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Light vehicle fuelling errors in the UK: The nature of the problem, its consequences and prevention

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Abstract

Errors arising during the fuelling of light vehicles are increasing. It is estimated that around 300,000 misfuellings occurred in the UK in 2001 alone, with direct costs of approximately £35 million and considerable inconvenience caused to all those involved.

This study has investigated the causes of fuelling errors. A hierarchical task analysis of the fuelling of light vehicles was developed and data gathered from 23 individuals who had misfuelled. Errors were found to have occurred because the physical and psychological conditions on the filling station forecourt presented sufficient opportunity for an error producing sequence of events to be triggered. These occurred when specific factors were present either singly or in combination in the fuelling environment, creating an error 'pathway'. The probability of an error occurring is dependent upon the strength and type of influence these factors have on the performance of the fuelling task.

It is proposed that errors are best prevented by applying ergonomic principles to the design, and/or modification of filling station layout and equipment. In this way, the error pathways may be broken and successful fuelling encouraged.

Keywords: Error; Vehicles; Fuelling

1. Introduction

Attempts to investigate and understand the causes of human error have tended to concentrate on preventing incidents in high hazard industries with complex processes or in transport systems. Human error was identified as a major causative factor in up to 45% of critical incidents in nuclear power plants, 60% of aircraft incidents and 80% of marine accidents (Pheasant, 1991). Reason (1990) investigated the psychological mechanisms underlying human error and defined the general principles of error production. His Generic Error Modelling System (GEMS) provided a framework for the analysis of human errors that was developed from the distinction between skill, rule and knowledge based levels of cognitive control (Rasmussen, 1987). In addition, Reason (1995) identified the contribution made to major disasters by both 'active' failures committed by operators, and 'latent' failures which arose from flawed top-level decision making by managers and designers. Human error identification and assessment techniques (Lees, 1997; Kirwan, 1998a,b) have been developed based upon an analysis of the tasks performed (Kirwan and Ainsworth, 1992). Such methods can be used to increase understanding about how hazardous situations can arise within organisations that may result in major incidents, and be used as a basis for programmes of prevention.

It is also important, however, to address the errors that occur in less dramatic situations such as the tasks performed regularly by the general population. These may be a more pervasive problem for society than the failures that arise in complex industrial systems. Norman (1998) examined the errors associated with the use of 'everyday things' and suggested that because everyone perceived the fault to be their own, nobody wanted to admit to having had the problem. This encouraged a conspiracy of silence, leading to feelings of guilt and helplessness amongst users. Norman (1998) proposed that errors should be prevented by task analysis and evaluation,

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and the application of cognitive principles to the design of products for everyday use. Kanis (1998) also identified the need to prevent the problems that can occur when using 'everyday' products and advocated the study of actual as opposed to assumed usage as the basis for improved design.

Fuelling a light vehicle is one such everyday activity; it is a straightforward task that is carried out successfully by millions of people every day. Yet those who have fuelled their vehicles successfully on many previous occasions still make errors.

Fuelling error, or misfuelling, occurs when an individual puts the incorrect specification of fuel into a vehicle even though the pump and vehicle are in working order; for example, petrol into a diesel-driven vehicle. Recovery is then necessary to restore the vehicle to its former operating condition.

Such errors have not been widely recognised, nor has their impact been fully assessed at either an individual or national level. This apparent level of complacency may have arisen because of the belief that fuelling errors result from stupidity, leading to the concealment of incidents. In addition, no national system exists to report and collate misfuelling data. As a consequence, an unwillingness to acknowledge the extent of the problem may exist and this could result in a reluctance to introduce measures to prevent the problem from occurring.

This study has sought:

- to describe fuelling task performance and investigate why errors occur,
- to examine the scope for ergonomic improvements in the task environment,
- to determine the consequences of fuelling error in the UK.

This was done by analysing the fuelling task to determine the nature and origins of errors, by investigating misfuelling incidents, by identifying ergonomic deficiencies in the fuelling task and by collecting data to estimate the prevalence and the cost of misfuelling in the UK.

2. Methods

Data about the problems associated with refuelling light vehicles were gathered using a variety of observational and survey techniques.

Participants: Potential participants for the study were sought throughout the UK from the authors' social and business contacts by requesting those who drove light vehicles to volunteer for the study. Following an information briefing, 40 of those contacted volunteered to participate in the study. They formed two groups:

- 23 persons who had misfuelled a light vehicle within the past 30 months—the '*misfuellers*', and
- 17 persons who had not misfuelled—the '*control*' group.

Task analysis: Data were gathered from task observations and interviews to prepare a hierarchical task analysis of refuelling (Kirwan and Ainsworth, 1992).

- *Data collection*: Twenty-six sets of observations of refuelling were made at 13 filling stations. The filling stations were selected to form a representative sample of those found in the UK with respect to the HSE categories for fire risk (Health and Safety Executive, 1996). This resulted in a variation between those selected in size, the throughput of fuel, location, design era and layout of refuelling equipment.
- *Representation*: A descriptive task analysis of the fuelling of light vehicles, when free from error, was developed in tabular format. Subjects from the control group were asked to confirm that this descriptive analysis represented normal fuelling behaviour in terms of 'user actions' and 'user decisions'.

The tabular task analysis was then transformed into a hierarchical task analysis for use during interviews with those from the 'misfuellers' group.

Interviews to determine the factors contributing to misfuelling: A semi-structured interview format was developed to collect background information about fuelling behaviour from both the control group and from those who had made an error (the 'misfuellers'). Data were gathered about the fuelling task, driving habits, range of fuels used, fuelling behaviour and decision making (Appendix A). An additional interview format was developed to gather data on the factors that may have contributed to an error and on the consequences of that error, for the 'misfuellers' group (Appendix B).

The two interview formats were used to elicit responses from the 'misfuellers' and the 'control' groups. When interviewing the 'misfuellers', events were considered in sequence using the hierarchical task analysis as a basis for recalling what had happened and the factors that had contributed to the error(s). Sketches were drawn where appropriate, and details were gathered about the consequences in terms of costs, inconvenience and any related personal injuries. Additionally, data were collected about the vehicles being driven at the time of the error, and about other vehicles driven by the individuals involved.

Responses were analysed and the frequency data for the 'control' and 'misfuellers' groups compared using chi-square tests. The strengths of the differences found between the two groups were categorised as 'major', 'substantial', 'moderate' or 'not too important' using the method of Erickson and Nosanchuk (1992).

Further, the responses from the 'misfuellers' group were analysed in two additional ways:

Firstly, each case was classified according to the specific words used by the individual to describe their perceived reasons for making the error, dependent upon whether the error was principally associated with:

- a personal problem that pre-disposed the individual to commit an error, such as tiredness, anxiety or excitement,