NOPSEMA
Australia's offshore energy regulator

INFORMATION PAPER

# Human factors in accident investigations

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## Key messages

- Human performance difficulties are consistently identified as root causes of accidents and hazardous events reported to NOPSEMA.
- This pattern of repeated human performance difficulties suggests that corrective actions may not be appropriately targeted and so may be ineffective in preventing future accidents and hazardous events.
- A thorough exploration of the human factors contribution to accidents and hazardous events is dependent upon a clear understanding of where human error fits within the chain of event causation.
- Popular root cause analysis tools may not provide a sufficiently thorough analysis of human factors contributions to event causation.
- In-depth analysis of the human factors contributions to accidents and hazardous events can lead to the development of more effective corrective actions.

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# Key definitions for this information paper

The following are some useful definitions for terms used in this information paper. They are a suggested starting point only and are not prescriptively defined, unless otherwise indicated.

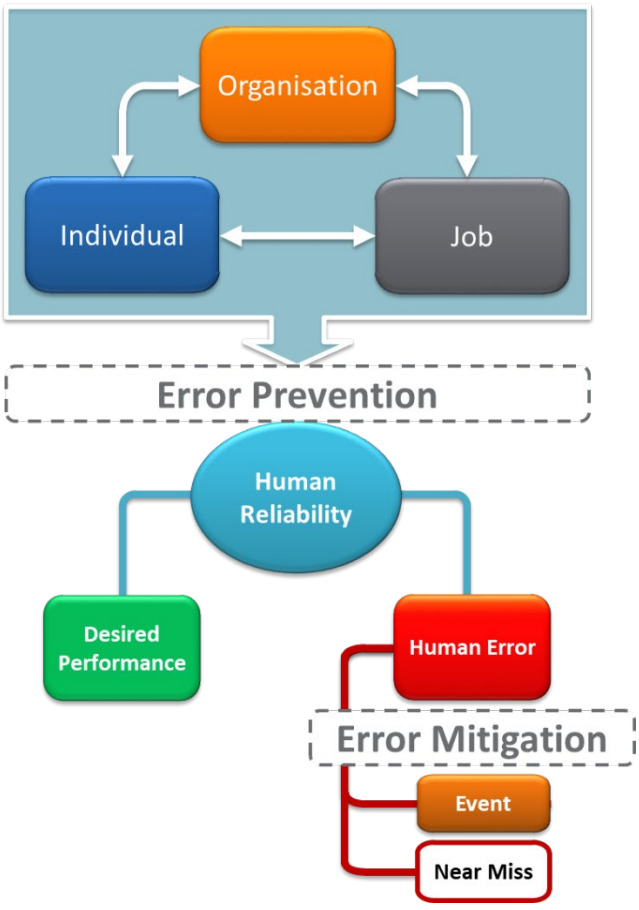
| | |
|---|---|
| *Critical human task* | *Those activities people are expected to perform as barriers against the occurrence of an incident, or to prevent escalation in the event an incident does occur. They include activities required to support or maintain physical and technological barriers (OGP, 2011).* |
| *Hazardous event* | *A collective term encompassing safety, integrity, and environmental incidents, used for readability purposes within this information paper.* |
| *Human error* | *Failure of a planned action to achieve a desired outcome.* |
| *Major accident event* | *An event connected with a facility, including a natural event, having the potential to cause multiple fatalities of persons at or near the facility. (Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2024, regulation 1.5)* |

# 1. Introduction to the human factors information paper series

'Human Error' has long been identified as a contributing factor to incident causation. Commonly cited statistics claim that human error is responsible for anywhere between 70-100% of incidents. It seems logical, therefore, to blame incidents on individuals or small groups of people and to focus remedial actions at the individual level (e.g. training, disciplinary action, etc.). However, by taking this approach in addressing human error, organisations ignore the latent conditions in their work systems that contribute to human error across the workforce. Rather, human error should be recognised as an outcome of combined factors, instead of the root cause of an incident. Organisational, job, and individual factors all interact to influence human reliability, that is, the likelihood that an individual will perform their task effectively or make an error.

This publication forms part of a series of information papers focusing on human factors. NOPSEMA defines human factors as "the ways in which the organisation, the job, and the individual interact to influence human reliability in hazardous event causation". Reliable behaviour results in desired performance, while unreliable behaviour may result in human error, which can lead to events and near misses. This interaction is represented in Figure 1.

***Figure 1 – A Model of Human Factors***




The Human Factors Information Paper Series is designed to provide information about the ways in which organisational, individual, and job factors influence human reliability, and how organisations can minimise or optimise the effect of these factors, to assist in the prevention and mitigation of hazardous events and drive continuous improvement in safety, integrity and environment performance.

## 1.1. Intent and purpose of this information paper

It is widely accepted that human reliability plays a role in preventing or contributing to major accident events (MAE), accidents, and hazardous events in the Australian offshore petroleum industry (the industry). Human performance difficulties have been identified as a root cause in 1917 notifiable occupational health and safety (OHS) occurrences reported to NOPSEMA, including 61 instances of serious injury, and 255 instances where death or serious injury could have occurred. Proportionally, this indicates that human performance difficulties were found to contribute to 48% of all notified OHS occurrences, 81% of all occurrences resulting in serious injury, and 75% of all occurrences where death or serious injury could have occurred.

NOPSEMA's most recent annual offshore performance report (2015) identifies a pattern of human performance difficulties contributing to accidents over time. Table 1, extracted from the report, identifies that 'procedures', 'work direction', and 'human engineering' appear among the most frequently identified basic root causes for accidents every year since data collection began in 2005.

***Table 1 - Accident basic root causes***

| 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|
| Procedures | Human engineering | Procedures | Procedures | Procedures | Work direction | Procedures | Management systems - people | Work direction | Procedures |
| Work direction | Work direction | Work direction | Work direction | Work direction | Procedures | Work direction | Human engineering | Design | Design |
| Human engineering | Training | Human engineering | Human engineering | Human engineering | Design | Human engineering | Procedures | Procedures | Human engineering |
| Training | Procedures | Training | Training | Design | Training | Management systems - people | Work direction | Human engineering | Work direction |
| Equipment parts/defects | Management systems - people | Equipment parts/defects | Communications | Other | Human engineering | Design | Design | Training | Quality control |

This consistent pattern of root causes suggests that opportunity exists for duty holders to focus their risk management and control measures on these areas to yield better safety outcomes. For control measures to be effective however, they must be appropriately targeted, which requires a sound understanding of the causal factors contributing to an event, including the human factors.

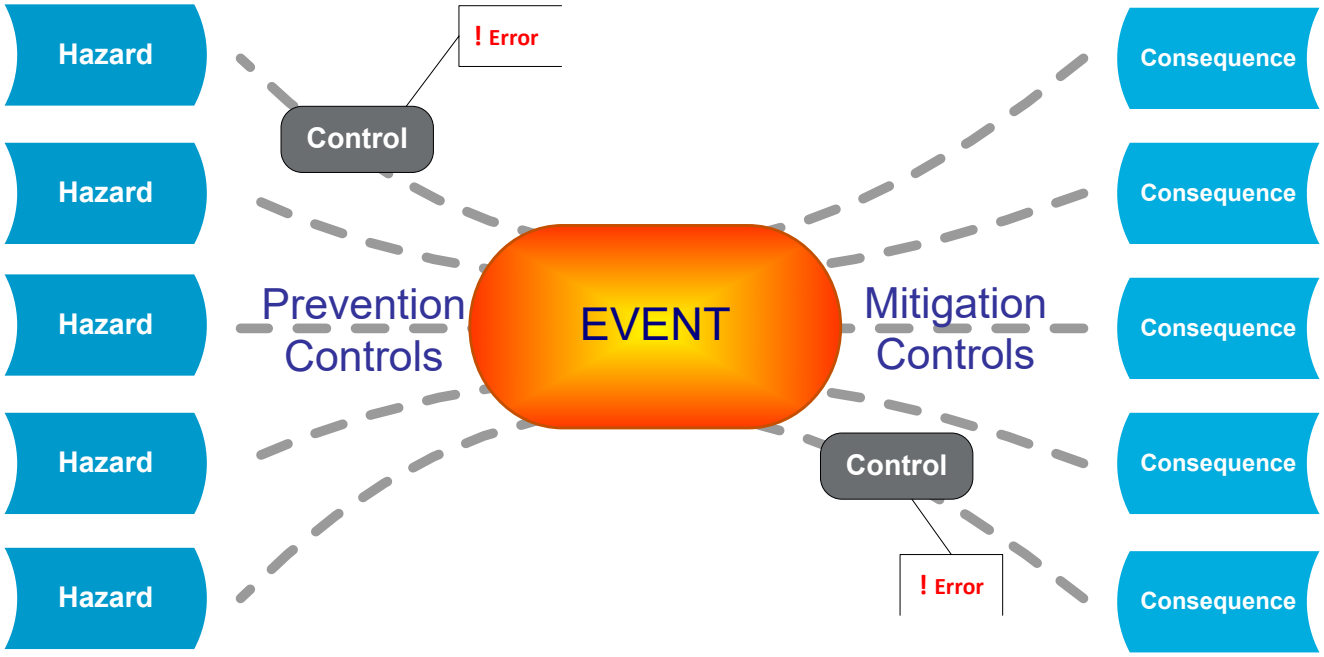
This information paper seeks to facilitate improvement in the quality of exploration of human factors contributions during investigations and so contribute to the development of more effective corrective actions. It provides a suggested approach to exploring human factors contributions within accident and hazardous event (event) investigations.

*Please note: Information papers provide information, background and practices to foster continuous improvement within industry. NOPSEMA acknowledges that what is good practice, and what approaches are valid and viable, will vary according to the nature of different organisations, offshore facilities and their hazards.*

## 2. Accident and event investigation

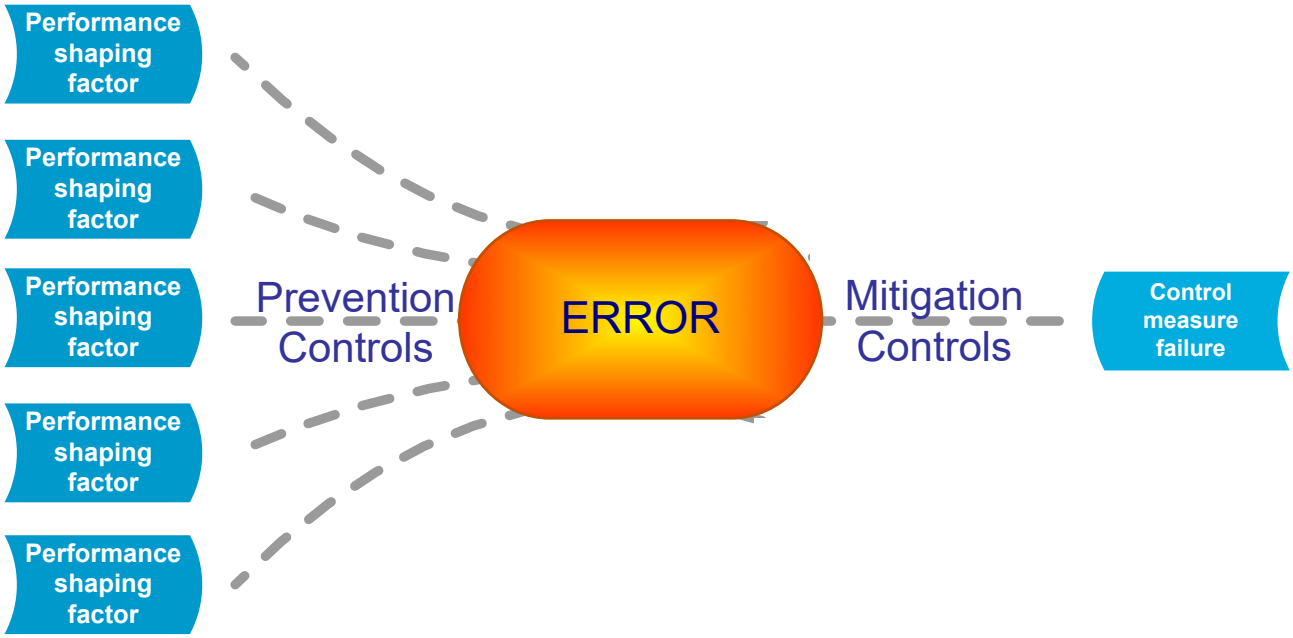
A thorough exploration of the human factors contribution to events is dependent upon a clear understanding of where human error fits within the chain of event causation. Error is often identified within formal safety assessments as a hazard or threat with the potential to lead to an event. This representation of error is inaccurate. Rather, error should be understood as a potential failure mechanism of a control measure. Figure 2 shows a representation of a BowTie diagram, where controls are identified to eliminate hazards and prevent them from leading to an event, and to reduce the severity of an event and mitigate its consequences. Within this representation of event control, error potential poses a risk to the integrity of control measures, acting as an escalation factor.

***Figure 2 - Error as an escalation factor***




Appropriate positioning of error within the causal chain can facilitate thorough assessment of error risk and evaluation of associated control measures. As shown in Figure 3, classification of error in relation to specific control measure failure allows for the identification of performance-shaping factors relevant to the control measure in question, and can highlight potential weaknesses and improvement opportunities within the preventive and mitigative layers of defence.

*Figure 3 - Error analysis*




Further information on this approach to error risk reduction can be found in the ***Human error risk reduction to ALARP*** information paper on the NOPSEMA webpage.

## 2.1. Investigation inclusion criteria for human factors

A thorough consideration of human factors within an event requires an investment of time and resources. It is therefore appropriate to demonstrate selectivity in deciding which events to investigate. A risk-based approach is recommended to ensure effective use of resources. It is suggested that an exploration of human factors is included within the investigation of those events where an error occurred within a critical human task, and where that error contributed to control measure failure.

## 2.2. Human factors investigation tools

Typically, root cause analysis tools do not offer a sufficiently deep analysis of human factors issues. This can result in an overly simplistic explanation of the human contribution to an event, and corresponding corrective actions that do not target the true root of the problem. In response to this issue, specialised tools and methods have been developed to improve the exploration of human factors within investigations. The ***Energy Institute*** has published an evaluation of a number of these products against set criteria (pp. 23-58). The publication is intended to help organisations select an appropriate human factors investigation method within the context of their particular requirements, preferences, and competencies.

# 3. A suggested process

The following sections outline a suggested approach to the exploration of human factors contributions within event investigations.

## 3.1. Classify the error

When error within a critical human task is identified as contributing to control measure failure, the first step in a human factors investigation should be to classify the error type. Error classification should follow a cognition/information-processing taxonomy of error rather than an action-based classification system. Identification of the cognitive factors underpinning the error can facilitate the development of appropriately targeted corrective actions.

The following webpages provide summaries of cognition-based error taxonomies:

- nopsema.gov.au/resources/human-factors/human-error/
- energyinst.org/technical/human-and-organisational-factors/human-and-organisational-factors-human-failure-types
- hse.gov.uk/humanfactors/topics/humanfail.htm

## 3.2. Identify performance-shaping factors

Identification of the relevant performance-shaping factors (PSFs) contributing to the error/s is critical to a sound understanding of the chain of causation. The investigation process should seek to identify PSFs that contributed to the error in question.

**A note on the relevance of performance-shaping factors:**

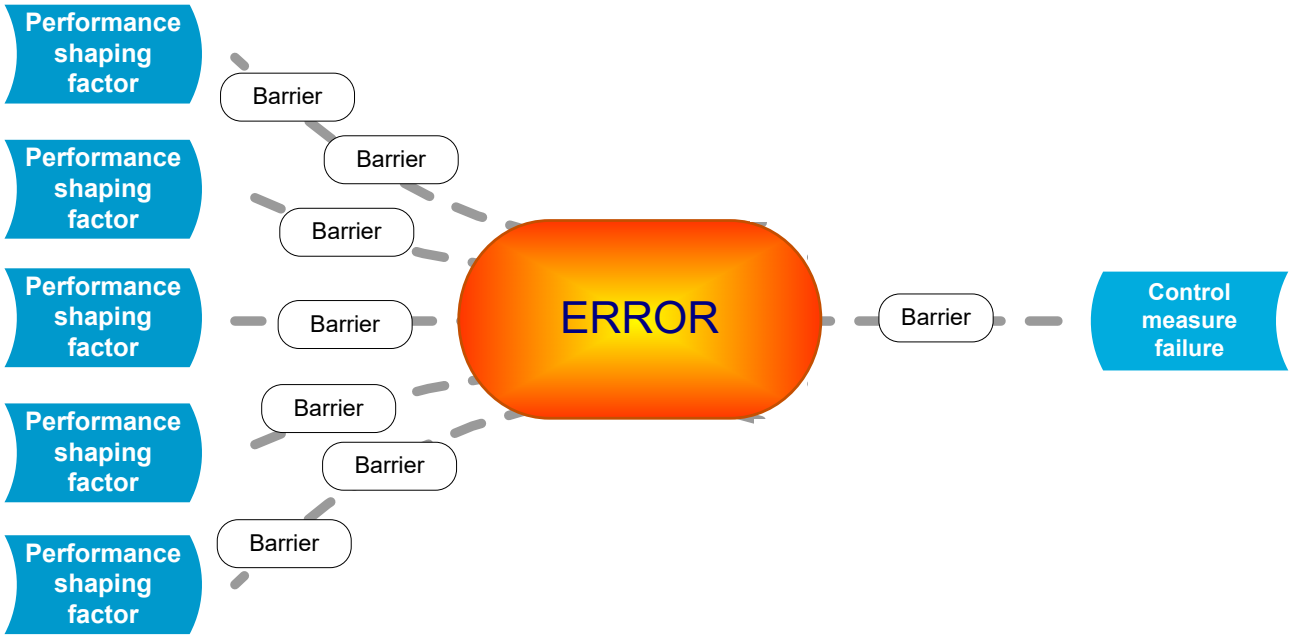
Some PSFs such as fatigue, intoxication, and environmental stressors can facilitate all error types. However, most PSFs are relevant to particular error types. For example, PSFs such as knowledge and competence are likely to contribute to rule-based and knowledge-based mistakes, but are unlikely to contribute to slips of action or memory lapses.

Performance-shaping factors should be identified through interviews with personnel familiar with the task/s within which the error/s occurred. Interviewees should include the individuals or teams involved in the event and their counterparts on alternate swings to identify situational and systemic PSFs. Human reliability analysis tools can help to guide PSF exploration; however to ensure sufficient breadth of investigation the use of multiple tools and methods is recommended.

## 3.3. Conduct barrier analysis

Where PSFs have the potential to facilitate error, barriers should be in place to reduce the likelihood that a PSF will lead to error. Similarly, where error has the potential to lead to the failure of a control measure, barriers should be in place to facilitate error identification and recovery before the associated control measure fails, as shown in Figure 4.

*Figure 4 - Preventive and mitigative barriers*




An error-induced event indicates that preventive and mitigative barriers to error were either not established or not sufficient to control error risk. Barrier analysis should be conducted for each PSF to identify which barriers were ineffective in preventing error, and to determine how the error led to the failure of the associated control measure.

## 3.4. Develop corrective actions

Corrective actions should target improvements to the integrity of the barriers identified in the preceding step, with the aim of reducing error risk to a level that is as low as reasonably practicable (ALARP). Corrective actions should be appropriate to the type of error in question, and should either address the influence of specific PSFs to improve human reliability, or facilitate error capture and recovery. Additional barriers may be required in some situations where the existing layers of defence are not sufficient to reduce error risk to ALARP. Appropriate change management processes should be applied to ensure that corrective actions are incorporated into formal organisational systems and structures, driving organisational learning and sustained change.

Further information on effective change management can be found in the ***Human factors: change management*** information paper on the NOPSEMA webpage.

## 4. References, acknowledgments & notes

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