The use of mandatory equipment on board cargo ships: An outline report based on research undertaken in the period 2012-2016

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Contents

Executive Summary

Introduction

This report provides an account of the main findings from an investigation of seafarers' experiences of mandatory equipment in the course of their shipboard employment. The study was extensive and was conducted in the period 2012-2016. As the first study of its kind, it aimed to understand the underlying causes of poor mandatory equipment use, where this exists. In describing the findings, the report provides a contribution to improvements in safety at sea by identifying reasons for poor use of mandatory equipment at sea and recommending some ways in which this might be improved.

Methods

The study incorporated a review of related literature, observation on nine vessels, semi structured interviews with 152 seafarers at sea, vignette-based interviews with 211 active seafarers ashore, and the completion of questionnaires by 2,500 serving officers. NVivo and SPSS were used in the process of data analysis. Participation in the study was undertaken on a confidential basis and the report does not identify any individuals, companies, or ships by their real names.

Main Findings

The main findings of the report relate to design issues, user 'buy in' (to the need for mandatory equipment) and training in the use of such equipment.

Design Issues

Design issues were identified in relation to a range of lifesaving equipment. These centred on:

- 'On load release and retrieval systems' associated with davit launched 'gravity' lifeboats.
- The adequacy of shock absorption and restraint systems associated with freefall lifeboats.
- Restricted space on freefall lifeboats.
- Inadequate arrangements for unassisted boarding of liferafts.
- Poorly designed immersion suits restricting mobility and dexterity due to weight and glove design.

These design issues impacted on attitudes to equipment producing considerable fear in the course of drills and fearfulness with regard to use of such equipment during emergencies. Loss of faith in the design of equipment had a knock on effect in terms of training and drills.

There were also design problems identified in relation to navigational and bridge equipment. In this respect the following findings emerged:

- Manual re-set and motion sensitive bridge watch alarm systems were criticised as periodically interfering with necessary watch-keeping duties. As a result they were quite often switched off.
- Fully integrated bridge watch alarm systems were relatively well-tolerated by seafarers.
- Global Maritime Distress and Safety System (GMDSS) equipment was believed to include some redundant components.
- GMDSS design was regarded as very out of date and as a result was seen as less-user friendly than it should be.
- Electronic Chart Display and Information System (ECDIS) was regarded as relatively complex but reasonably user friendly.
- The complexity associated with ECDIS led seafarers to consider that available shore side assistance was essential with regard to problem solving and maintenance.
- Some seafarers regarded echo sounders as poorly situated and a preference for integrated echo sounders was expressed.
- Digital displays were preferred in relation to gyro compasses as was the siting of a repeater inside the bridge.
- Automatic Radar Plotting Aid (ARPA) was well-regarded but some seafarers raised issues about 'clutter', user-friendliness and the undesirability of having to adapt to different designs from different manufacturers.

Oily Water Separators (OWS) were widely considered to be improving in terms of design and maintenance issues. However, cleaning and maintenance were nevertheless identified as issues requiring on going improvements in order to increase reliability in 'real' conditions.

A relatively high proportion of seafarers (23%) had experienced being on board a ship where a 'magic pipe' was in use to bypass the OWS. They reported, however, that the practice was increasingly rare.

There were reports of the incorrect placement of emergency pumps and high maintenance and insufficient capacity in relation to incinerators.

Belief in the benefits of mandatory equipment: User 'buy in'

- Bridge watch alarms were widely supported by seafarers who recognised their usefulness.
- Some seafarers questioned the need for the use of the bridge watch alarm at night time if/when a watchman was present on the bridge in addition to the navigating officer.
- Bridge watch alarms were relatively commonly switched off for periods of time (usually, but not always, with the Captain's permission).
- Because of their volume and frequency GMDSS alarms were frequently silenced by seafarers without checking on their trigger.
- ECDIS was regarded as useful and potentially time saving. However, concerns were raised in relation to over-reliance on ECDIS.
- Most seafarers had a positive experience and attitude towards OWS. They appreciated the equipment's environmental significance.

Training

Drills were generally regarded as important by seafarers. This was particularly the case when shore-side training was identified as inadequate. However, in relation to lifeboat drills seafarers identified a number of issues that interfered with their effectiveness:

- The vessel schedule did not always allow sufficient time for drills resulting in the conduct of inadequate training exercises and/or some drills being recorded but not completed.
- Some seafarers stepped back from drill participation due to fear of the equipment involved.
- Knowledge of accidents increased fear levels amongst seafarers.
- Some Captains avoided drills due to fears for the safety of seafarers.
- Drills could be made more hazardous as a result of their infrequent conduct.

Training relating to the operation of OWS was well-regarded. However ECDIS training remains patchy and many seafarers have not yet received training ashore or on board.

Recommendations

These recommendations emerge from the empirical data collected in this study. They are not intended to be prescriptive but to form the basis for what we hope will be constructive future discussions with different elements of the maritime sector. Our ultimate intention is for such discussions to lead to improvements in the design of mandatory equipment, and its use, at sea.

Three key, related, areas emerged in relation to this study of mandatory equipment: design issues; belief in the need for equipment ('buy in' by seafarers); and training. The findings which emerged in relation to each of these areas have resulted in the following recommendations:

1) Until such time as lifeboat On-Load Release and Retrieval Systems (OLRRS) are effectively modified to substantially increase the safety of lifeboats, fall prevention devices should be made **mandatory** (they are currently recommended).
2) Where fall prevention devices are utilised, companies should provide seafarers with appropriate training in their use.
3) Following modification of OLRRS in compliance with revised Life-Saving Appliance Code (LSA) sections 4.4.7.6.4 to 4.4.7.6.6, vessels which have already fitted fall prevention devices (FPDs) should continue to make use of them. Whilst compliance with the new regulations should make FPDs superfluous their continued use should increase the confidence of seafarers until such time as the new designs/modifications have been demonstrated to be fit for purpose and fears amongst seafarers have consequently subsided.
4) Regular maintenance of OLRRS by specialist licensed and certified personnel should be a mandatory requirement.
5) The space between rows of seats inside freefall lifeboats should be increased to allow for adequate leg-room for seafarers of all heights whilst they await rescue.
6) Freefall lifeboats should incorporate sufficient space to facilitate the storage of immersion suits and life jackets.
7) The weight/height allowance utilised in the design of freefall lifeboats should be increased to take account of the increasing size/weight of the overall population. Bringing the weight allowance into line with that utilised in the North Sea off-shore sector would seem appropriate and the average weight/height calculation should be reviewed at regular five-year intervals and adjusted in line with population weight/size trends.
8) Freefall lifeboats should be designed to further reduce the risk of spinal injuries. This may require the better design of seating (to provide greater shock absorption) and/or better restraint mechanisms including head-straps.
9) Liferafts require modification to allow for unassisted boarding from the water by seafarers of different size, weight and strength.
10) Regulation should be adapted to require immersion suits to be the lightest weight possible whilst retaining thermal properties. Regular immersion suit maintenance and upgrading should be made mandatory in support of this.

11) Regulations should be adapted to require all immersion suits to incorporate five-fingered gloves for both hands.

12) Regulation should be adapted to require lifejackets to be of minimal bulk and weight whilst retaining buoyancy properties.

13) The design of GMDSS should be updated to remove redundant equipment and to maximise user-friendliness.

14) The effective use of OWS should be supported by continued vigilance in inspection practices and by employers providing filter replacements and permission to dispose of oily waste ashore.

15) Efforts should be made to ensure that ports provide oily waste reception facilities at low cost.

16) Training standards ashore require improvement in relation to life saving equipment such as lifeboats and liferafts. It is important that all such courses include practical 'hands on' experience.

17) Companies should be required to provide 24-hour shore-side technical support to seafarers in relation to the use of complex systems such as ECDIS.

18) Integrated bridge watch alarm systems should replace motion sensitive and manual re-set systems on all new ships.

Introduction

The relatively simple wooden sailing vessels which characterised the early shipping industry have been replaced by complex modern merchant 'machines' which incorporate various mechanical and electrical systems. The use of some of the equipment carried on board contemporary merchant cargo vessels is mandatory and is carried in line with international shipping regulations, most notably those associated with the prevention of marine pollution (MARPOL regulations) and those connected with the preservation of life at sea (SOLAS regulations). Mandatory equipment specified by the SOLAS and MARPOL conventions of the International Maritime Organization (IMO) includes for example, fire-fighting equipment, navigation aids, lifesaving equipment and environmental protection equipment.

On board a vessel it is vital that the use of such mandatory equipment is understood and that it is used appropriately and maintained correctly. However there is evidence which suggests that from time to time such equipment is either poorly operated and/or poorly maintained resulting in both a threat to human life and to the environment. If the reasons for such practices are to be understood it is essential to access the views of the 'end users' of such equipment, i.e. seafarers.

This report provides an account of the main findings from a unique systematic investigation of seafarers' experiences of using mandatory equipment in the course of their shipboard employment. The global study (see Appendix 1) was extensive and was conducted in the period 2012-2016. It aimed to understand the underlying causes of poor mandatory equipment use, where this exists. In describing the findings, the report provides a contribution to improvements in safety at sea by identifying the reasons for the poor use of mandatory equipment at sea and recommending some ways in which this might be improved.

Methods

The study was organised into four phases.

Phase one

Phase one involved a literature review relating to academic and non-academic literatures connected to the research. Together they were used to identify the issues that had been recognised by members of the maritime community (professional associations, media commentators etc) as problematic in relation to the use of mandatory equipment. These were then included as areas of investigation within the study (see Turgo et al 2013). The literature search also allowed us to identify issues which had been recognised in land-based contexts as pertinent to equipment use such as the benefits and drawbacks of alarms (e.g. Edworthy and Hellier 2005). Awareness of these issues informed the research design but did not constrain it. In Phase Two of the study the methodological approach was of a grounded nature (Glaser and Strauss 1999, Charmaz 2006) allowing for the emergence of issues as identified by participants rather than the imposition of a series of issues on the early stages of the research with attendant questions. Once we had established the issues as understood from the perspective of seafarers we were able to ascertain how widespread such concerns were by using a more structured approach, in the design of vignette-based interviews and questionnaires, and focussing upon the specific issues that had emerged.

Phase two

Phase two of the study was the first of three phases of data collection. It involved researchers joining vessels for prolonged periods of time to enable them to develop a detailed understanding of the ways in which mandatory equipment is used, understood, and maintained on board. In this phase a total of eight ethnographic voyages were undertaken on different kinds of cargo ships operated by different companies (see Table 1 for details).

Table 1: Details of ethnographic voyages[1]

Ship Pseudonym	Type of vessel	Number of crew	Nationality of crew	Days on board
Florida Beach	Bulk Carrier	16	Chinese	22
Gemstone	Car Carrier	25	Filipino, Indian, Bangladeshi, Ethiopian, Ukrainian	26
Aguacon	Container	19	Filipino, Ukrainian, Danish, Swedish, Russian, Romanian	33
China Exchange	Bulk Carrier	21	Chinese	35
Spiritual Protector	Bulk Carrier	20	Chinese	31
Bananarama	Reefer/Container	23	British, Panamanian, Filipino	35
Braveheart	Chemical Tanker	21	Romanian, Croatian, Indian, Montenegro, Hungarian, Latvian, Filipino	37
Pantank	Oil Tanker	23	Indian, Filipino	25

In total we spent 244 days at sea observing the use of mandatory equipment in practice and in drill situations, interviewing seafarers, and informally chatting with serving seafarers about the equipment being used on board. On return to Cardiff we transcribed the 152 formal semi- structured interviews that had been conducted and we analysed these alongside the eight sets of coded fieldnotes compiled by researchers in the course of their shipboard fieldwork. This allowed us to identify the main themes which had emerged in the course of interviews and observations and we used these to construct the instruments for Phase Three of the research which was based on a far greater number of vignette-based interviews.

Phase three

In phase three of the study we conducted a second sweep of data collection. In order to broaden the range of accounts offered to us by seafarers we needed to base this phase of data collection ashore where more seafarers could be accessed and on a more 'time-efficient' basis. We were mindful however of the extent to which approaches to 'strangers' in seafarer centres and other venues might yield rather superficial and hasty responses to semi-structured interview questions as in these circumstances it is difficult to fully engage interview participants – they are busy, distracted, and caught unawares. We therefore elected to construct an interview schedule based upon real events and accounts offered to us by seafarers on board vessels. In adopting this 'vignette-based' approach

[1] NB researchers were required to combine interviews and observations for two parallel projects whilst on board – this study of mandatory equipment and a study of ship-shore interaction which was also supported by the same funders (Lloyd's Register Foundation, The TK Foundation and Cardiff University) and which ran over the same time period.

we sought verification, refutation, and/or elaboration from participants and we used the 'stories' provided by the vignettes (all of which derived from the real examples found in phase two) to stimulate seafarers to offer their own perspectives and experiences of mandatory equipment. In total we completed 211 vignette-based interviews in the UK, India, Philippines, China and on board one further vessel. This 'further' vessel (*Beluga*) provided the opportunity to conduct a five-week 'validation voyage' towards the end of the data collection process. The ship was a container vessel with Polish, Ukrainian, South African, British, Filipino, Myanmar and Chinese nationals on board.

Phase four

Phase three of the research allowed us to collect a relatively high number of accounts by seafarers of their experiences of various kinds of mandatory equipment. This was very useful in terms of adding to the wealth of qualitative data collected in the course of the project and our understanding of the range of issues impacting effective usage of mandatory equipment. However, we felt that in relation to some very specific issues that had emerged it would be valuable to gain a better understanding of how widespread these were. Specifically we were concerned to see how commonly seafarers experienced issues concerning:

- liferafts
- lifeboats
- alarms
- equipment maintenance and malfunctions
- problems with the use of equipment such as oily water separators

Whilst we are unable to draw a true *random* sample of seafarers from the global workforce (we cannot identify the members of this global population and their contact details effectively and therefore cannot generate a random sample in the normal manner) we are nevertheless able to gather responses from seafarers in different parts of the world and to attempt to minimise sample bias via careful attention to the means of identifying active seafarers. We therefore collected a total of 2,500 interviewer administered questionnaires in five countries (India, Philippines, UK, China, Singapore). In undertaking this exercise we made use of sites where seafarers from a variety of companies and ship types might gather such as training centres and seafarer welfare centres and we avoided sites where seafarers might share critical characteristics such as the same employer.

Phase four summary of sample characteristics

Questionnaires were collected in five countries: Philippines (46%); India (18%); China (21%); UK (14%); Singapore (1%). This produced a sample incorporating seafarers of 35 different nationalities. The four main groups were Filipino (45%), Indian (26%), Chinese (21%), British (4%). The remaining nationalities were grouped into two 'other' categories for the purposes of analysis – 'EU/Former USSR/Scandinavia', and 'the rest of the world'. The sample was almost equally split between junior and senior officers. Almost half of the sample (48%) were senior officers which we defined as: captain, chief engineer, chief officer, and second engineer. The remainder (52%) were junior officers. Only 11 seafarers (0.4% of the sample) were female. The average age of respondents was 37 and on average respondents had been at sea for 14 years.

Summary of methods

In total, in relation to this research project, the team conducted eight ethnographic voyages, one ethnographic validation voyage, 152 semi-structured interviews with seafarers on board, 211 vignette-based interviews with active seafarers ashore/on board, and 2,500 'interviewer administered' questionnaires with seafarers ashore (1,497 with deck officers and 1,003 with engine officers). All interviews were recorded, transcribed and coded using NVivo software and questionnaires were input into SPSS and analysed using SPSS.

In reporting our findings we make use of pseudonyms and do not identify any personnel or companies.

Main Findings

Design issues

Lifesaving equipment

Lifeboats and perceptions of danger

Accident investigation reports (Tang et al 2013) and a variety of sources in the maritime community have highlighted the safety issues, linked to design, that are associated with lifeboat drills involving the launch and retrieval of lifeboats (Filor and Rutherford 2002, Gale 2011). These safety issues can be expected to have created a certain amount of trepidation amongst seafarers (Gale 2011). In the course of the ethnographic voyages undertaken in phase two of the study we identified a considerable amount of fear amongst seafarers. This related to both davit launched and freefall lifeboats. In terms of freefall lifeboats seafarers were most frequently fearful of the impact associated with a launch and some had heard of seafarers sustaining back and neck injuries in drills. As one explained:

> We always scared about the free fall because when it goes into the water there is a chance you whack the head back [whiplash]...That is the chances. (Pantank SS ME 25)

Fear of injury was the most frequently expressed reason why freefall lifeboats were disliked by seafarers but we also noted that these lifeboats were experienced as extremely cramped and uncomfortable. Many seafarers described how there was no space inside the freefall lifeboat for survival suits, life jackets, and supplies. More disturbingly perhaps they found that they were not able to sit comfortably in them (due to insufficient leg room) and many could not conceive of spending a sustained period of time in such confined and uncomfortable conditions.

In terms of davit launched lifeboats there were frequently expressed fears about inadvertent lifeboat release and many accounts (some of which were first hand) of seafarers who had been injured or killed in drills where lifeboats were lowered. One such example was provided by a messman who told us that:

> Seafarer: I think better to use the liferaft, because in the lifeboats, my last classmate on my training, he have a story, there are two brothers, one chief mate, and one AB, and they have an incident like that, he tried to lower the lifeboat, then there was a mistake, and it first released on the forward, and it fell in the water, the forward.

> Interviewer: I see, the forward fell to the water. Were they injured?
> Seafarer: Dead. [...] [if] they ask me if I go to the lifeboat. No. (Gemstone SS ME mess)

In addition there was some acknowledgement that sometimes drills and, moreover, maintenance were logged but not conducted. As one seafarer explained:

> I remember in some instances the wires were rotted due to poor maintenance. Usually the lifespan of a wire is five years but in a number of cases companies would extend their use beyond the expiry date rather than replace them. Certificates can be forged to show that the wire is still useable or not yet reaching its expiry date. Most accidents happen, in this instance, because of wires snapping.
> (Bananarama SS ME 16)

We discovered that some Captains were understood to have avoided launching lifeboats out of concern for the safety of their crew members or for fear of being unable to retrieve a lifeboat undamaged (or at all) following a drill. In these cases launches might be logged as having taken place when in fact a substitute drill may have occurred (a 'table-top drill' for example). We also identified seafarers who refused to take part in drills when they were held. As one, whose attitude had hardened over time, described:

> Back then every time I was asked to be part of the drill where the lifeboat is launched, I felt a certain unease, nervousness. Now whenever I am asked to participate, I talk to the bosun and tell him that I am not going to join the drill. It really freaks me out. (Bananarama SS ME 4)

In the course of our vignette-based interviews these concerns were confirmed and some seafarers told us of the falsification of records in place of drills.

A second engineer described for example how:

> I also worked for some small companies. On those ships, no drill was conducted ever. They only falsify record. (Vig LT 18 2E)

While a deck officer suggested:

> To be frank, since you'll not put my name, or the company name, I'm telling most of the Masters forge it. But there are company where people tell they seriously do it, and there are Master who also seriously do this thing, and some Masters they forge it. And some Masters they say that 'As a Master, my responsibility is safety for the people. I don't feel safe, I'm not doing it. If something happens, blame will come on me'. (Vig NT 09)

Where fall prevention devices (FPDs) had been fitted seafarers felt reassured that their safety was increased in the course of drills. One seafarer had even looked into personally purchasing FPDs for his ship but had been shocked to learn that they were beyond his budget costing several thousand pounds.

In order to understand attitudes towards lifeboats across a broader population of seafarers we incorporated into the questionnaire several questions relating to issues that emerged in the course of interviews and ethnographic voyages.

We first asked seafarers to state which type of lifeboat they preferred. Seafarers were presented with the options of 'freefall', 'davit-launched (gravity) closed', 'davit-launched (gravity) open', and 'other'. The favoured option proved to be the 'davit launched (gravity) closed' lifeboat which was identified as the preference of 55% of seafarers. A small number (5%) identified a preference for 'davit-launched (gravity) open lifeboats' and most of the remaining respondents (40%) expressed a preference for 'freefall' lifeboats. A small number of seafarers who ticked the 'other' option explained that they did not like lifeboats at all and would prefer to use a liferaft and a small number said they had no preference.

Further to this, we explored seafarer attitudes to taking part in drills on lifeboats. We asked seafarers if they were happier to take part in drills where seafarers did not board lifeboats or if they preferred drills where seafarers did board lifeboats. We also asked if they believed that drills where seafarers did not board lifeboats provided adequate preparation for emergencies. Just over half of seafarers (52%) believed that the partial lowering of lifeboats without seafarers on board was adequate preparation for emergency situations. A similar proportion (50%) suggested that they were happier to take part in drills where seafarers did not board lifeboats. Our ethnographic fieldnotes and interviews identified that there are some seafarers who ask to be excused from boarding lifeboats during drills and that in contrast to other matters their requests are reasonably well-tolerated and understood by Captains who generally do not insist on participation. It should be noted, however, that making such requests for 'exemption' from any activity on board is very rare and that such requests are both made and 'tolerated' is indicative of the seriousness with which the fears associated with lifeboat launches are taken.

In relation to drills being recorded and yet not carried out, the questionnaire was important in ascertaining how widespread this practice is known to be at sea. We asked seafarers to specifically state whether they had been on a vessel where a lifeboat drill was not carried out but was recorded as having been done. Despite the fact that many seafarers simply wouldn't be aware of such

practices, even when they had sailed on a vessel where they existed, over a third of seafarers (36%) asserted that they had experience of this practice. Deck officers were more likely than engineers to state that they had direct experience of it and 40% of deck officers said that they had sailed on a vessel where lifeboat drills were recorded and not carried out. Half of the deck officers who responded to the questionnaire stated that they had experienced Captains who did not lower lifeboats because they were afraid (41% of all respondents – deck and engine combined stated this) and 60% said that there had been occasions where they had avoided lowering a lifeboat due to concerns about safety.

Respondents were also asked whether they thought that in a 'real emergency' seafarers would be afraid of using lifeboats. This question was incorporated to ascertain the level of mistrust in lifeboats found amongst seafarers. The expected response was that in a real emergency seafarers would not be afraid of using the lifeboats as the alternative of not using them would be terrifying. The lifeboats would therefore be regarded as the 'lifelines' that they should represent in such situations. The majority of seafarers (69%) reflected this view and suggested that in a real emergency they thought that seafarers would not be afraid of using the lifeboats. However a very substantial proportion of the respondents (27%) stated that in real emergency they believed that seafarers would be afraid of using the lifeboats. This figure indicates a very widespread mistrust of lifeboats amongst seafarers such that more than a quarter of our respondents considered they would be fearful even in the throes of an emergency. This finding gives rise to serious concern as it suggests that in emergency situations seafarers might eschew the lifeboats in favour of what could be less effective means of safe disembarkation.

The issues identified in the course of the qualitative and quantitative investigation of attitudes to lifeboats are of significance because of their implications. Where training is not conducted, as a result of fear, then seafarers are likely to be ill-prepared for either the future conduct of drills under other senior officers or indeed a genuine emergency. Similarly lifeboats that are not properly maintained as a result of fears associated with safety inevitably become more unsafe and may represent 'an accident waiting to happen' in relation to future use whether in real emergencies or in training scenarios. An analysis by Tang et al (2013) of accident investigation reports published in the UK, Australia, New Zealand, and USA in the period 2002-2011, indicates that both training and maintenance issues are strongly implicated as causes of lifeboat accidents. They describe how:

> In relation to lifeboat incidents, 'inappropriate/ineffective maintenance' (38.5%), 'inadequate training/experience' (23.1%), and poor judgement/operation (23.1%) were identified most frequently by accident investigators as immediate causes of accidents, and

> ‘inadequate training/experience’ (38.5%) was noteworthy as a contributory cause. (Tang et al 2013:12)

Understanding the high levels of fear (associated with both freefall and davit launched lifeboats) which underpin such ‘inadequate training’ and ‘ineffective maintenance’ should lead vessel operators to arrive at better strategies for approaching emergency evacuation training and lifeboat maintenance. It should also produce some impetus for improvements in lifeboat design (including in terms of the space made available to lifeboat passengers) which might usefully be underscored by regulatory amendments. We return to issues of fear and lifeboat drills later in the report.

Liferafts

In contrast to our findings relating to lifeboats, the design issues associated with liferafts did not give rise to concern amongst seafarers on the basis of presenting a danger to them or even in terms of physical comfort. However what did emerge, in the course of the research, was that liferafts were designed in such a way as to prevent access for a proportion of serving seafarers. The issue first presented itself when researchers themselves attended sea survival training at reputable training centres. To their surprise several of the members of the research team found that they were unable to board the training liferaft using the ‘ladder’ unaided. When the issue was explored with training instructors they described how, as a result of the requirement for ‘refresher’ training, they were seeing increasing numbers of seafarers who were unable to board liferafts unaided. A literature search uncovered evidence that men and women have been shown to struggle to board liferafts unaided in experimental conditions in warm calm water (Tikuisis et al 2004). Tikuisis et al (2004) studied a small sample of 24 men and 24 women aged 18 to 52 and found that strength and height were positive attributes correlated with success in boarding using the liferaft ladder. Thus shorter and weaker individuals are likely to enjoy less success in boarding a liferaft given current designs.

As a result of these indications of a potential problem with the design of liferafts, researchers explored this issue in the course of their ethnographic fieldwork on board ship.

Here some seafarers confirmed that they had personally found it difficult to board a liferaft unaided. Others suggested they had seen people struggle to do so unaided and in one case we were told that everyone on one particular course was assisted in boarding their liferaft by the first two seafarers to board who were described as stronger than the rest of the group. In this case the interviewee explained that:

> It was a bit difficult for the first two persons who entered it, and it was easy for those [who] followed. The first two were stronger ones and they climbed in first. It was difficult for them especially if there were waves. It was easy for the rest as the first two could give them a hand. Therefore, you have to choose two strong people to climb in first. (China Exchange SS LT 20)

The problems that can be experienced by seafarers attempting to board liferafts even in ideal training situations were confirmed in the course of the much larger number of vignette-based interviews. In these interviews seafarers also began to elaborate on the problems with liferaft design as they had experienced them. Some suggested that ladders were too 'soft' to give proper support when entering the liferaft, others suggested that the sides of liferafts were too high, some suggested that the design of immersion suits did not help a great deal and highlighted the weight of immersion suits and the construction of the 'hands' as issues. Some immersion suits were considered to be too heavy and where 'hands' did not incorporate separate spaces for each individual finger but were designed more like 'mittens' or with just two or three fingers these were regarded as inhibiting. The following comments from different interviewees are illustrative of these ideas:

> I did experience using the liferaft when I did my training. I think that in deep water it is really difficult to get on to the liferaft if nobody will be helping you. I think liferafts should not be too high, anyway, they will float even if water comes in. And there should be something there for us to grasp and help us heave ourselves into the liferaft. So, they should modify the design a bit. (Vig ME IA 20)

> Massively, I struggled majorly when I had to do mine, obviously when we had our group event we helped each other in but you had to prove that you could get in it on your own and it took me about five attempts because the ladder for me [...] the ladder was too short so I couldn't get the leverage to pull myself up and I've got no upper body strength (Vig ME NE 15)

> It's not so easy to get into the liferaft wearing this life jacket or your life jacket should be of a different kind one. Like it should be not so heavy like they are here. It should be thin layer only. (Vig ME NT 12)

> No, it is a 1.2 metre high so it's not easy. And sometimes when you give your weight the liferaft will incline and this is a liferaft if you give a weight it will be inclined and then you yourself roll down and then you will get in. But if already two three persons are inside then you ask someone to help. (Vig ME NT 33)

> No immersion suit. We wore a boiler suit and a life jacket. Immersion suit, it will be a lot harder because you don't have use of your hands properly. And because it is so thick, there's movement… I think it would be very hard actually to climb in… to one of those, wearing an immersion suit. Maybe that should be during the training, put immersion suit on, and see how you can move and try climb into a liferaft with a suit on rather than... (Vig ME HS 02)

> Fifty-fifty can manage [to board a liferaft] because… when you have this immersion suit, it's very hard to move, you cannot move easily. Even you cannot climb maybe to the liferaft. I am not sure with that. [...] Better. Better to have this five fingers. Yes, like a gloves. You can even use to… to write. A pen. Because when we climb, when we handle something, needs to

> have five fingers. Because it is more difficult to have only two fingers. [...] Yes, we have to change that system. (Vig ME HS 01)

We explored these issues further in the questionnaire administered to seafarers. Thirty percent of respondents stated that they had never had experience of boarding a liferaft from the water in any circumstances (swimming pool or sea during training or sea during an emergency). Just over half (52%) of the 1,869 respondents who reported some experience of boarding a liferaft described having experienced a degree of difficulty in boarding unaided. Almost one in ten seafarers (9%) who had experienced climbing into a liferaft said that they had never managed to do so unassisted, 12% said that they had often had difficulties boarding a liferaft unassisted and 30% described sometimes having difficulties boarding unaided. Just under half of seafarers (48%) said that they had always been able to board a liferaft unassisted.

We also asked seafarers if they thought that they would be able to board a liferaft from the sea wearing an immersion suit in a real emergency and without any help. Just over half of seafarers (51%) thought that they would be able to do so. However, 27% of seafarers stated that they did not think they could board a liferaft in these circumstances and a further 22% did not know whether they would be able to do so or not.

In terms of the design of liferafts and immersion suits there was evidence at all stages of the research that they were not regarded as fit for purpose by a significant number of seafarer respondents. In particular, immersion suits were regarded as heavy and impeding motion and dexterity (see also MAIB 2011), while liferafts had been experienced by many as difficult or impossible to board unaided even in ideal conditions. In terms of liferafts it was felt that ladders required re-design and that the freeboard of liferafts might helpfully be reconsidered.

Bridge Equipment

Bridge Watch Alarm Systems

On board vessels, in the course of the ethnographic voyages undertaken, researchers talked to seafarers about the different kinds of bridge watch alarm systems (BWAS) that they had experienced. Seafarers identified that the manual re-set alarms which some had on board (or had previously experienced) were not as convenient as those which incorporated motion sensors or were fully integrated into

bridge equipment (triggered by officer activity in interacting with radar and ECDIS for example). As one seafarer explained regarding manual re-set alarms:

> It is a bit troublesome. You need to press the button from time to time. On the previous ship, we were using it. That one was different and detected movements. This one you have to press it, which is troublesome. (SS ME LT 02)

Another described how the time interval that was programmed for alarms was critical and how frustrating and disturbing he had found alarms to be. Describing a motion sensitive alarm which did not fully cover the bridge including the chart correction area he told us:

> Well, actually it is pretty annoying [...] The setting was 3 minutes. If you go out just to take the temperature the alarm goes off. After departure from Poland, the first morning, the Captain's wife was on board. So one morning the chief mate was smoking, or I don't know what he was doing outside, and the alarm went off. The sound of the alarm was coming from the Captain's cabin and it was so loud. I was sleeping in the deck below and I could hear it. It was so loud that I woke up.[...][on that ship] I was correcting charts and I had to correct charts like 200 charts per week and every three minutes I had to press the okay button because the system works like this - you have movement sensors on the bridge, if the sensors do not sense that you are moving then in three minutes the alarm will go off but there is a part of the bridge, especially on some vessels, which are not covered by the sensor and if the second mate is doing the chart there, [he has to manually re-set the alarm every three minutes]. (SS ME Bananarama 15).

While another illustrated the more positive attitudes to integrated systems when he described how:

> In some Japanese ships they have a sensor, the alarm will be there, if you just move the mouse it will be reset. But in this ship you have to press it every 12 minutes.
> (SS ME Gemstone C2)

Frustrations with alarms could lead Captains to authorise silencing them by switching off the BWAS. This meant that on some ships we found that BWAS were not in use (a finding which is reinforced by accounts elsewhere e.g. Kataria et al 2015). We therefore felt the issue was worthy of exploration with greater numbers of seafarers and in our questionnaire we asked seafarers if they had personal experience of switching BWAS off both with and without the Captain's permission. A sizeable minority (42% of respondents) had switched off the BWAS with the Captain's permission. Far fewer seafarers stated that they had switched off the BWAS without the Captains' permission (5%).

In relation to design we found that seafarers expressed a preference for fully integrated BWAS systems that could be re-set by use of bridge equipment. As one explained:

> I spoke with some guys who work for [company name] and stuff, and more reputable companies and they work that if you touch any piece of Bridge equipment, so if you're using the radar it's all interlinked, it's all interfaced, so it registers with the Bridge alarm that you're still awake, whereas ours is just a button, so you've got to keep going to this button,

> so it's sort of like it doesn't really work for us. If they updated the system and made it a bit better. (Vig ME NE 11)

Of all our respondents 42% preferred this type of integrated system, 28% expressed a preference for manual re-set systems and 26% favoured motion sensitive systems. The majority of seafarers (70%) stated that they could understand why seafarers switch off alarm systems from time to time.[2]

GMDSS

In our semi structured interviews with seafarers on board there were some indications of a feeling that GMDSS could be made more user friendly and could be updated to exclude equipment (e.g. TELEX) that was now regarded by seafarers as redundant. This was confirmed in our vignette-based interviews where seafarers mentioned outdated designs and difficulties in operating the unnecessarily complex equipment. As one seafarer put it:

> The GMDSS... that should be updated. This should be a small panel with equipment, it should have easily available, easy screen, and you know, and some GMDSS equipment is very difficult to operate. For the test also, it is very difficult to operate. Input etc. So if we can just make a one distress button for all, and maybe with a touch screen to operate. You know GMDSS has never been updated, it is the same as it has always been. (Vig ME NE 09)

Another explained that he felt it was important that GMDSS could be readily operated in times of emergency and should be designed with this in mind. He said:

> We should have a simple layout in the case of emergency, during emergency you don't get puzzled and you don't get confused. (Vig ME NE 31)

Others expressed their feelings more strongly when they described GMDSS in disparaging terms as being like an 'old car radio [...] ridiculous' , 'antiquated', and 'an absolute nightmare'.

We explored the issue of redundant elements with GMDSS as part of our questionnaire with deck officers (we did not ask engineers in the sample to consider this question). Of the 1,476 deck officers who responded 48% stated that some components of GMDSS were redundant. However almost as many (46%) said that they did not think this was the case and 6% did not know.

[2] NB This report does not detail every response to every question and where presented figures do not total 100%, this is either because some responses such as 'don't know' are not reported in the text or alternatively because some questions allow for multiple responses.

ECDIS

Some problems with ECDIS were identified in the course of semi structured interviews and observations on board. These often related to the relatively recent introduction of ECDIS, lack of charts, differences in operation of ECDIS from system to system (see for example Murray 2013, McDonald 2016) and concerns about troubleshooting. We pursued some of these issues in vignette-based interviews.

Generally we found that many seafarers were positive about ECDIS and where they identified problems these were often related to issues such as ordering updates. There was also acknowledgement that training was required in relation to ECDIS[3] and that getting used to it could take time. Updating it was also said to be time consuming and in many cases updates were irregular meaning that some seafarers did not feel they could trust ECDIS fully. However, there was also recognition that full dependence on ECDIS would mean that the time-consuming corrections required for paper charts would no longer be necessary. Typical comments included the following:

> For the first time, for the beginner, it might be complicated. Complicated, er… I mean like just normal… daily routine, like loading charts, it is user friendly. But there is still some complicated part, this ECDIS, because it is a lot of software, also a lot of things… features. So in order for officer to get to use to it, he has to learn. He has to learn, he has to… read manual, for him to… But apart from that, it is user friendly. [Interviewer asks if manuals are clear]...Yes, yes, it's clear. But… it needs time, because a lot of feature. It's just compared with paper charts, you have lots of feature, so you have need times… to learn it. You have to spend time in order for you to get used to what er… the operation of this (Vig ME HS 002).

> The size of the ECDIS screen is limited and so your view is limited. So you need to zoom out and then in. So in the beginning, you may not be used to this. Also in the beginning, you may forget some operational procedures that you do not use often. Then it will take you some time to figure out how to do it again. (Vig ME LT 03)

Covering many of the main points made by seafarers, one interviewee reflected at length on ECDIS. This extended quote illustrates how the realities of life on board impact upon the use of equipment such as ECDIS as follows:

> I think I have the experience to talk about this. Either you have paper charts and one ECDIS. Or you can have two sets of independent ECDIS. In the latter case, both have to be updated timely. I have not had ECDIS training. My employer was a German shipping owner. Their 15 ships are all fitted with ECDIS. The updates were not very timely. CDs were used for update. I have not worked on ships relying solely on ECDIS. Maybe I can work on that kind of ships later. If it relies on ECDIS only, updates perhaps would be done via satellites rather than CDs. I do

[3] See also, for example, Eason (2010).

> not know the detail yet. In general, I heard that the company would collect update information and send on board ships via email. In this way, update can be done more timely. On the ship I worked last time, we were in African anchorage for two months. And also it was not convenient to dispatch mails to Africa. Therefore we did not get update CDs for months. Of course, we mainly depended on paper charts which were corrected every week. Every Thursday, the chandler sent me chart correction information. I worked on relative old ships before without ECDIS. I have not got training. When I changed to this German company, I was not familiar with it nor with its updating. In the beginning, it was difficult for me. Because the handover was done on the New Year time, the previous officer left immediately when I just got on board. He told me that if I could ask the 3rd officer if I had questions. It was in the afternoon and they feared that the immigration office might be close if they left too late. We had less than an hour for handover. In the first few days, it was difficult for me, including ECDIS update and passage plan on ECDIS. Actually, it is very simple, too simple. But I never used it before. It took time to get familiar with it. At that time, we were ready for sailing. It was really difficult for me at that time. Three days later, I had studied the system and got familiar with it. It became very easy. There is also a problem – because we have ECDIS, it makes watch keeping officers lazy. In principle, you should fix positions on paper charts because we do not rely on ECDIS, but once you got used to ECDIS, people are too lazy to fix positions on paper charts. In order to cope with inspection, I have to put positions on paper charts retrospectively afterwards. I also found that some paper charts were not corrected. The ship was delivered in 2008. I found that on one chart, corrections issued in 2011 were missing. (Vig ME LT 22)

In our questionnaires we asked seafarers if they felt that ECDIS was user-friendly and the majority of respondents (82%) said that it was. Nine percent of respondents felt that ECDIS was not user friendly and some (10%) did not know.

There was some anxiety expressed with regard to solving ECDIS problems on board and 38% of questionnaire respondents stated that they did not think that ECDIS software problems could usually be solved by seafarers on board. The majority of seafarer respondents (57%) felt that ECDIS problems could be solved on board if shore-side assistance was obtained but only 5% of respondents believed that seafarers could resolve ECDIS software problems on board without resorting to shore-side assistance.

Other bridge equipment

There were brief mentions of design issues in relation to the integration of bridge systems such as NAVTEX and ECDIS and the ergonomics of bridge equipment in the course of semi structured interviews but these were not very consistent or widespread and were not explored in any further detail using vignette based interviews or questionnaires. However a flavour of them is detailed here for illustrative purposes.

In terms of echo sounders, issues were raised about the position of the equipment (bow better than stern) and whether it was electronically integrated or not. One Captain commented for example that:

> Echo sounding... I don't know why it is, like they want these graphs and all. Why everything is not electronic so that you don't have to bother marking it every time and like when you are keeping watch and like you have to mark it and all those things. Some ships have those electronic ones in which you don't have to mark the graph and graph you have to start and stop and mark and all that. But if it is all electronic recording then it is much better actually. (SS ME HS Pantank 09)

The gyro compass attracted little negative comment in relation to design but digital displays were regarded as preferable and clearer and gyro repeaters installed inside the bridge were preferred to systems where seafarers were required to go out onto the bridge wing in all weathers for routine procedures[4]. Similarly ARPA was generally reasonably well-regarded and the few comments that were made related to clutter, to user friendliness and to the adjustments that seafarers have to make when transferring between ships with systems designed by different manufacturers.

In relation to AIS it appears that the issues which have previously been identified in work undertaken on AIS (Bailey et al 2008) persist in terms of design. Seafarers commented that screens were small and contained limited information, that inputting information is laborious and time consuming, and that switching from one kind of system to another can be confusing. Examples of comments along these lines included the following:

> Regarding the AIS on this ship, its screen is small with low resolution, and as such can only show limited information on each screen. You have to keep turning to next pages to find information you require, which takes time. It would be better if the screen is bigger, showing more information on one page. (SS ME NE 20)

> How to say. It feels like sending text messages using an ancient mobile phone. [...] It could be made more convenient to use. Typing can be made much more convenient. It takes lots of time to type at the moment. You need to choose a letter by scrolling down the list of all letters and symbols. (SS ME NE DC)

> It is difficult to write and edit a message with it. It is very slow. It would be more convenient if it has a small keyboard. It has only number keys, like a mobile. It is very slow writing a message. If you are in a hurry, it is very slow. (SS ME LT 30)

[4] One vessel where we undertook fieldwork did not have a repeater on the bridge although this would normally be the case.

> Yes, it is easy. For me it is little bit complicated too much buttons. On Japanese it is simpler. Yeah, they can simplify. Maybe because I get used to Japanese type. (Gemstone SS ME 30)

OWS use and maintenance

In relation to oily water separators (OWS) there was some evidence from phase two of the study, when researchers sailed with seafarers on board, that the design of OWS was problematic[5]. Seafarers identified that mud and cleaning agents could interfere with the operation of OWS (see also Martin Ottaway 2015). Some seafarers also suggested that notwithstanding measures to secure OWS and prevent them from being by-passed it was nevertheless possible to 'trick' the system allowing for oily water to be pumped overside. Diluting bilge water with sufficient sea-water or water from air cooler drains were both processes described as achieving this.

The issues were further explored using vignette-based interviews and there was some evidence that the views expressed in the earlier stages of the research were endorsed by other seafarers. Some seafarers described, for example, how OWS systems which worked well under ideal or laboratory conditions had not been designed well enough to cope with real conditions at sea. One seafarer put it this way:

> As I say if you run it as the parameters, as the manufacturer designed, they're normally spot on with how you have to change them. But one of the big problems with oily water separators is the manufacturers design and build an oily water separator that functions. What they don't take into account is all the other shit that's going on in the ship. [...] Vibration, rolling, temperature changes, moving this tank, that tank, the other tank, where it's sucking from. Quite often the unit in the correct conditions functions perfectly. (Vig ME NE 33)

Another suggested that:

> I've never had one that works well for an extended period of time, you'll get one overall and it will work but it never lasts long and you need to, they're very maintenance intensive. (Vig ME NE 25)

Some seafarers identified the maintenance associated with OWS as quite labour intensive. Filters were reported to regularly clog up and require replacement or cleaning. One seafarer explained:

> Of course it is not easy because the sludge when it comes to filter, filter gets dirty and this is a paper filter that you can't use repeatedly. First thing. Second thing there is a pump which is a screw pump which cannot tolerate any foreign bodies around with the screw. And these electronic probes, these are...this goes very frequently. So this is a very complicated equipment. (Vig ME NT 33)

[5] See also, for example, Grey 2006, Maitland 2010.

Overall however it seemed as if seafarers on newer ships with newer OWS systems were much happier with both their reliability and maintenance. One chief engineer described his perception of the system he had found on his relatively new ship. He explained:

> The design of the oily water separator itself, and quality of the filters, it is a big improvement. It's a big improvement, I can see it. (Vig ME HS CE)

In our questionnaire we sought to establish the extensiveness of these perceptions. We asked engineers if they thought that OWS were reliable pieces of equipment. The majority (65%) answered that they believed that they were very reliable and 26% felt they were 'fairly' reliable. Only 1% of respondents considered OWS to be completely unreliable and 8% thought they were 'not very reliable'. However, when we asked engineers if they had ever been on board a vessel where the Parts Per Million (PPM) sensor was being 'tricked' 39% stated that they had with one in ten engineers stating that they had 'often' been on ships where the PPM was being 'tricked'. Furthermore, we were surprised to find that almost a quarter of engineers (23%) had experienced being on board a ship where a 'magic pipe' was in use to bypass the OWS[6].

Thus the accumulated evidence suggests that seafarers believe that there are design problems associated with OWS. These may result in poor operation in 'real' conditions and high levels of maintenance or they may allow for the system to be by-passed or 'tricked'. However, it was very positive to note that in terms of operation and user friendly maintenance there appeared to be support for the idea that modern systems were substantially better-designed than older ones.

Other design issues

In the course of the initial semi structured interviews conducted on board vessels a small number of other issues were mentioned by just a few seafarers and these were not pursued at greater length in terms of vignette based interviews or questionnaires. However some related to important pieces of equipment such as emergency pumps. In one case the pump was said to be sited wrongly so that it did not function when the ship was in ballast condition. A seafarer explained that:

> Last time on the way to the US, the ship was empty [...] and it could not suck water up. The sea water suction point is too high. It is difficult to pump water up when the ship is empty. [...] This is a design problem. (SS ME LT EC)

Incinerators were also mentioned to us in relation to their need for high maintenance, and their poor quality design in terms of temperature sensors, insufficient capacity, and relatedly insufficient

[6] 4% often, 10% had experienced this but 'not very often' and 9% had just experienced this once.

sludge storage capacity. The general view seemed to be that seafarers would find life easier if all sludge and garbage could be landed ashore making incinerators redundant.

Belief in the benefits of mandatory equipment: User 'buy in'

Having considered the design issues associated with a range of mandatory equipment on board ships we turn now to the important issue of 'buy in'. The extent to which seafarers believe that equipment serves a useful purpose is an important element in understanding the way in which it is used. For example, if seafarers perceive some equipment to be lacking utility they may circumvent its use, fail to maintain it fully, and/or disengage during training (e.g. drills). Belief amongst seafarers that equipment is necessary can therefore constitute a critical element in its use and maintenance.

The importance of bridge watch alarms

In our shipboard fieldwork we picked up very mixed messages from seafarers and some specific individuals about bridge watch alarms. Many seafarers regarded the bridge watch alarm as a useful piece of equipment which was on the bridge to protect them and the safety of their colleagues. As one seafarer explained:

> I am okay with that for the safety of the ship because at night especially only the officer on watch is awake while the rest are sleeping. So he should really be awake because the life of the people on board rests on him. (SS ME IA 3AB)

Additionally, some seafarers felt that it had the benefit of protecting seafarers on the ship in the event of something untoward happening to the officer on watch. One explained that:

> It is for safety. Suppose that officer fall asleep or he slips while he is in the toilet so it is a very good design. I don't feel annoyed with it. It is very good. It has actually saved a lot of ships because the navigator maybe has fallen asleep. (SS ME IA CP)

However there were seafarers who questioned the need for bridge watch alarms pointing out that in the daytime it was unlikely that seafarers would fall asleep on the bridge and at night it was a requirement for the officer on watch to be accompanied by a watchman. In these circumstances they did not believe a bridge watch alarm was really necessary. One seafarer told us that:

> At night time it is compulsory to have it even with an A/B we still use this dead alarm. I don't know what is the reason for this. One person is if something happened but if we have two person, why do we use it still. It is just disturbing. If there are two people there is no reason to keep it on. (SS ME IA CM2)

Some had a nuanced view of its usefulness suggesting that there were times when the alarm was helpful and times when it was unnecessary at best and a nuisance at worst. The following account is illustrative:

> I feel that this piece of equipment is useful when seafarers are fatigued during times of port calls. During normal sailing times when seafarers have regular rest hours, I feel that it is unnecessary. (SS ME NE 20)

A few seafarers saw the bridge watch alarm as something that was used by Captains when they were unsure of their team members on board. One described how on his ship:

> This is the first time I came across BWAS. When I first joined the ship, Captain and Chief Officer were also newly joined. Captain was cautious at that time and he put the BWAS on in the beginning. After a few days when we got familiar with the ship and bridge equipment, Captain then turned it off. (SS ME 20)

While another suggested that the alarm was to 'stop us being lazy'. He suggested that the usefulness therefore depended on your position on board and associated perspective. Several seafarers felt quite negatively about the bridge watch alarm however, and suggested that it created unnecessary tension for watch-keepers and could be a dangerous distraction. One explained his view as follows:

> If you let it on, it is annoying and you have to reset it in every few minutes. If you forget to reset it, the alarm would go off on the whole ship which makes everybody nervous. It is not a good thing to create tense situations. (SS ME CP)

In the course of our vignette-based interviews we explored the issue in greater depth and found further irritations with bridge watch alarms relating to the need to periodically vacate the bridge in order to visit the toilet (sea-sickness and stomach upsets were described as exacerbating the situation). However, we also found seafarers who had experienced falling asleep themselves on watch and/or colleagues falling asleep. These seafarers had very positive attitudes to bridge watch alarms:

> But at open sea, this is the best thing you know, because I have seen people who have, okay, this, I joined on my first ship and there was an ... incident before I joined, that the 3rd Officer was sleeping on the bridge, and the ship went off-course for one hour. (Vig ME NT 06)

Thus our interview data produced a variety of contrasting views relating to the usefulness of the bridge watch alarm. In this context the questionnaire findings were particularly important in helping us to establish what the broad consensus was amongst seafarers in relation to their use. We therefore asked deck officers whether they believed that bridge watch alarms should be mandatory on board. An overwhelming majority said that they should be mandatory (87%) with a small proportion (11%) suggesting that they should not. However although this is a very strong 'vote' in

favour of bridge watch alarms the findings from the questionnaire nevertheless indicate that one in every ten deck officers do not feel that bridge watch alarms should be mandatory on board. This contextualises a second finding from the questionnaire which indicated that, as previously mentioned, while 55% of respondents had not personally switched off a bridge alarm on duty at all, 5% of questionnaire respondents (78 individuals) stated that they had turned off the bridge watch alarm without the Captain's permission. The remaining seafarers (42% n=617) had switched off the alarm with their Captain's permission.

Need for other alarms

In relation to alarms more generally we found a relatively high level of consensus when we undertook our shipboard and vignette-based interviews. This indicated that seafarers differentiated between alarms regarding some as worthy of attention and others a mere, and potentially dangerous, distraction[7]. With respect to the irritations of some alarms seafarers were most likely to point to the GMDSS alarms as both noisy and likely to be irrelevant. As a consequence GMDSS alarms were frequently silenced without an officer giving a related message due attention. As one experienced seafarer explained:

> Too many alarms...depending on what equipment is giving that. Now I would be very careful in listening to Echo Sound alarm. Or a ... a radar alarm, like your target acquisition like CPA, TCPA going low alarm, I would pay attention. But I would not pay attention to a GMDSS alarm. So equipment-specific alarms I would, some I ignore, say for example this. Yes. Yes it is, we have done it [silenced an alarm without making a related check], the equipment in question being GMDSS again. Whereas in we have acknowledged the MF/HF repeated alarms cropping up without really bothering to check what it is. (Vig ME NT 04)

In the responses to the questionnaire we found that while the majority (81%) of seafarers described experience of noisy/distracting alarms on board, and just over half (52%) considered that some of the alarms on board were unnecessary, just under a quarter of seafarers (24%) said that they had switched off an alarm 'without first checking on the problem it is indicating'.

Perceptions of the need for OWS

Despite complaints about design issues relating to older OWS systems, on the whole, seafarers expressed relatively positive attitudes to the need for OWS at sea. Their support for such systems was strengthened by the recognition that many of the problems with older OWS had disappeared in relation to newer and better designed equipment. OWS were consequently seen as more reliable

[7] Research ashore has reported similar findings e.g. Bliss et al 1995.

and ‘less of a problem’ and seafarers appreciated their environmental significance. As one seafarer succinctly summed it up:

> Yes, it is reliable. It keeps our sea clean. And we need that equipment to do that. (Vig ME NT 45)

Notwithstanding this finding, and as we touched upon previously, we found that 43% of engineers who responded to our questionnaire said that they could ‘understand’ why seafarers sometimes used ‘magic pipes’ to illegally discharge oily water overboard and nearly a quarter (23%) stated that they had been present on board a vessel when a ‘magic pipe’ was in use. Only 9% of these respondents stated that this was only ‘once’ with 10% responding that it had not been ‘very often’. However, 4% suggested that they had ‘often’ been on board a vessel when a magic pipe was in use. This apparently shocking finding should be contextualised in relation to company policies concerning disposal of contaminated water. Many seafarers report that if companies organise the discharge of oily water ashore there is no need to take risks with pumping oil overboard. However, where companies refuse to pay for shore-side disposal and/or make inadequate provision for incineration, storage, and the maintenance of OWS (e.g. replacement filters) on board, seafarers felt that their colleagues could be placed in impossible positions leading them to ignore international regulations relating to pollution. As one explained:

> The pressure [to bypass the OWS) is from the company because they don’t want to spend money sending the oil bilge water ashore, so they are forcing you to [...] manage however you feel like because they never gave you the right thing. So [...] you can see, so some people do these things. (Vig ME NE 44)

In contrast, in the course of our vignette-based interviews we found that some seafarers were incredulous about others continuing with such practices today given current inspection regimes and the likelihood of criminal charges being brought. To illustrate the ‘tenor’ of such views it is worth quoting one young second engineer at length as follows:

> Practically nobody do this [use a magic pipe]. What for? What for I must do this? It’s rules. No more than 15ppm. Even I know that this has sea water or river water inside. I know exactly it’s not any, any… oil content and just mud. First we need to inform company, they have to decide. Because we must be in line with the all international regulation. I will not do this, and I think 99.9 percent of engineers will not do this. What for? No. Because inside oily water separator we have memory card. Memory card. Every time when we start it’s all recorded. And any… like inspector, he can go, he can take out this memory from inside, he can connect and he can see in which day we discharge, what time we start, what time we store up, like this [...] it’s useless to – what for? Nobody will do this [...] I never see that somebody do bypass really, never see. And practically, you know, my opinion, useless. First of all to do bypass it will be visible for any inspector [...] It’s very easy to recognise, for… if coming the inspector who was before it’s very easy to recognise. I very easy recognise on my new vessel where is this

> magic pipe, very easy. For this reason, my opinion, to fabricate this, to do this is useless, my opinion. Useless, absolutely! (SS ME HS 2E)

It also needs to be made clear that questionnaire responses may have related to the past. In this respect it is important to note that our vignette-based interviews highlighted that whilst seafarers recognised that malpractice had been relatively commonplace in the past (in what one interviewee referred to as 'the dark days of being a seaman') today it was far more unusual. As one explained:

> Many years back, yes, seafarers used to do that, primarily during the times when regulations were still lax and not very many countries pay attention to issues related to marine pollution. [...] It's a way out for seafarers when they have no more room for bilge waste primarily when you have a principal who can't provide an adequate tank to store your bilge waste or when in port they don't want to spend money for waste disposal. You really have to find ways. You see, they are saving money. (Vig ME IA 70072)

Many seafarers strongly indicated at interview that they supported the international regulations pertaining to protection of the environment and on some occasions they expressed outrage at malpractice in relation to the discharge of water overboard. However the interview data and that supplied via our questionnaire does strongly indicate that in the absence of very strong enforcement of MARPOL regulation, by port state control authorities, it is quite likely that such practices could return. Thus in this case it is not sufficient for seafarers to 'buy in' to the purpose of OWS, they also require infrastructural and organisational support to allow them to make proper use of such equipment and to dispose of waste water responsibly.

Seafarers' attitudes to ECDIS and its usefulness

ECDIS was generally liked by seafarers on board and its full introduction with the potential to replace paper charts was welcomed by some of the seafarers who were part of our shipboard research. Generally they were positive about the amount of time that they would save once ECDIS replaced paper charts in relation to making chart corrections. They also liked some of the integrated functions offered by ECDIS. A Captain explained as follows:

> I am happy, [and] the 2nd mates will be really happy if they bring full ECDIS because now it is double work for them. They are maintaining this also and the chart also. But for us it is really helpful because when we are in very restricted waters, like the Singapore Straits, you have no time to look at the charts or anything. Like ECDIS is very important in such areas. [...] Because that is a real time picture you are seeing like. (SS ME HS 09)

In the vignette-based interviews such attitudes were broadly endorsed and ECDIS was described in glowing terms by some interviewees as the following excerpt demonstrates:

> It is really convenient to use because everything is incorporated there – radar, chart, AIS. All the main navigational equipment in the bridge is all there – GPS, speed log. This is such a very good equipment, useful, easy-to-use. (Vig ME IA 44)

It was recognised by many seafarers that the ECDIS that they were familiar with was not fully 'operational' and that it should be understood as an aid and not something which could be wholly relied upon for safe navigation. Seafarers were also aware of some ECDIS-related incidents[8] and the ways in which systems differed. Concerns were raised about maintenance as the following quote from the enthusiastic Captain mentioned above illustrates:

> One disadvantage that I see here and also somewhat dangerous is that once it breaks down, there is no technician that is capable to rectify this. There is no computer engineer to help out. (Vig ME IA 44)

Fears about the maintenance of ECDIS were expressed by respondents completing our questionnaire. Very few seafarers believed that they could resolve problems with ECDIS on board without external help (5%) and while 57% of seafarers thought that with shore-side help they would be able to resolve ECDIS-related difficulties 38% said that they did not think this was the case. Perhaps relatedly just over half of respondents (52%) said that they *did not think it was safe* for vessels to discard paper charts even when they were equipped with a back-up ECDIS system. Correspondingly just under half of the respondents who expressed a view said that they would not like full dependence on ECDIS (49% of all respondents answering), 47% said they would like full dependence on ECDIS and 4% stated that they did not know.

Training

Lifeboats

In the course of the shipboard observations and semi structured interviews we explored attitudes to drills in general terms. Most seafarers expressed general support for drills and suggested that they were usually taken relatively seriously. However there were some seafarers who described how the

[8] See for example recent case of the oil/chemical tanker *Ovit* in the Dover Strait in September 2013 https://www.gov.uk/maib-reports/grounding-of-oil-chemical-tanker-ovit-on-the-varne-bank-in-the-dover-strait-off-the-south-east-coast-of-england.

busy schedule of the ship could make drills difficult to fit in and also unpopular and potentially ineffective with the crew. One Captain explained the situation as follows:

> Obviously it [training/drills] has to be continuously done and we like to do it, the only problem what is there is the ship's hectic schedule. Because of this sometimes we are not able to do the drills and all and then if you just one or two days in between and if you tell them we have drill then obviously nobody likes it. Although we have to do it, [...] but that thing we find it a bit hard actually because there are so many things, so many trainings to do and we have to do it all. I am not saying we can do away with it, but only thing is sometimes it becomes too much for us. Like we say like now it is too many trainings, too many drills and that thing is there now in our mind. But if you are in open sea then there is no problem, then sometimes we will do drills twice in a week also. (SS ME Pantank 09)

On another vessel a seafarer told a similar tale. He explained that:

> [...] Our only problem in this company is that there are so many drills that they want us to accomplish. On the other hand, our workload is too much which compromises the quality of training because we tend to be in a hurry since there is so much work to do. And sometimes when a particular drill needs an hour to make sense, it is reduced to 30 mins. The Captain will tell you, "make a quick one". What does quick mean? And if it takes you longer than expected, they will start asking, "what's happening?" I usually give long drills to ensure that people learn. But since there are so many things to finish, what can I do? (SS ME Bananarama 19)

These comments were made in the context of others which suggested that shore-side training could be inadequate and that seafarers' unfamiliarity with equipment could produce fears about using it. One seafarer explained:

> The school that I went to, they lacked facilities for the training of use of equipment. Most of the time, training is based on books, you are shown pictures and you read instructions on how to use equipment but you don't get the chance to use them. Schools should have the equipment so that when you go on board you won't feel ignorant as to their use. (SS ME Bananarama 4)

In the course of vignette-based interviews we explored training in further detail and found that there were fears among seafarers about the use of lifeboats in drills and training. This impacted on attitudes to training more broadly and in discussing quality issues some consensus emerged in relation to the key importance of Chief Officers and Captains in determining the standard of training. As one seafarer put it:

> I would say it's master dependent on how useful the drills are. I've sailed with one master who was very, very good and every drill we done he done it too [...] On the other hand I've had other guys who just drop you in your life jacket, tick, tick, tick job done. (Vig ME NE 16)

The imagination of training officers was important as seafarers felt that if training were repetitive and boring and reliant on very poor simulation of tasks then it was of little use. In contrast where

officers really succeeded in motivating seafarers with regard to drills the payoffs were readily acknowledged. One seafarer described how on one of his ships:

> ...we had one chief officer who was very, very keen on launching the lifeboat so if the drill said every 3 months he'd do it every month and he really pushed to have it done every month, lifeboats, and he'd always grab a crew, so walk around and say you're coming with me, you're coming with me. [...]They'd go in the boat with him and they'd be launched, they'd be lowered from the embarkation point down. [...] I think it made you less wary of the boat and [...] because of course we were doing it so often, we knew all the things that went wrong, to the point where towards the end we'd launch it no problem, come back no problem whereas at the start we may struggle to get hooks on and all these sort of things. So I think that was a good thing, I mean admittedly [in the beginning] I was even a bit wary of getting into the boat, but …(Vig ME NE 14)

Where drills had not been carried out regularly on board some ships seafarers reported equipment malfunctions and failures. The following account is illustrative:

> Six month pass and nobody does [a drill]. Only paperwork. [...] then one Captain came and told that we were going to have one [drill] in the port. Okay, he started lowering the lifeboat. It is not possible to slowly lower because that's not working properly, many, many long time nobody did like this, what is required. And after this, the boat lowering to sea water level and then again he want to support with not any person inside boat. Because they want to look properly, lowering. Going down just quickly and after, we are trying to take out, it's possible not coming. Too much, one hour, two hour, three hour, very problem. Not coming up. (Vig ME NT 39)

Such experiences inevitably undermined seafarers' confidence as did the (sometimes very serious) accidents which we found had been witnessed or experienced during drills. One seafarer described how in the course of an inspection something went wrong:

> The plan was to swing it out, lower it to the water, lift it clear of the water, reset the hydrostatic and then pull a lever, doing the emergency procedure, so that we could drop it off the hooks whilst in the air. The MCA surveyor decided halfway down, actually no, we won't lower it all the way to the water, we'll stop just above it. And so lowering it down, he decided, no, no, yeah, that'll do. Actually, lower it a little bit down more. Yeah, that'll do. Okay, pumpie. Okay, do it. [...] Eventually, gush. Freefall. Bang. We were meant to do it sort of barely above the water, we dropped it [...] we dropped it 1.2 metres above the water. One guy had two cracked vertebrae. [...] The MCA surveyor, we don't know what happened to his back. He could still walk, just about, but he was in severe back pains as well. We cracked the lifeboat itself and it had to go back in to the repair yard bit. So that had to get fixed, and pretty much all the rest of us had severe whiplash. (Vig ME NE 17)

In another example we heard how:

> We have put a Second Officer in the hospital doing this because once they'd released, the other side didn't, so you've got one side swinging and the other side not and he ended up like a ping-pong ball and got very severe concussion and a back injury. (Vig ME NE 42)

In the context of such incidents which are often talked about and written about in the sector even minor incidents could undermine seafarers' confidence. One for example explained that:

> I have been in situations, ok the boats were fine, but the Captain forgot to take out the pin, and we were in the boat and it went 45 degrees down, luckily nothing happened. But ever since then I have a small phobia of drills [...] Yeah a little cautious, and once the pump man, he was adjusting the brake when people were inside, so a mistake, he slipped the wire, slipped it went down, it dropped a meter down, but still it's a sudden jolt. So I think people should be given…… it should not be like a long 10 day course or whatever, but at least, and maybe the hooks, one particular type, like he said [referring to the example given in the vignette], that would be great. (Vig ME NE 03)

In situations where seafarers have been involved in serious incidents it is understandable that they may take a very long time to regain confidence in the equipment and in the people they are working with. One engineer described the following events to us and then went on to explain their impact:

> The first week we had a drill and a guy lost his arm. The second week a wire snapped in the boat and went on the side of the ship. [...] Same ship. [This happened just the] week after [the incident where the seafarer lost his arm], at the end of the week, for a while I was nervous to go close to the boats. So whenever we have a drill I would do my duty then step back to see whatever everyone else is [doing]. Cause no one is taking charge making sure everyone else is okay.
>
> I think a lot of things were just…I feel…cause I saw what happened and I wrote down what I saw happened, it was like it was just ignored. Because the Chief Engineer played a very big part [in the accident] and he should not have done what he did while the Bosun was doing what he was supposed to do but it was just overlooked in my opinion so I felt that it should have been taken more seriously. It should have, a lot of things should have changed with regard to when the next drill happened. But then we had the other incident because still things are not happening the way it was supposed to happen. [...] So I don't think enough was done to change. [...] But to me the worst is I can see that on almost every ship I am on because no one pays attention or takes it seriously. I have seen so many bad things happening and it upsets me because no one is taking charge in making sure that everyone is paying attention. No one is taking charge making sure that everyone knows what they are supposed to do even if it is not their duty you know exactly how to do it. But it is not being done. So every time we have a drill I am like 'please don't let anything bad happen.' (Vig ME HS 3E)

In the context of these accounts from seafarers we asked several questions about lifeboat drills in our questionnaire. Despite the increasing tendency for drills to involve lowering empty boats to the ocean (whereupon seafarers may embark via a ladder) almost one in five respondents (18%) stated that they had only experienced drills where seafarers were lowered with seafarers on board.

As discussed earlier in this report, we found that half of our respondents (50%) were happier to take part in lifeboat drills where boats were lowered without seafarers on board. Of the remainder 11% stated that they had no preference and 38% stated that they preferred to take part in drills where

seafarers did enter the lifeboats. Given seafarers' fears about drills (as revealed at interview and during observation) we were surprised that more respondents did not express a preference for drills without seafarers on board. We therefore considered the responses of seafarers who preferred drills with seafarers in the boat and those who preferred drills without seafarers in the boat alongside responses to a question that we asked about the effectiveness of each kind of drill. This revealed that 48% of the seafarers who preferred to have drills with seafarers on board lifeboats thought that the partial lowering of empty lifeboats was not adequate preparation for emergencies compared with 33% who thought it was. In support of this pattern 60% of seafarers who were happier to take part in drills without seafarers on board lifeboats believed that this was adequate preparation for drills with 39% suggesting that although they preferred drills without seafarers on board they did not believe this was adequate preparation for emergencies. Overall, more seafarers believed that partial lowering of lifeboats was adequate preparation for an emergency (52%) than thought that it was not (43%).

OWS

Training did not emerge as a major concern to engineers who discussed OWS at interview. This pattern was confirmed in our questionnaire whereby 89% stated that they felt that their training relating to OWS had been adequate[9].

ECDIS

Interviews on board revealed that training relating to ECDIS is currently patchy and for a number of seafarers the first contact they have with ECDIS is when it is installed on board their vessel or when they join a vessel where it has been provided. In some cases seafarers described how companies had installed a single ECDIS unit on board to facilitate seafarer familiarity. One seafarer explained:

> We had only one set of ECDIS, only for training. The Convention requires to have two sets of it in order to replace the paper charts. So it was only for training on the previous ship, and we just learned to use it with reference to the manual. For everybody, it was the first time to touch ECDIS. So nobody was familiar with it, including Captain and Chief Officer. So we just learned it from the manual. (SS ME LT 30)

Even where seafarers had received training relating to ECDIS generically, as well as the ECDIS equipment supplied to their vessels, this was not regarded as sufficient and seafarers described how they consulted manuals, learned from each other and generally attempted to increase their

[9] This finding is in contrast with recommendations reported by Martin Ottaway 2015.

understanding of ECDIS on board. However their ability to do this depended on the attitude of their Captain and fellow officers. As one Captain illustrated when he told us:

> The previous Captain did not allow officers to use it [ECDIS]. After I came, I explored it with the previous 3rd officer, because he studied it a bit with the previous Captain. Later, I studied it with chief officer … I just had one day training on ECDIS, not very long. ECDIS operations are simple. It is mainly E-Navigation that is more complicated. It is about ordering charts and the installing them in the system. You have seen that we explored it together among all deck officers and that we trained ourselves up together. Frequent practice familiarizes us with it. Many of our e-charts are outdated and they are only for reference. We depend on paper charts. At the moment, we ask the company to buy a few e-charts from time to time. The main reason for this is to get familiar with the whole process of e-charts selection and ordering. It is a new thing, and it is good. We are familiar with the operation. (SS ME LT CP)

There are some dangers associated with trial and error learning and with learning from manuals which have been highlighted by research elsewhere. A more detailed investigation of ECDIS training provision and the benefits of different forms of training can be found in an earlier report published by SIRC (Sampson and Tang 2011).

Conclusions

Three key, related, areas emerged in relation to this study of mandatory equipment: design issues; belief in the need for equipment ('buy in' by seafarers); and training.

In terms of design issues we identified significant problems in relation to lifesaving equipment. Some freefall lifeboats were identified as incredibly cramped and uncomfortable leading seafarers to feel that they would not wish to be cooped up in one for any significant amount of time. Over time this problem is likely to become worse as there are indications that the overall size and stature of humans is continuing to increase. Freefall lifeboats were also connected with fears associated with launch and the potential for injury (especially spinal injury). Davit launched (gravity) lifeboats were subject to a considerable amount of concern in relation to design due to known issues associated with on load release systems. Whilst these are now being addressed in line with IMO regulation (SOLAS III/1.5) the latest date for the follow-up overhaul of lifeboats on existing vessels is July 1 2019. If the new systems prove to be effective[10], it can nevertheless be expected that the huge loss of faith in lifeboat safety will take some time to repair across the seafarer workforce. Confidence in new systems is likely to remain fragile and could be rapidly undermined by even a limited number of accidents or incidents.

Liferafts were often liked by seafarers, in principle, but it emerged that many had experienced problems boarding liferafts in the course of training in warm 'ideal' conditions. In immersion suits, carrying injuries, and/or suffering from hypothermia it is likely that many seafarers would not be successful in boarding a liferaft from the water. Many immersion suits were themselves identified by seafarers as poorly designed and were described as heavy and impeding movement, particularly where proper five fingered 'gloves' were not integrated in the suit. It appears therefore that an unsatisfactory situation persists on board merchant cargo ships whereby design issues undermine the effectiveness of all forms of lifesaving craft. These may be exacerbated by personal survival equipment which is bulky and heavy resulting in impeded movement.

Design issues were also identified in relation to some bridge equipment. GMDSS was regarded as very old fashioned and out of date, and motion sensitive and manual re-set bridge watch alarms were regarded as less preferable compared with more sophisticated systems which integrated alarms into navigational equipment.

[10] There have been suggestions that the modified designs remain insufficiently failsafe (e.g. Gale 2011).

In contrast, positive feedback from seafarers was received in connection with ECDIS which was broadly liked as were the newer OWS systems.

In relation to 'buy in' from seafarers we found a strong commitment revealed by seafarers in relation to most of the equipment discussed. Although bridge watch alarm systems were not regarded as being necessary all of the time, their use was generally well-supported. GMDSS alarms were often ignored by seafarers because of their frequent irrelevance but GMDSS was not regarded as something that should be abandoned. Rather seafarers wished to see it updated and designed more effectively. OWS were also seen as very important on board ships in the battle against pollution. However, seafarers recognised that management had to support OWS (with replacement parts and/or the provision of reception facilities) if pollution incidents were to be avoided altogether. Finally ECDIS was very well-received and considered to be a positive development in relation to navigation by most seafarers.

In terms of training, manuals and colleagues were regarded as important supplementary sources of information by seafarers who needed time to become familiar with different ECDIS systems on board. Lifeboat drills were seen as important by most seafarers and yet fear and heavy schedules often interfered with training plans and this also affected attitudes to training. Lifeboat drills on board have particular importance due to the training provided ashore being identified as poor by many seafarers. However some seafarers have become so concerned about the risk of serious injury in the course of lifeboat drills that they avoid taking part. This serious situation needs to be addressed.

Recommendations

These recommendations emerge from the empirical data collected in this study. They are not intended to be prescriptive but to form the basis for what we hope will be constructive future discussions with different elements of the maritime sector. Our ultimate intention is for such discussions to lead to improvements in the design of mandatory equipment, and its use, at sea.

1) Until such time as lifeboat On-Load Release and Retrieval systems (OLRRS) are effectively modified to substantially increase the safety of lifeboats, fall prevention devices should be made **mandatory** (they are currently recommended).
2) Where fall prevention devices are utilised, companies should provide seafarers with appropriate training in their use.
3) Following modification of (OLRRS) in compliance with revised LSA Code sections 4.4.7.6.4 to 4.4.7.6.6, vessels which have already fitted fall prevention devices (FPDs) should continue to make use of them. Whilst compliance with the new regulations should make FPDs superfluous their continued use should increase the confidence of seafarers until such time as the new designs/modifications have been demonstrated to be fit for purpose and fears amongst seafarers have consequently subsided.
4) Regular maintenance of OLRRS by specialist licensed and certified personnel should be a mandatory requirement.
5) The space between rows of seats inside freefall lifeboats should be increased to allow for adequate leg-room for seafarers of all heights whilst they await rescue.
6) Freefall lifeboats should incorporate sufficient space to facilitate the storage of immersion suits and life jackets.
7) The weight/height allowance utilised in the design of freefall lifeboats should be increased to take account of the increasing size/weight of the overall population. Bringing the weight allowance into line with that utilised in the North Sea off-shore sector would seem appropriate and the average weight/height calculation should be reviewed at regular five-year intervals and adjusted in line with population weight/size trends.
8) Freefall lifeboats should be designed to further reduce the risk of spinal injuries. This may require the better design of seating (to provide greater shock absorption) and/or better restraint mechanisms including headstraps.
9) Liferafts require modification to allow for unassisted boarding from the water by seafarers of different size, weight and strength.
10) Regulation should be adapted to require immersion suits to be the lightest weight possible whilst retaining thermal properties. Regular immersion suit maintenance and upgrading should be made mandatory in support of this.

11) Regulations should be adapted to require all immersion suits to incorporate five-fingered gloves for both hands.

12) Regulation should be adapted to require lifejackets to be of minimal bulk and weight whilst retaining buoyancy properties.

13) The design of GMDSS should be updated to remove redundant equipment and to maximise user-friendliness.

14) The effective use of OWS should be supported by continued vigilance in inspection practices and by employers providing filter replacements and permission to dispose of oily waste ashore.

15) Efforts should be made to ensure that ports provide oily waste reception facilities at low cost.

16) Training standards ashore require improvement in relation to life saving equipment such as lifeboats and liferafts. It is important that all such courses include practical 'hands on' experience.

17) Companies should be required to provide 24-hour shore-side technical support to seafarers in relation to the use of complex systems such as ECDIS.

18) Integrated bridge watch alarm systems should replace motion sensitive and manual re-set systems on all new ships.

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[11] Lloyd's Register Foundation helps to protect life and property by supporting engineering-related education, public engagement and the application of research.

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Glossary

AB – Able seaman

AIS – Automatic Identification System

ARPA – Automatic Radar Plotting Aid

BWAS – Bridge Watch Alarm System

CPA Alarm - Closest Point of Approach Alarm

ECDIS - Electronic Chart Display and Information System

e-chart – electronic chart

FPDs – Fall Prevention Devices

GMDSS - Global Maritime Distress and Safety System

GPS – Global Positioning System

IMO – International Maritime Organization

LSA Code – Life-Saving Appliance Code

MARPOL – MARPOL is the International Convention for the Prevention of Pollution from Ships

MCA – Maritime and Coastguard Agency

NAVTEX – Navtex (Navigational Telex) is an international automated medium frequency direct-printing service for delivery of navigational and meteorological warnings and forecasts, as well as urgent maritime safety information to ships

NVivo – NVivo is a qualitative data analysis computer software package

OLRRS – On-Load Release and Retrieval systems

OWS – Oily Water Separators

PPM – Parts Per Million

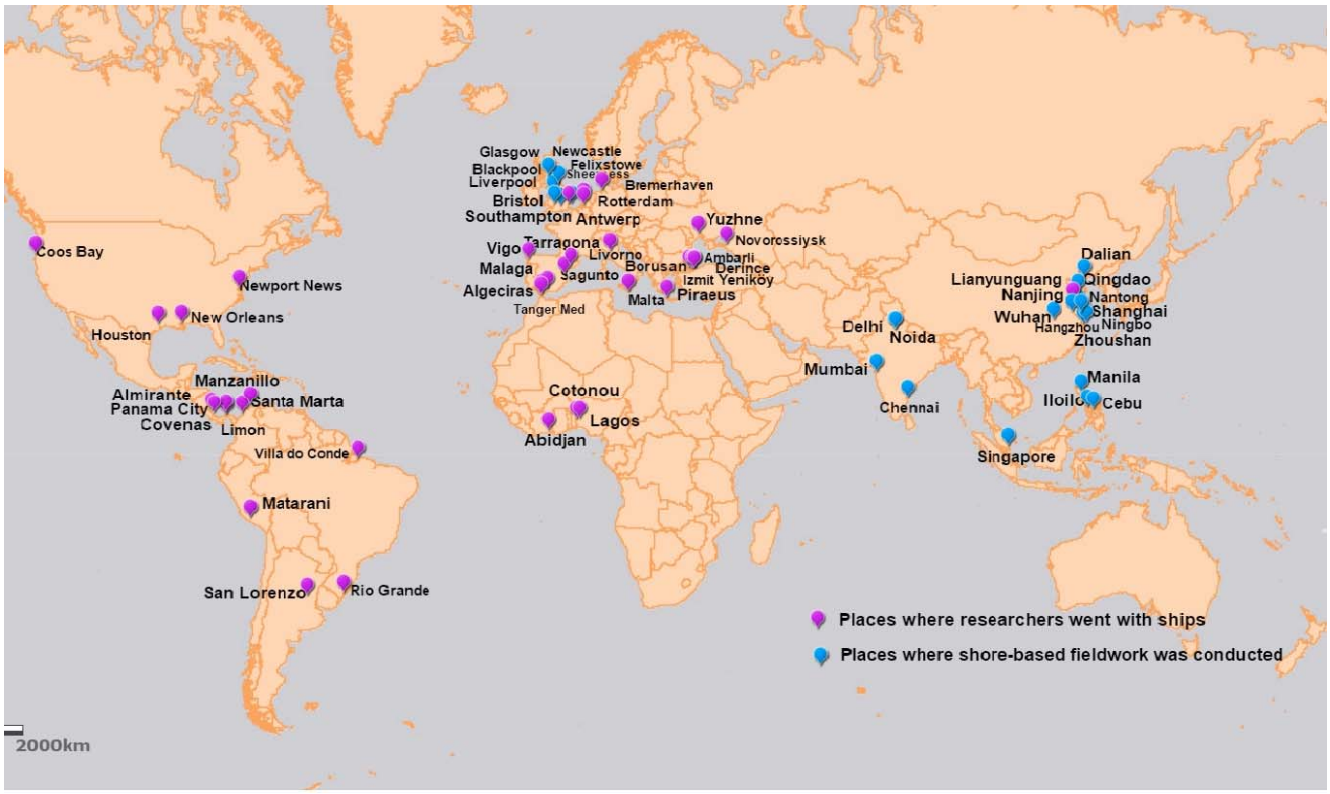
SOLAS – Safety of Life at Sea Code

SPSS – Statistical Package for the Social Sciences

TCPA Alarm – Time to Closest Point of Approach Alarm.

TELEX – an international system of telegraphy with printed messages transmitted and received by teleprinters

Appendix 1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