assessment of the existing safety culture to identify areas of strength, weaknesses of defenses, and opportunities for improvement against operational incidents, personal injuries, etc. The ABS Model also incorporates a process for identifying an organization's potential Leading Safety Indicators (LI). There are two ways of conducting this process:

- By the identification of *objective* leading indicators. This is done by correlating safety metrics with safety performance data. This is the preferred approach because of its objectivity; because it utilizes metrics that the organization has collected; and it does not require a survey of the workforce, which can be time-consuming
- By the identification of *subjective* leading indicators from a safety culture survey. These indicators are based on the values, attitudes and observations of employees. This method may identify potentially beneficial safety metrics not yet tracked by the organization. This approach is used when the organization lacks sufficient metrics to use the *objective* leading indicators process

5.4 NEXT STEPS

The next steps of the SC/LI project include:

1. Additional organization participation
2. Develop repositories for safety culture and leading indicator data, LI/SC effect on safety performance, corrective actions and interventions
3. Further development of data-driven training aids (e.g., toolbox talks)
4. Analyze data for additional potential leading indicators of safety
5. Revise automated data collection/analysis tool based on industry feedback
6. Expand SC/LI Programs to offshore and other maritime-related industry

The goal of the Safety Culture and Leading Safety Indicators (SC/LI) project and other ongoing projects, like the Mariner Personal Safety (MPS) project, is to create a Mariner Safety Research Center.

6. GUIDANCE NOTES ON PROCEDURES AND TECHNICAL MANUALS

Safety and environmental concerns demand an investment in time and energy to develop and implement accurate, effective procedures and technical manuals. Consistency is the key to efficiency, quality control and safe operations. That consistency can come from the use of well-written administrative, regulatory, operating, emergency, maintenance and routine duty procedures and manuals.

With requests from numerous clients, ABS is responding to the need within the maritime industry for guidance in the areas of:

- Developing new procedures and technical manuals
- Aligning procedures and manuals to safety and environmental considerations
- Revising existing procedures and manuals for conformance to current practices, policies, and regulatory requirements
- Implementing the new and/or updated procedures and manuals into a safety program designed to enhance productivity and reduce accidents.
- Management of procedural change to maintain control of the announcement of procedural changes, training, the placing of updated procedures at their operating or maintenance storage locations.

To this end, the ABS *Guidance Notes for the Development of Procedures and Technical Manuals* is being created.

The principles and guidelines in the Guidance Notes apply to writers of maritime procedures who wish to

further understand the development process for procedures and technical manuals, the intent of procedures and manuals, and the benefits derived from appropriate procedure / manual design, development, implementation, and life-cycle tracking.

The Guidance Notes are intended to serve as a reference for maritime organizations when planning, developing, implementing, and maintaining procedures and technical manuals. They describe general concepts, provide design considerations, and offer content suggestions.

The intent of the Guidance Notes is for the procedure writer to tailor the provided information to the organization's own unique needs and preferences, so long as the concepts of clarity, accuracy, and completeness are maintained while promoting safety.

Written procedures and manuals provide personnel with instructions for behavior and/or performance, assisting seafarers in completing their requisite tasks safely and efficiently. Procedures and manuals represent the link among administrative personnel, management, supervisors, and the personnel who perform the various tasks described in the procedures or manuals. When personnel perform their work in accordance with procedures / manuals, they implement the plans, agreements and policies required by management and regulators.

Working memory is that memory involved in directed conscious attention. For example, start-up operating instructions for the manual operation of a potable water system requires the operator to remember pumps, chemical levels, etc. For this reason, on an individual's memory should not be relied upon exclusively to perform work-related tasks, especially those that are complex, hazardous, and have the potential to impact personnel safety or the environment. Appropriately written and implemented procedures and manuals can aid in reducing the cognitive effort of personnel, especially the memory element of performing a task, thus aiding in reducing human errors.

Procedures and manuals provide a means by which important components of an organization's operational environment promote compatibility and consistency, thereby helping to standardize behavior, avoid confusion, improve efficiency, and enhance safety.

Human performance (e.g., safe, efficient, and reliable task performance) can be monitored and influenced. An inadequate level of human performance can adversely impact operations. The primary objective for influencing human performance is the reduction of errors. Written procedures and manuals can influence human performance by reducing variation in work performance. This is accomplished by documenting standard work processes.

Procedures and manuals can reliably carry information concerning decision rules. Risk perceptions can be mitigated via the use of dangers, warnings, and cautions. Procedures can also aid in memory requirements by listing steps and their particulars, directing the when, where, how, why, and what of procedure steps, and indicate any factors related to task timing and task time.

The Guidance Notes focus on the following:

- The role and function of procedures and technical manuals
- Procedure and manual writing
- Verifying, validating, approving, certifying, and implementing procedures and manuals
- Managing procedures and technical manuals

Also provided for reference are checklists for the development of procedures and manuals, for example, constrained word/language lists, analysis techniques, as well as examples of procedures and checklists.

7. THE ABS SUITE OF HUMAN ELEMENT GUIDES AND GUIDANCE NOTES

The ABS Safety and Human Factors Group maintains an abiding interest in providing the maritime industry with usable and pragmatic information related to the human element. Current Guides and Guidance Notes are listed below. Each of these documents can be downloaded for free from www.eagle.org.

- *Guidance Notes for the Application of Ergonomics to Marine Systems (2013)*. Updated during 2012, to be republished in the first quarter of 2013. Publication # 86
- *Guidance Notes on Ergonomic Design of Navigation Bridges (2003)*. Publication # 119
- *Guidance Notes on Safety Culture And Leading Indicators of Safety (2012)*. Publication # 188
- *Guidance Notes on the Investigation of Marine Incidents (2005)*. Publication # 142
- *Guide for Compliance with the ILO Maritime Labour Convention, (2006). Title 3 Requirements*. Offers one notation. Publication # 166
- *Guide for Crew Habitability on Mobile Offshore Drilling Units (MODUs) (2012)*. Offers three notations. Publication # 190
- *Guide for Crew Habitability on Offshore Installations (2012)*. Offers three notations. Publication # 105
- *Guide for Crew Habitability on Ships (2012)*. Offers three notations. Publication # 102
- *Guide for Crew Habitability on Workboats (2012)*. Offers three notations. Publication # 163
- *Guide for Ergonomic Notations (2013)*. Offers four notations. Publication # 201

- *Guide for Means of Access to Tanks and Holds for Inspection (2007)*. Offers two notations. Publication # 154
- *Guide for Passenger Comfort on Ships (2001)*. Offers two notations. Publication # 103
- *Guide for the Class Notation Comfort – YACHT (COMF(Y)) AND COMFORT PLUS – YACHT (COMF+(Y)) (2008)*. Offers two notations. Publication # 162
- *Guidance Notes on Vibration and Noise Control (in preparation)*
- *Guidance Notes on the Application of Ergonomics to Marine Engineering Spaces (in preparation)*
- *Guidance Notes for the Development of Procedures and Technical Manuals (in preparation)*
- *Guidance Notes on the Implementation of Human factors Engineering into the Design of Offshore Installations (in preparation)*

8. CONCLUSION

The ABS Safety and Human Factors Group maintains its abiding interest in providing the maritime industry with usable and pragmatic information related to the “human element.” With increased attention by Maritime Organizations on human element issues, our plan for activities and products in the out years is constantly evolving as we remain aware of and strive to meet the needs of the industry.

9. REFERENCES

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10. AUTHORS BIOGRAPHY

Julie Pray holds the current position of Senior Engineer in the Safety and Human Factors Group at ABS. Ms. Pray has experience in applying human factors techniques and data to diverse areas of the maritime and offshore industries both commercial and government sectors. Ms. Pray’s primary area of focus is improving human performance and safety while

reducing human errors and increasing productivity, by providing input into adequate working and living environments for seafarers in terms of accommodation area design and ambient environmental qualities.

Kevin McSweeney is the Manager of the Safety and Human Factors Group at ABS. Dr. McSweeney's responsibilities include the development of HFE design criteria and recommendations for ships and offshore installations as well as serving as a Human Factors Engineering subject matter expert (SME) to the U.S. Navy and U.S. Coast Guard regarding the ABS Naval Vessel Rules Human Systems Integration, System Safety and Habitability requirements. Dr. McSweeney's previous experience includes involvement with the National Institute for Occupational Safety and Health's (NIOSH) Ergonomics Intervention Review Panel for the Maritime Industry, the Marine Advisory Council for Occupational Safety and Health (MACOSH) the development and the implementation of the Human Systems Engineering and System Safety programs for the U.S. Navy.

Christine Tomlinson is a Staff Consultant in the Safety and Human Factors group at ABS. Dr. Tomlinson has twenty-five years' experience of researching how human and organizational issues impact safety-critical systems. Since 1995 she has served on numerous safety-related committees, most notably as human element advisor at the United Nation's International Maritime Organization (IMO). She also serves on INTERTANKO's Human Element in Shipping Committee (HEiSC), the MCA's Human Element Advisory Group (HEAG), and she is the human element advisor to the Royal Institute of Naval Architecture's IMO Committee.

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