Safety Science 49 (2011) 139–147

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

A preliminary ergonomic assessment of piloting a lifeboat in ice

Michael J. Taber [a,b,*], Antonio Simões Ré [c], Jonathan Power [c]

[a] School of Health and Human Performance, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4R2
[b] Survival Systems Training Limited, Dartmouth, Nova Scotia, Canada B3G 4K9
[c] Institute for Ocean Technology, National Research Council, Canada

ARTICLE INFO

Article history:
Received 22 January 2009
Received in revised form 23 November 2009
Accepted 30 November 2009

Keywords:
Human performance
Lifeboat
Usability
Functionality
Habitability

ABSTRACT

This paper examines human factors associated with piloting a totally enclosed motor propelled survival craft (TEMPSC or lifeboat) in ice. The first section of the paper describes the use of a usability assessment scale to evaluate the coxswain's (TEMPSC captain) control panel. The second portion examines environmental conditions (habitability) inside the lifeboat during evacuation. All testing was completed in conditions that were consistent with those that might be experienced by ship or offshore oil and gas crewmembers in the event of abandonment due to an onboard emergency. Results indicated that the lifeboat test configuration presented considerable challenges to usability/functionality as well as habitability. These findings suggest that further research should be conducted to evaluate the safety of all existing lifeboat designs. Finally, it is recommended that the international maritime organization (IMO) and safety of life at sea (SOLAS) Convention should mandate user-centered design evaluations for future lifeboat manufacturing.

1. Introduction

Marine evacuation craft are a legislative requirement and have been for over a century. The original craft were open to the elements with oars or sails as basis of propulsion and their sole purpose was to move personnel from the immediate danger to a position of relative safety until rescue personnel and equipment arrived. Marine rescue operations in modern times have advanced considerably; however, with the expanding exploration for oil and gas, international shipping, and extreme tourism such as Arctic cruises and polar expeditions, individuals are placing themselves in more remote locations than ever before. Given the distance of these remote environments in relation to the closest search and rescue stations, evacuation scenarios require a clear understanding how survival equipment will perform in the conditions that prevail. It is equally important to consider the interaction between the marine evacuation craft and the people that use them. Unfortunately lifeboat (also known as a totally enclosed motor propelled survival craft or TEMPSC) manufacturers do not appear to consider the fact that individuals may need to survive for longer periods of time under more harsh environmental conditions. Furthermore, it is doubtful that usability/functionality and habitability in icy conditions such as those tested in this study are given much consideration during the development and design of modern lifeboats.

1.1. Current and changing standards

As evidence to the fact that minimal effort has been placed on environmental influencing factors, Fig. 1 identifies that even though advancements have been made to nearly every other aspect of modern ships, the lifeboats used onboard recently designed vessels have remained virtually unchanged for nearly a century. Based on comments gathered during an internal investigation into the sinking of the Queen of the North on March 22, 2006, BC Ferries officials indicated that passengers reported being completely exposed to the elements during their time spent in the lifeboat (BC, 2007). Similar comments are repeated by passengers after evacuating the MV Explorer off the coast of Antarctica (Bureau of Maritime Affairs, 2009). In response, BC Ferries has announced plans to replace all of its open lifeboat to totally enclosed versions by the end of 2009 (BC, 2007).

Fortunately, the maritime community as a whole has also begun to recognize that standards need to be set to ensure not only the safety of personnel in need of a lifeboat, but also that the usability and habitability of equipment need to be assessed (Robson, 2007). For instance, Robson (2007) points out that:

> Manoeuvring away from an installation in anything other than benign conditions is likely to be more difficult than a similar manoeuvre away from a vessel. Wash back may result in the TEMPSC being driven either against an installation's structural members or between them where the sea conditions are much more confused, eddies and vortices are created and a partial

* Corresponding author. Pressent address: 37 Nicholas Drive, Ontario, Canada L2S 4C5. Tel.: +1 905 397 4801.
E-mail address: miket@inbox.com (M.J. Taber).

0925-7535/$ - see front matter © 2009 Published by Elsevier Ltd.
doi:10.1016/j.ssci.2009.11.011

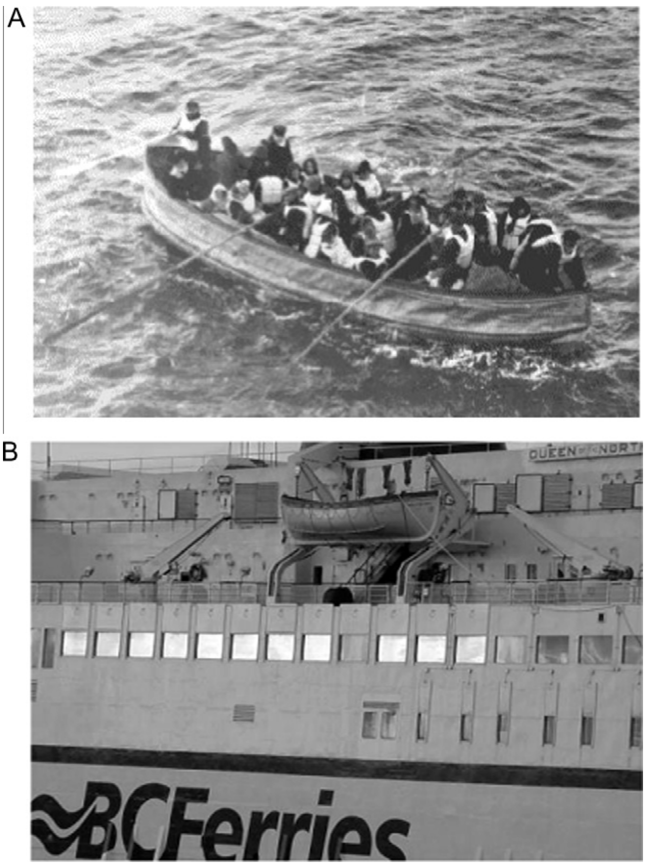

Fig. 1. Panel A – titanic open lifeboat (1912). Panel B – one of the two lifeboats that were available for passengers onboard the queen of the north (2006).

> loss of buoyancy may occur. Extricating a battened down TEMPSC from such a situation will place great demands on the coxswain, possibly over and above those in which he has been trained (p. 14).

However compelling Robson's statement might be, the greatest cry for change has been focused primarily on lifeboat release mechanisms, self-righting capabilities and personnel size limitations (Kozey et al., 2005; Peachey and Pollard, 2006; Reilly et al., 2005). Unfortunately, reports addressing the conditions inside the lifeboat as well as performance in icy environments are virtually none existent.

The technology of the shipping industry has traditionally been governed by specification-based regulations (i.e. safety of life at sea – SOLAS), which for marine related matters was inherited by the offshore petroleum industry. As a consequence, both the shipping and offshore petroleum industries are governed, at least in many jurisdictions, by prescriptive specification-based conventions and regulations in matters of marine evacuation.

Much of the inherited regulatory apparatus and corresponding evacuation technology is inadequate in terms of its coverage of and utility for northern regions and Arctic. In these circumstances, compliance with regulations and off-the-shelf solutions are inadequate. As the shipping and offshore petroleum industries increase activities in the Arctic and other ice-covered regions, they will have to deal with a host of issues that will require innovative solutions that are unlikely to be fully addressed under existing regulations and existing technical solutions. In such circumstances, developments in cold regions may be most effectively advanced under a goal-based regulatory approach. It was with this goal-based approach in mind that the National Research Council Canada (NRC) initiated a research program aimed at both the engineering and human factors (i.e. ergonomics) problems associated with manoeuvring evacuation craft (i.e. lifeboats) in ice covered waters. Therefore, this paper explores the ergonomic and performance characteristics associated with habitability and piloting a lifeboat/TEMPSC in icy conditions. To direct focus on these two specific areas of interest, the first section of this paper addresses the usability/functionality of a commercially available lifeboat control system, while the second section examines habitability inside the lifeboat to ensure safe conditions exist until rescue services can be provided.

2. Usability/functionality of a modern lifeboat control system

The individual piloting the lifeboat (known as a coxswain) is responsible for manoeuvring the survival craft away from areas of hazard, thus the controls need to be configured in such a manner as to facilitate required tasks (e.g. obstacle avoidance) effectively and efficiently. Although in their most basic form, controls, specifically those necessary to perform the primary task of driving to safety, should be organized logically to ensure that cognitive loading is reduced during an emergency (Grootjen et al., 2006). Lee et al. (2009) also point out that when testing automobile driver attention, the performance of a secondary task reduces the ability to focus on a relevant primary task such as avoiding other vehicles and pedestrians. Driving a lifeboat under extreme conditions such as abandonment at night or into icy and windy conditions similarly requires focused attention to ensure that the boat is manoeuvred to a safe location. Obstacle avoidance should be considered the primary task, particularly if large amounts of debris or ice are floating on the surface of the water. If attention is drawn away from the primary task and valuable time is lost trying to locate or manipulate a particular control, it could be the difference between life and death. Therefore, this first section of the paper examines the primary task of driving the lifeboat to a safe location by testing the usability of the navigational and engine control system.

To ensure ecological validity, the lifeboat used in this study met all requirements prescribed by the safety of life at sea (SOLAS) Convention (IMO, 1997) and the International Lifesaving Appliance (LSA) Code (IMO, 2003). In addition, baseline tests were completed according to corresponding guidance from the international maritime organization (IMO, 1998, 2007). These preliminary tests were completed in an effort to establish baseline measures of engine and manoeuvrability performance that would be used to examine trials completed in icy conditions.

3. Abandonment task requirements

3.1. Methods

The methods section for this portion of the paper is divided into four main components. The first component addresses the level of participant experience required to ensure maximal safety during the trials, while the second outlines the instrumentation used to identify navigation of the lifeboat. The third component discusses the conditions under which the testing occurred and finally the last component details the self-rating human factors assessment data collected as it relates to usability and functionality of piloting the lifeboat.

3.2. Participants

As this form of lifeboat testing in icy conditions had never been conducted before, it was believed that participants should have considerable experience piloting a lifeboat under windy and wavy