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Forces required to jettison a simulated S92 passenger exit: Optimal helicopter underwater egress training techniques

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ABSTRACT

This paper outlines the first known examination of the forces required to jettison a simulated exit used during helicopter underwater egress training (HUET). To capture the forces placed on the simulated cabin exit, a purpose build force plate was designed to replace an existing simulator exit used during HUET. A 25-point map was created to identify specific jettison forces required across the entire exit surface. Ten participants completed a total of 120 underwater egress sequences in–air and in-water from a normal flight and fully compressed crash attenuating seat position. The results indicate that the force required to jettison the simulated exit is significantly different in relationship to location on the exit surface. From the results, it can be concluded that helicopter underwater egress training protocols should ensure that offshore candidates are informed of the different force requirements as well as have the opportunity to practice jettisoning a high physical fidelity exit from a fully compressed crash attenuating seat.

Relevance to industry: This is the first paper to investigate the forces required to jettison a simulated S92 exit used in an underwater egress simulator. The combined exit force map and maximal voluntary jettison force data provide a greater understanding of influencing factors associated with training offshore personnel to egress a ditched helicopter.

1. Introduction

Offshore helicopter transportation is generally safe; however, recent events such as the two forced landing in the North Sea in 2012 (Ewen, 2013) and the most recent incident off of the Shetland Islands (AAIB, 2013) have highlighted the possibility that water impacts and ditchings can occur. Further evidence of this fact is provided by Taber (2014), who reported that since January of 2000, a total of 97 offshore transport helicopter mishaps have occurred. Within these 97 events and the numerous accident reports cited in previous research, it is clear that only a small percentage of the ditched helicopter will remain upright throughout the evacuation phase, and that the majority invert immediately after touching the surface of the water (Brooks et al., 2008; Taber and McCabe, 2006, 2007; Taber, 2013, 2014). The obvious difference between the two environmental conditions requires that careful consideration is placed on how to egress in the event of a capsize and flooding (Taber, 2013, 2014). Unfortunately, ergonomic assessments of helicopter egress have shown that a logical approach is not always utilized in the development of interior passenger compartments and/or exits (Brooks and Bohemier, 1997).

To investigate the influence of simulated helicopter ditching exit design usability, this paper outlines the first known study to explore the forces required to open a simulated S92 Sikorsky cabin exit used during helicopter underwater egress training (HUET). In fact, this is the only known study to explore the helicopter exit forces for any other simulators used in HUET programs around the world. The following sections contextualize the need to consider ergonomic implications of personnel transport helicopter exit design criteria, their placement, and possible usage as they relate to underwater egress training.

1.1. Offshore helicopter underwater egress

Creating a ditching plan before a flight requires that individuals have some idea of how to open an exit that they are seated next to, or the egress path needed to locate the nearest emergency exit (Taber, 2014). To address this potential knowledge gap related to exit designs and use, the majority of offshore oil and gas organizations require their workforce to attend and successfully complete a HUET program. The HUET program is specifically designed to aid in the development of a ditching plan through the performance of several underwater egress sequences. These practical hands-on egress exercises are designed to build confidence (Mills and Muir, 1995; Taber and McGarr, 2013) in the ability to perform specialized motor programs needed to open an exit in the event of capsize

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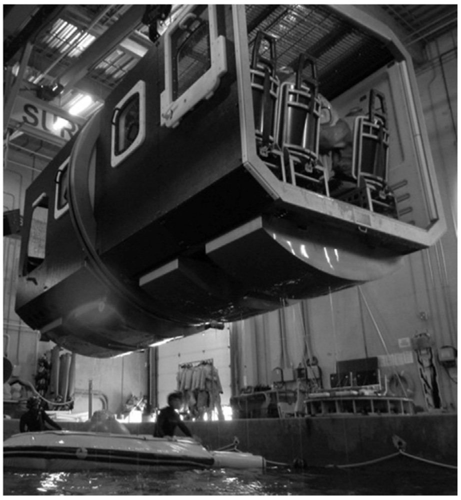

Fig. 1. Modular Egress Training Simulator (METS™) model 50 configured for an S92 HUET program.

after a ditching has occurred. Taber and McGarr (2013) reported that there were significant increases in self-rated confidence related to the capability of performing egress skills after completing a HUET program and that comfort levels associated with being in the water also increased. Coleshaw (2006) also reports that participants where more confident in their ability to complete egress tasks after having had the opportunity to practice more realistic requirements. To build confidence, underwater sequences are typically carried out in a full-scale helicopter simulator. In some instances, the skills are completed in a simulated environment that resembles the exact helicopter configuration used for transporting personnel to and from an offshore installation. However, in other cases, skills are completed in a more generic simulator design that accommodates an approximation of several different aircraft (Taber, 2010, 2014).

Research has shown that providing a high level of physical fidelity during skill acquisition has a number of benefits such as a faster transfer of knowledge between the simulated and real-world conditions (Baldwin and Ford, 1988; Gonzales, 2004). Hochmitz and Yuviler-Gavish (2011) reported that cognitive requirements are reduced when simulations are as close to the actual environmental surroundings as possible. To take advantages of benefits associated with high levels of physical fidelity, a number of HUET program providers utilize a Modular Egress Training Simulator (METS™ – Fig. 1). In fact, following the Helicopter Safety Inquiry to investigate the ditching of Cougar 491, Commissioner Robert Wells (2010), recommended that the offshore employees should be given the opportunity to jettison representative exits during their mandatory HUET program.

1.2. Integration of S92 helicopter information

Although dozens of different helicopter types are currently been used to transport workers to and from offshore installations, it has been reported that approximately 130 S92s are used to carry out this service (http://www.aeroboek.nl/ab-092.htm). Despite the integration of a new airframe, the S92 has yet to be examined with regard to offshore egress tasks and interior configurations. Given the overall number of individuals flown in an S92 globally, understanding egress requirements of this particular helicopter design is critical. From an ergonomic standpoint, it appears that evacuation procedures from the main cabin area of most helicopters (including the S92) are based on a premise that passengers can breath air and have some level of visual acuity while remaining upright on the surface. However, research has shown that little consideration is given to the underwater egress aspects of helicopter cabin interior configuration or exit positions and functionality during the design phase (Brooks and Bohemier, 1997; Taber and McCabe, 2009, Taber, 2013). By replicating an existing S92 interior configuration it is possible to identify underwater egress pathway issues; however, the forces required to open a simulated exit have yet to be examined.

By establishing the required forces needed to jettison the cabin windows in the simulator, it is possible to consider individual factors such as age, sex, mass, seated acromion height, function reach as well as environmental factors associated with the helicopter and physical space surrounding personnel. The complex combination of these factors are believed to influence successful jettisoning of the exit following a capsize of a helicopter after a ditching has occurred. For example, Taber and McGarr (2013) noted that during HUET skill demonstration, smaller individuals require the greatest amount of assistance from instructors or divers when trying to open simulated exits. These results suggest that individual difference such as mass plays a considerable role in the capability to egress.

1.3. Egress exits

Although the Sikorsky S92 passenger cabin is equipped with operable windows on both sides of the helicopter and at every row of seats, only four of the 14 exits are considered emergency exits (Fig. 2). The remaining windows are of a push-out design and do not meet global Aviation Administration requirements needed to be considered an emergency exit (CAA, 2009; FAA, 1997). Therefore, the manufacturer is not required to report information regarding the necessary forces required to open these types of exits. Despite the fact that these push-out cabin windows are not considered emergency exits, it is likely that anyone sitting next to one during a ditching will attempt to open and egress through it following a capsize. Fig. 2 displays a typical offshore seating and exit configuration. Exits number 1, 7, 8, and 14 are designated as mechanical emergency exits, while the remaining exits are considered cabin windows that are of a push-out design.

1.4. Underwater egress simulation

The exits installed on high fidelity HUET simulators typically match the actual helicopter windows to within 1/8″ (.32 cm) tolerances (personal communication with simulator manufacturer). However, without specific information related to jettison forces required for an actual helicopter, underwater egress simulators and HUET programs are developed to maximize success during training. If the forces needed to open simulated exits are too great for the majority of personnel to overcome, there is little opportunity for them to carry out the entire egress sequence. If however, the forces are not great enough during the water ingress phase, the force of inrushing water may jettison the simulated exits before individuals have the opportunity to carry out the necessary tasks. Therefore, a balance between realistic forces required to open the simulated exits and accomplishing HUET program objectives is required to ensure an optimal training environment.

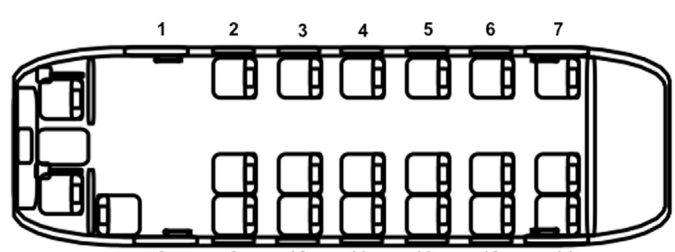

Fig. 2. Typical S92 exit and seat configuration for offshore personal transport.