

# Alert!



## An Unfortunate Error

### Control Room

Design

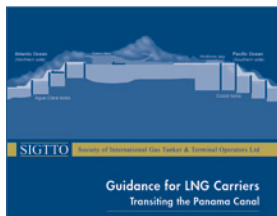
p3



### LNG Vessels

and the Panama Canal

p6



### Increasing the Safety

Offshore Operations

p7



A Nautical Institute project



sponsored by  
The Lloyd's Register  
Foundation



Lloyd's Register  
Foundation

w: [www.he-alert.org](http://www.he-alert.org)

e: [editor@he-alert.org](mailto:editor@he-alert.org)

Nils had been proud to be appointed senior master of such a smart and impressive ship. She was one of the largest high-speed catamarans ever built, designed to maximise both passenger comfort and freight capacity and fitted with 'state of the art' instrumentation. Capable of speeds in excess of 40 knots, she'd instantly become the company's flagship, pictured on the front of brochures and given rave reviews in the transport press. It was fitting that he, as the longest serving master, with a completely unblemished career, be given the task to introduce her onto her new route.

At first Nils had enjoyed the challenge of overcoming the vessel's handling idiosyncrasies.

The sense of power at his fingertips was inspiring and he was always thrilled by the sudden acceleration

as he pushed the joystick forward and by the accompanying throaty roar as the diesels cranked up. She performed well at sea and, with a permit to operate in wave heights up to 3.5 metres, she was rarely beaten by the conditions. Her relatively small pod-like bridge was positioned centrally, perched high on top of the passenger accommodation. From there he had a 360-degree view although, with the lack of any bridge wings, the sides and stern of the vessel were out of sight.

The designers had counteracted this lack of direct view with seven controllable CCTV cameras. It was taking time for Nils to become proficient in their use. He found it difficult to accurately interpret angle and distance from the pictures and, furthermore, the numerous screens partially obscured the direct view aft needed as he manoeuvred the vessel astern towards the linkspan.

The ship had been in service for three months when, with summer turning to autumn, the first equinoctial gale of the season disrupted the

service. The vessel had spent the day stern-to her linkspan with her port side alongside the dolphins as the gale raged outside. In the afternoon, a message was received that the vessel had to shift to an adjacent berth. The movement commenced at 1600 with Nils and the chief officer on the bridge and mooring parties stationed forward and aft. Nils stood by the aft facing controls and ordered the head line to be let go. The chief officer, whose role was communications, passed the order on.

The wind in the harbour had picked up to about 30 knots although Nils, cocooned and insulated in the bridge, was unaware of this. The only wind speed indicator was positioned at the forward console. The forward mooring team and the adjacent quayside were not visible from the aft control console. The bow was caught

by the wind and Nils was unaware that the crew had had problems letting go the head line. With the bow drifting rapidly away from the dolphins, Nils ordered the stern line to be let go as he used the waterjets to try to manoeuvre the vessel into a position nearly parallel to the berth and head into wind. By this time, however, with the wind firmly on the port bow, he was unable to stop the starboard swing.

Nils became disorientated, the CCTV screens were only a distraction and the bow swung across the basin and struck the end of an adjacent finger jetty, holing the vessel beneath the waterline and flooding a void space. Then, broadside onto the wind, she was blown down onto another moored vessel before a temporary lull allowed Nils to regain control and bring the vessel into the centre of the basin. A tug was connected and the vessel was subsequently brought alongside her destination berth without further incident.

The next day a subdued Nils appeared before the company's board of directors to try to explain his error.

*The wind in the harbour had picked up to about 30 knots*

# Introduction

David Squire, FNI FCMI



The Editor

**Alert!**

The Nautical Institute

202 Lambeth Road

London SE1 7LQ

United Kingdom

[editor@he-alert.org](mailto:editor@he-alert.org)

The cover story in this issue paints the unfortunate tale of the day that it all went wrong for the master, when he briefly lost control of his ship due to weather conditions and a number of design flaws related to operability and manoeuvrability which, with a little thought during design, could have been avoided.

In this Issue, we focus on operability (controllability + workability), accessibility and manoeuvrability.

It is often said that if you ask 10 ship's masters how they want their bridge laid out you will get 10 different answers. Likewise, if you were to ask 10 chief mates to design the layout of their cargo control room or 10 chief engineers their machinery control room. This is not surprising, because, for a variety of reasons, each person has his own preferences for the layout of control spaces, for the way in which he/she monitors, receives and processes information, reacts to alarms and alerts and manages the various controls associated with a myriad of instruments and systems associated with the navigation and the safe conduct of the ship.

Height, stature, hearing, viscosity, manual dexterity (right-handed or left-handed), culture, language, age (boomers, generation x, generation y) can dictate one's personal preferences for the positioning (head-up, head-down, line of sight)

and type (analogue, digital, linear, circular, roller ball, mouse) of controls, readouts, gauges and operating systems. Add to that the problems of understanding the operation of different systems from different manufacturers - each of whom is competing for business and wants to add another 'useful tool' - and without proper familiarisation and training, then it is no wonder that accidents such as that described in our cover story occur.

It is impossible to pander to personal preferences, but at least by consulting the users, applying some human interaction principles (such as those set out in ISO 9241-110), sticking to some simple guidelines - such as are offered in this **Alert!** bulletin - and heeding the advice of a human factors engineer, the operator will be able to tell the designers what is needed in terms of user requirements and the required functionality of the systems they will operate.

Relevant **Alert!** bulletins, Issues No. 3 - **Ergonomics**, No. 7 - **Design and usability**, No. 8 - **Building**, No. 11 - **Integration**, No. 15 - **Automation**, No. 17 - **Slips, trips and falls** and No 21 - **Information Management**, and their associated centrespreads and videos can be downloaded from:

<http://www.he-alert.org/en/all-issues.cfm>

To access all the appropriate centrespread features, scan the QR Code.



## Reports & Studies

### The human factor

David W Smith

David Smith reports for Shipping World & Shipbuilder, June 2014, on the latest research into seafarer fatigue, as it relates to ships' engineers, and the importance of safety culture in marine casualties.

Downloadable from:  
[www.he-alert.org/docs/published/he01265](http://www.he-alert.org/docs/published/he01265)

### Human Factors criteria for hand held devices

Brian Sherwood-Jones, Process Contracting Limited

With an emphasis on devices for maintenance and diagnosis, this document is based on a report produced for what is now MLS5 in the MoD. It has been found that the topic and material is still relevant. It covers such subjects as: operational

functions; context of use; task analysis and criteria for device selection; criteria for each type of device; criteria for device components; user interface design guidelines; and standards.

Downloadable from:  
[www.he-alert.org/docs/published/he01255](http://www.he-alert.org/docs/published/he01255)

### Interaction design in shipbuilding – An investigation into the integration of the user perspective in ship bridge design

U. Meek, S. Strohschneider, U. Bruggemann

This study investigates the involvement of the user in the design process on ship bridges and navigational equipment as seen from the designers' perspective.

Downloadable from:  
[www.he-alert.org/docs/published/he01260](http://www.he-alert.org/docs/published/he01260)

Join us on the following sites



<https://facebook.com/thenauticalinstitute>



<https://twitter.com/NauticalInst>



<http://www.linkedin.com/groups/Nautical-Institute-1107227>



<http://www.youtube.com/TheNauticalInstitute>



# Control room design

tell the designers what you want and the required functionality

*During a recent visit to the P&O cruise ship MV AURORA, the editor - accompanied by Mr Richard Vie, Vice President Technical Development and Quality Assurance, Corporate Shipbuilding, Carnival Corporation & plc. - was able to see and hear of some of the simple problems of equipment layout, accessibility and functionality that could have an effect on operability and manoeuvrability, both on the bridge and in the machinery control room.*

This is not one of the newest ships in the P&O Fleet but generally the bridge layout, including bridge wing controls is well thought out; and the machinery control room layout is simple, but effective. But, like all such systems, there is room for improvement.

This is a 76,152 GRT ship with an overall length of 270.0 metres and moulded beam of 32.2 metres, which is powered by two STN AEG propulsion motors driving two propellers. Unusually, the propellers are inward-turning, which is not the best configuration in terms of manoeuvrability, but this is a trade off in favour of passenger comfort because it reduces noise and vibration.

However, the ship is also blessed with 3 powerful bow thrusters and a stern thruster which makes her capable of being manoeuvred alongside in 25 to 30 knot winds in waters where there is a draft limitation of 8.5 metres. It is clear, therefore, that some consideration has been given to ship manoeuvrability.

In terms of the controls and instrumentation on the bridge, their layout accessibility and functionality are generally well-considered, but for some niggling differences in system functionality between different manufacturers. For example, on the bridge wing control panels, there are as many as 4 different dimmer switches and a number of different 'shades of red' warning lights which, according to Richard Vie, demonstrates that even an Integrator will source items of equipment from different manufacturers such that they cannot be truly integrated.

Following a discussion about the value of analogue instruments versus digital, the Master explained that he preferred the bridge deckhead mounted panoramic rudder



angle indicator rather than the front panel-mounted version, and the digital rate of turn indicator (which gave him a much better indication of rate of turn) than the analogue version.

One glaring error in terms of accessibility is the internal communications panel at the officer of the watch's position, where the officer of the watch has to lean over at a considerable angle to operate this system – which demonstrates the importance of accessibility.

The Carnival Group has embraced the concepts of Bridge and Engine Room Resource Management but BRM/ERM is very much about building a team and properly using the resources available to that team to operate the ship. However, it does not teach the operators how to understand and properly use the technology.

Richard Vie recognised the inevitability of changing technology and that every ship that comes into service is different. In the case of the older ships, obsolescence is a serious issue, not least with regard to replacement systems. He concedes that it is not hard to keep up with these changes but they do create more and more software

issues, which may not be known to the operator, who has implicit faith in that software

There was very little to see in the machinery control room, other than a number of desk mounted display screens and the water mist fire extinguishing control panel. The Chief Engineer explained the importance of 'line of sight' visibility of the various monitors and of the water mist control panel, together with proper alarm management.

What of the future? Richard Vie explained that the Carnival Group were investigating the design of standardized bridges and machinery control rooms. "But," he says, "it could potentially increase costs and the key to optimum bridge and control room design will be in SMART procurement – which, in short, means not specifying any particular type of equipment but telling the designers what you need in terms of user requirements and the required functionality of the systems they will operate."

*The editor wishes to thank Mr Richard Vie and the Master and Chief Engineer of MV AURORA for their contributions to this article.*

# Ergonomic criteria for control room equipment and

## User interaction

- In accordance with ergonomic standards
- Response speed sufficient for interaction without disrupting task
- Comfortable for long watches
- Operator interface permits monitoring, control/supervision of machinery/equipment
- Visual/audible/mechanical feedback acknowledges operator input
- Functions requested by operator confirmed by displays on completion

## Visual clarity

- Information clear
- Display formats free from irrelevant information
- Logical grouping & structure of information
- Display formats not densely packed/cluttered
- No distraction from user's primary tasks

## Consistency

- Information consistently presented within & between sub-systems
- No confusion/errors through inconsistencies
- Graphical symbols and colour coding in accordance with recognised International Standard
- Symbols used in mimic diagrams consistent across all displays
- Screen layout & arrangement of information consistent
- Flashing of information reserved for unacknowledged alerts or transient states

## Compatibility with users' expectations

- Information/labelling in accordance with recognised standards/conventions
- Information in form that users are accustomed to
- Control functions work as users expect
- Equipment mode obvious to user

## Alarms

- Provision of alarms consistent with Human Hazard Assessment
- No unnecessary alarms
- Alarm philosophy based on good practice
- Accepting/cancelling alarms do not cause distraction/excessive workload
- Alarms prioritised/grouped to reflect urgency
- Captions/alarm list messages easily understood
- Different audibles easy to distinguish
- Sufficient alerting when user busy with other item of equipment

## Error prevention and correction

- Failure indications clear & unambiguous
- Sufficient information to identify cause of failure
- Assistance in recovering from user error
- 'Undo' function provided
- Single user errors identified and avoidable
- Operator confirmation provided for control action that could affect safety of ship

## Flexibility and control

- Equipment meets needs of different users
- User 'in control' of sequence of commands/actions
- Able to switch between tasks with some incomplete
- Obvious to team who is in control of particular function(s)
- Transfer of control compatible with good watchkeeping procedures

## Situation awareness

- Functional overview display provided
- Equipment & arrangements assist operator in maintaining awareness of overall situation
- Operator not absorbed in what equipment is doing
- 'Head-down mode' avoided

## Automation and status indication

- Operating mode of machinery & equipment clearly indicated
- Defects/failures & their implications obvious to user
- Able to override automation or intervene part way through process
- No monotonous monitoring tasks
- Procedures & assigned tasks address failure modes

## Support for operator tasks

- User interaction in accordance with task requirements
- Needs of all watch conditions & situations considered
- Specific needs of particular users considered
- Workstation design supports teamworking & assignment of tasks
- Operator able to crosscheck control actions

## Supporting tasks

- Adequate storage of manuals, log books, work surfaces, etc
- Able to perform background tasks at workstation
- Background or supporting tasks do not cause distraction or additional workload

## Panel layout

- Panel layout logical
- Items grouped & sequenced in manner that supports correct use & helps to prevent errors
- Controls & displays positioned according to frequency, urgency and criticality



# layout **A checklist**

# Alert!

Controls & displays grouped according to sequence of use   
 Keyboards divided logically into functional areas

## Controls, displays & labelling

Controls, displays & labelling clear & easy to access   
 Purpose of each control clearly indicated   
 Controls and indicators easily distinguishable   
 Displays & indicators present operator with clear, timely & relevant information   
 Operating mode of machinery & equipment clearly indicated   
 Failure indications clear & unambiguous   
 Sufficient information to identify cause of failure   
 Display visibility satisfactory in conditions of daylight, darkness or no natural light

## Documentation design

Appropriate formats of documentation provided   
 Documentation consistent with equipment   
 Documentation provided in correct language   
 Documentation easy to use   
 Documentation does not cause distraction from safe and effective watchkeeping   
 Needs of all watch conditions and situations considered   
 Specific needs of particular users considered

## Environment

Control room environment meets criteria for heating, ventilation, air conditioning, airflow, humidity, heat sources; noise; vibration; ship movement   
 Lighting sufficient to avoid glare/reflections from working & display surfaces, flicker-free   
 Non-reflective or matt finish on surfaces

## Field of view

External view meets Regulatory requirements   
 Satisfactory horizontal field of view from each workstation   
 Satisfactory vertical field of view over bow from conning & manoeuvring positions   
 Window inclination, dimensions, framing & heights of upper & lower edges satisfactory   
 Satisfactory view between different workstations/operators

## Room layout

Layout supports operation in all watch conditions & emergency situations   
 Location of equipment appropriate to operator task does not cause distraction to other users   
 Sufficient space & access for intended number of operators in expected operating conditions   
 Local control stations positioned to minimise risk of harm to operator   
 Instruments face operator's intended working position

## Access

Access to & within control room meet ergonomic criteria   
 Controls easily accessible to operator at workstation   
 Layout of control room meets ergonomic criteria   
 Ease of maintenance addressed   
 Ease of cleaning addressed

## Occupational safety

Measures for occupational safety, including grab rails, non-slip surfaces, warning signs, protective clothing, protuberances, safety equipment marking, escape & survivability, security, cleaning

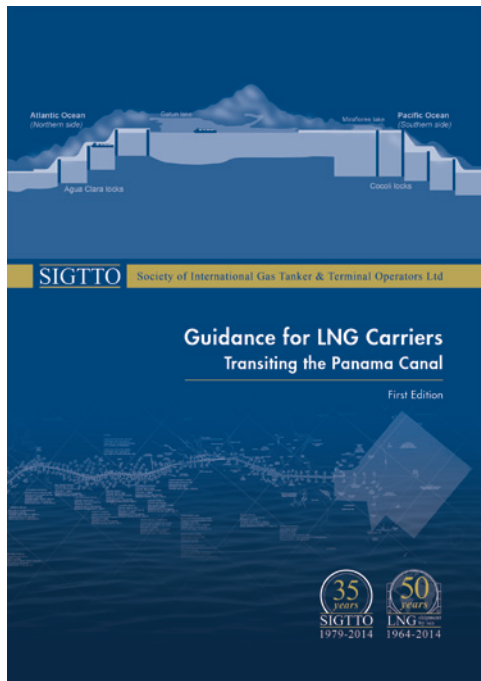
Adapted from Lloyd's Register Rules and Regulations for the Classification of Ships, Part 6, Chapter 1 Control Engineering Systems, Section 3 Ergonomics of control stations; and the ATOMOS IV SOLAS Regulation V/15 Template 2013 Retrofit and Newbuild

To access a more comprehensive checklist together with appropriate reference documents, scan the QR Code



# LNG Vessels and the Panama Canal

Andrew Clifton, General Manager, SIGTTO - [www.sigtto.org](http://www.sigtto.org)



- Safety
- Pre-Arrival
- Security
- Pollution Prevention
- Navigation
- Pilotage
- Mooring
- Anchoring and Mooring Areas
- Tugs
- LNG Cargo Carriage
- Cargo Tank Vapour Management
- Propulsion
- Bridge Visibility
- Environmental
- Contingency Planning

Organisations that actively take steps now to address human factors issues will be best placed to succeed.

LNG shipping is widely considered to be more advanced in addressing certain human factors issues than other parts of industry. The LNG segment's excellent safety record is the result of several factors, ranging from the underlying engineering through the operational procedures to the technical competence of operators.

Public confidence in the safe transportation of LNG is essential. The LNG shipping industry has an exceptional safety record; in almost 50 years of operation there have been over 77000 cargoes carried and no loss of cargo tank containment; and no fatalities directly related to the cargo have occurred. This is a very impressive, in fact, unprecedented safety record for the carriage of liquid hydrocarbons in bulk.

With the huge increase of activity the industry is experiencing, the LNG fleet has increased from 100 ships in 1997 to 400 ships this year with a further 120 on order. This increase in activity is, of course, to be welcomed however it does bring with it some fresh challenges.

One of these challenges is the Panama Canal. Until now only a handful of smaller LNG vessels and LPG vessels have been able to transit the existing locks. The Panama Canal (third set of locks) expansion project will enable the majority of LNG carriers to transit the Canal when the new locks open in late 2015/early 2016.

SIGTTO has produced guidance regarding technical aspects of an LNG vessel transit through the Canal, through its publication *Guidance for*

*LNG Carriers Transiting the Panama Canal*.

A key objective of the SIGTTO Guidance is to provide relevant information that may assist a vessel to plan a transit through the Canal. The publication also contains recommendations on safety, training, minimum equipment levels and good operating practices.

High level discussions and reviews carried out by SIGTTO and the Panama Canal Authority have resulted in significant measures being taken to achieve the objective of acceptable levels of risk for a transit through the Canal. These measures include canal design, risk mitigation measures and operational procedures. Two examples of this are that LNG carriers will be assisted by four tugs while entering the locks; this operation will be carried out at slow-speed, reducing the risk of any damage to the vessel. Additionally, LNG carriers transiting the Gaillard Cut will be accompanied by a tug and there will not be any head on traffic permitted in this area.

SIGTTO has noticed that Marine regulations are becoming increasingly focused on human factors, which is forcing industry to take account of this important topic. Organisations that actively take steps now to address human factors issues will be best placed to succeed.

The Panama Canal guidance is one example of how SIGTTO is addressing human factor issues.

*Guidance for LNG Carriers Transiting the Panama Canal* available from: [www.witherbyseamanship.com/guidance-for-lng-carriers-transiting-the-panama-canal.html](http://www.witherbyseamanship.com/guidance-for-lng-carriers-transiting-the-panama-canal.html)



# Increasing the safety

of demanding offshore operations through usability

Dr Frøy Birte Bjørneseth, - Rolls-Royce Marine, Norway



Maritime operations carried out for the oil industry are safety critical. Operators must monitor multiple displays that give feedback on aspects such as accurate vessel location when operating close to offshore installations, engine status and status of loading and pumping equipment. Meanwhile they must maintain *constant* awareness of the operating deck of the vessels. During these operations deckhands are often working on deck near dangerous equipment which is being controlled remotely from the bridge.

The safety issues are of greatest concern when large equipment is being used such as powerful winches during anchor handling operations and when loading/unloading during platform supply operations. The increasing use of multiple computerised systems for different aspects of monitoring and control, often with differing interfaces, introduces the risk that operators may focus too frequently and for too long on visual displays for the safety of deckhands. With this knowledge the focus was pointed to the human factors in demanding offshore operations and in collaboration with Aalesund University College (Norway) and University of Strathclyde (Scotland), a maritime human factors laboratory was established in Aalesund.

We have investigated both the extent of the problem mentioned above and if there are recognizable visual patterns during operation that give pointers on how to better design the bridge environment to support the operator both during standard work procedures and when reaching the critical point of operation. We believe that this will further reduce the human error rate. For this research, eye-tracking equipment was utilised and a comparison between experienced and novice operators were carried out.

One of the key elements of a bridge concept is to

maintain a good view to the outside environment, as the operators spend the majority of their time looking at the outside scenery. It is therefore important to have no significant occlusions in the field of vision (FOV), which is vital to ensure a safe working environment.

The experiments done are informed by our understanding of the operators' work, which is in a dynamic and visually challenging environment. This understanding comes from direct observation on vessels and in working closely with operators and their trainers. This working environment demands operator attention regularly during which they must monitor and process considerable information and make decisions under conditions where task load varies across a range of their capabilities.

Rolls-Royce Marine recently launched their new Unified Bridge which includes a complete re-design of bridge consoles, levers and maritime software. The Unified Bridge has been designed on a basis of human factors, usability and user experience research, hence it has been developed strictly using a user-centred design process.

The results from the experiments introduced possible improvements from the current aft bridge setup traditionally used, to that of the Rolls-Royce Unified Bridge. By removing the armrests all together on the operator chairs, cleaning the surfaces of equipment by integrating third party equipment into an auxiliary system controlled by a touch panel and moving all controllers (levers, button panels and VDUs) closer to the user, it is possible to reduce the number of VDUs and open up the FOV to the aft deck. This reduces visual scanning of the aft bridge and aft deck environment and less areas to maintain situational awareness. This can have an impact on the operator's workload during operation and critical phases.

*The experiments done are informed by our understanding of the operators' work, which is in a dynamic and visually challenging environment.*

# A basic approach to the elimination of Human Factors Engineering problems

(Courtesy of the U.S. Coast Guard Human Factors Course developed by Gerald E. Miller (GEM Associates), Rajiv Khandpur (USCG, Office of Compliance) and Soza & Co Ltd)

## Design the problem out

### 1. Design for the User

- Who is the user or operator?
- What tasks does the operator need to perform to operate/maintain the equipment?
- What is the worst case scenario for the operator?
- What is the physical operating environment?
- What training/skills does the operator need or have?
- What is the consequence of human error?.

### 2. Design for spatial relationship

- Arrangement/orientation of the crew work station must replicate the actual world to be monitored or controlled
- Multiple components of a single system should be visually related

### 3. Design for operational expectations

- Cultural.** In the western culture, red is associated with danger, yellow with caution and green with an all clear signal. In a stressful situation, colour coding in violation of cultural expectations could contribute to a serious accident.
- Equipment** – provide cues built into the system that guide the operator to behave in a

certain way, e.g. a knob with a T-handle is an invitation to pull whereas a knob in the shape of a mushroom will cause an initial push reaction from the operator

### 4. Design for feedback requirements

Feedback gives the operator information as to whether the action that was taken had any effect or not, e.g. if an operator shuts off a valve from the bridge, the green light goes dark and the red light comes on, to tell the operator that the valve is shut.

### 5. Design for accessibility

Equipment and system layout and arrangement must be designed keeping operability, maintainability and accessibility in mind.

### 6. Design for consistency

Avoid the risk of human error through changes in design, policy, or procedures, e.g. a display that appears in a specific location on a panel on one console should appear in the same location on another console for the same type of equipment

### 7. Design to eliminate ambiguity

Job tasks should be designed so that there is only one way to complete a task, e.g. an assembly should only be able to fit in one way – the right way – and not be able to be assembled in an improper manner.

## If the problem cannot be designed out

**1. Shield against it**, e.g. provide a handrail on a stairway or a guard cover on a flywheel

**2. Warn of the problem** visual alarms (labels, lights) or audio alarms (horns, bells, announcements).

**3. Provide easily understandable procedures or job aids** to allow the operator to avoid the problem.

# Alert!

The International Maritime Human Element Bulletin

**Editor:** David Squire, FNI

Published by the Nautical Institute, the world's leading international professional body for qualified mariners

[www.nautinst.org](http://www.nautinst.org)  
Membership info: [sec@nautinst.org](mailto:sec@nautinst.org)

The opinions expressed herein are those of the editor or contributors and do not necessarily represent the views of The Nautical Institute or Lloyd's Register Foundation.

The Nautical Institute and Lloyd's Register Foundation, their affiliates and subsidiaries and their respective officers, employees or agents are, individually and collectively, referred to as 'The Nautical Institute and Lloyd's Register Foundation'. The Nautical Institute and Lloyd's Register Foundation assume no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this Bulletin or howsoever provided, unless that person has signed a contract with an entity from The Nautical Institute and Lloyd's Register Foundation for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.

Cover story: Captain Nick Beer, FNI

Centrespread image: Danny Cornelissen  
[www.portpictures.nl](http://www.portpictures.nl) +31625555172

Printing: Indigo Press +44 (0)23 8023 1196

Website: Pixl8  
[www.pixl8.co.uk/](http://www.pixl8.co.uk/) +44 (0)845 260 0726

Design & artwork production by:  
Jacamar (UK) Ltd: [www.jacamar.co.uk](http://www.jacamar.co.uk)

This bulletin is distributed and promoted with the kind support of:  
Global Maritime Education & Training Association (GlobalMET); International Federation of Shipmasters' Associations (IFSMA); International Institute of Marine Surveying (IIMS); Institute of Marine Engineering, Science and Technology (IMarEST); International Maritime Pilots' Association (IMPA); NewsLink; Royal Institute of Navigation (RIN); Royal Institution of Naval Architects (RINA)