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Determination of human error probabilities for offshore platform musters

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Abstract

The focus of this work is on prediction of human error probabilities during the process of emergency musters on offshore oil and gas production platforms. Due to a lack of human error databases, and in particular human error data for offshore platform musters, an expert judgment technique, the Success Likelihood Index Methodology (SLIM), was adopted as a vehicle to predict human error probabilities. Three muster scenarios of varying severity (man overboard, gas release, and fire and explosion) were studied in detail. A panel of 24 judges active in the offshore oil and gas industry provided data for both the weighting and rating of six performance shaping factors. These data were subsequently processed by means of SLIM to calculate the probability of success for 18 muster actions ranging from point of muster initiator to the final actions in the temporary safe refuge (TSR). The six performance shaping factors considered in this work were stress, complexity, training, experience, event factors and atmospheric factors.

Keywords: Human error; Human factors; Risk assessment; Emergency response

1. Introduction

The study of human factors is a scientific discipline involving the systematic application of information regarding human characteristics and behavior to enhance the performance of man-machine systems. The majority of work in human error prediction has come from the nuclear power industry through the development of expert judgment techniques such as SLIM (Success Likelihood Index Methodology) and THERP (Technique for Human Error Rate Prediction) (Swain & Guttmann, 1983). The need for expert judgment techniques arises because of the lack of human error data and the potentially severe consequences of nuclear industry accidents such as Chernobyl. Analogously, the Piper Alpha and Ocean Ranger disasters have generated a greater awareness of the effects and ramifications of human error in offshore hydrocarbon processing. Humans play a significant role in both accident causation and in emergency response (Bellamy, 1994).

Offshore platform musters have significant potential for severe ramifications and present a challenging scenario for human error prediction and reduction. Due to the relatively slow progress in the field of quantification of human reliability, there is a need to advance this area of research and provide techniques that could link human factors with quantitative risk assessment (QRA). A primary issue is the concept of human error and how it has entered the safety vocabulary as a catchall phrase with a lack of consistent definition and application. The result is an inadequate understanding of how human error identification may be applied in a useful pre-emptive manner in high-risk scenarios.

A better understanding of human error and its consequences can be achieved through the application of human error identification models. To accomplish this, human error must first be removed from the emotional domain of blame and punishment and placed in a systems perspective. With this viewpoint, human error is treated as a natural consequence arising from a discontinuity between human capabilities and system demands. The factors that influence human error can then be recognized and managed. Such efforts are an essential component in an overall scheme of process safety management; see, for example, Wilson & McCutcheon (2003); RAEng (2003).

Human error plays a significant and sometimes overriding role in accident causation. Statistics that attribute accidents or losses to human error are varied and are reported to be as high as 85% (Sanders & McCormick, 1987).

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Nomenclature

a	constant in Eq. (1)
b	constant in Eq. (1)
BHEP	base human error probability
C	critical (consequence severity level)
CRT	core review team
EEP	elevated exposure phase (of muster)
ERT	elicitation review team
F&E	fire & explosion (muster scenario)
GR	gas release (muster scenario)
H	high (consequence severity level)
HEP	human error probability
HEPI	human error probability index
HRA	human reliability assessment
HTA	hierarchical task analysis
i	action (subscript)
L	low (consequence severity level)
m	arithmetic mean (subscript)
M	medium (consequence severity level)
MO	man overboard (muster scenario)
OIM	offshore installation manager
ORA	optimal risk analysis
POB	personnel on board
POS	probability of success
PSF	performance shaping factor
QRA	quantitative risk assessment
RRM	risk reduction measure
SLI	success likelihood index
SLIM	success likelihood index methodology
SRK	skill, rule, knowledge
THERP	technique for human error rate prediction
TSR	temporary safe refuge
t_A	elapsed time for awareness phase of muster
t_{Eg}	elapsed time for egress phase of muster
t_{Ev}	elapsed time for evaluation phase of muster
t_I	time of muster initiating event
t_M	total elapsed time of muster
t_R	elapsed time for recovery phase of muster

This wide variation is dependent on the source of data and the definitions applied to categorize human error. Nonetheless, it is reasonable to state that human error plays a significant role in accidents through either direct action or inadequate design.

Human error and human factors are often used interchangeably, thus creating confusion and compromising the quality of human reliability assessments. Therefore, defining human factors and human error is necessary to establish a basis for the discussion in the current paper. A definition of *human factors*, modified slightly from the UK's Health and Safety Executive (HSE, 1999), is as follows:

Environmental and organizational and job factors, system design, task attributes and human characteristics that influence behavior and affect health and safety.

The concept of *human error*, whether intentional or unintentional, is defined as (Lorenzo, 1990):

Any human action or lack thereof, that exceeds or fails to achieve some limit of acceptability, where limits of human performance are defined by the system.

Human factors play a major role in platform musters and their successful outcome (Kennedy, 1993). The importance of human factors in offshore operations has been recognized through several reports published by the UK Health and Safety Executive dealing with the inclusion of human factors in the offshore industry (Widdowson & Carr, 2002) and the human factors assessment of safety critical tasks in the offshore industry (Johnson & Hughes, 2002). These reports provide guidance for the integration of human factors principles into offshore system design, development and operation.

However, initiatives have not been developed to quantify the human error probabilities (HEPs) associated with the major actions that take place during a platform muster. On a regulatory basis there is generally no clear definition or specific requirement for the inclusion of human error considerations in management systems or risk assessments. This may perhaps be attributed to the ambiguity and comprehensiveness of the subject area, but is more likely due to the lack of readily available human reliability assessment (HRA) tools.

2. Objectives and framework of current study

The current work (DiMattia, 2004) was undertaken with the following objectives:

- To advance the field of human error identification for offshore platform musters in a unique manner.
- To promote and enhance safety in platform musters through the recognition and quantification of human error.
- To provide an accessible human reliability assessment tool yielding a meaningful and useful result.
- To provide risk reduction recommendations to mitigate the potential for human error during platform musters.