Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

WorkSafe
Western Australia
Petroleum Safety

INFORMATION SHEET

Human factors: Integrating human factors into major accident event investigations

Introduction

Human failure (or human error) is often identified as a contributing factor, and sometimes even a causal factor, to major accident events (MAEs). However, human failure is not the cause of incidents or accidents because human failure alone should not be capable of leading to a MAE. The controls (barriers and safeguards) for a MAE should be robust enough to withstand any degradation factors (factors that reduce the effectiveness of a barrier), including human failure.

Treating human failure as a causal factor ignores the conditions present in the organisation's systems that allowed for human failure to occur in the first place, and will continue to allow the human failure to occur unless identified and addressed. This approach also overlooks the many times work was successful and MAEs were avoided because of human performance.

The purpose of integrating human factors into investigations is to look beyond human error as the root cause of a near miss event or MAE and unearth the immediate and underlying factors that contributed to the undesirable human performance which degraded the barriers and thus to prevent these factors happening again.

Therefore, investigations involving high-potential near misses and MAEs should aim to understand the conditions and factors which impacted human performance in order to create a robust system that can withstand any degradation factors.

Scope and objectives

This information sheet provides guidance to assist major hazard facility, petroleum and geothermal energy operations in improving their ability to incorporate human factors into their investigation processes and includes:

- advice on when it is necessary to include human factors into the investigation process
- a framework for exploring human factors in investigations.

Definitions and abbreviations

Barrier – A physical control which on its own is capable of preventing a threat from becoming a MAE in the circumstance that are likely to exist when the barrier is needed.

Control measure/control(s) – The measures that will eliminate or, if it is not possible to eliminate, will reduce the risk of a hazard causing a MAE so far as reasonable practicable; defined in:

- regulation 4 of the Work Health and Safety (Petroleum and Geothermal Energy Operations) Regulations 2022 (WHS PAGEO Regulations)
- regulation 23(c) of the Dangerous Goods Safety (Major Hazard Facilities) Regulations 2007 (DGS MHF Regulations).

Degradation factors – A condition that leads to increased risk by defeating or reducing the effectiveness of a barrier.

Human failure – Human errors, mistakes and violations.

Major accident event (MAE) – an event connected with a facility, including a natural event, having the potential to cause multiple fatalities of persons at or near the facility (as defined by regulation 26 of the WHS PAGEO Regulations.

Major incident (MI) – As defined by regulation 4 of the DGS MHF Regulations, "major incident" refers to any incident involving or affecting a Schedule 1 substance that causes serious harm to people, property, or the environment. For the purpose of this information sheet, "major accident event" (MAE) is used to encompass "major incident".

Performance-shaping factors (PSFs) – factors that impact on human performance, contributing to how effectively and safely a worker is able to do their job.

Safeguard/degradation control – A control that cannot by itself prevent a MAE from occurring, but can help to minimise the degradation of barriers. Safeguards support and underpin the performance of barriers.

Safety critical task (SCT) – A task where human performance could cause or contribute to a MAE, or where the purpose of the task is to prevent or limit the effect of a MAE, including initiating events prevention and detection control and mitigation, and emergency response.

SFAIRP – So far as is reasonably practicable.

When to include human factors in investigations

Investigation of human factors should be an integral part of any high-potential near miss, MAE or MI investigation. The size and scope of the human factors portion of the investigation will depend on the circumstances of event, and it must be coordinated and integrated with other elements of the investigation.

Major hazard facility, petroleum and geothermal energy operations should provide guidance to internal investigators on when to include an investigation of human factors within their internal investigation policy. This includes guidance on the size and scope of the human factors investigation, and when to involve support from a human factors specialist.

Framework for exploring human factors in investigations

The following section outlines a framework for exploring whether human factors contributed to a high-potential near miss or MAE. This framework is summarised in Figure 1[1].

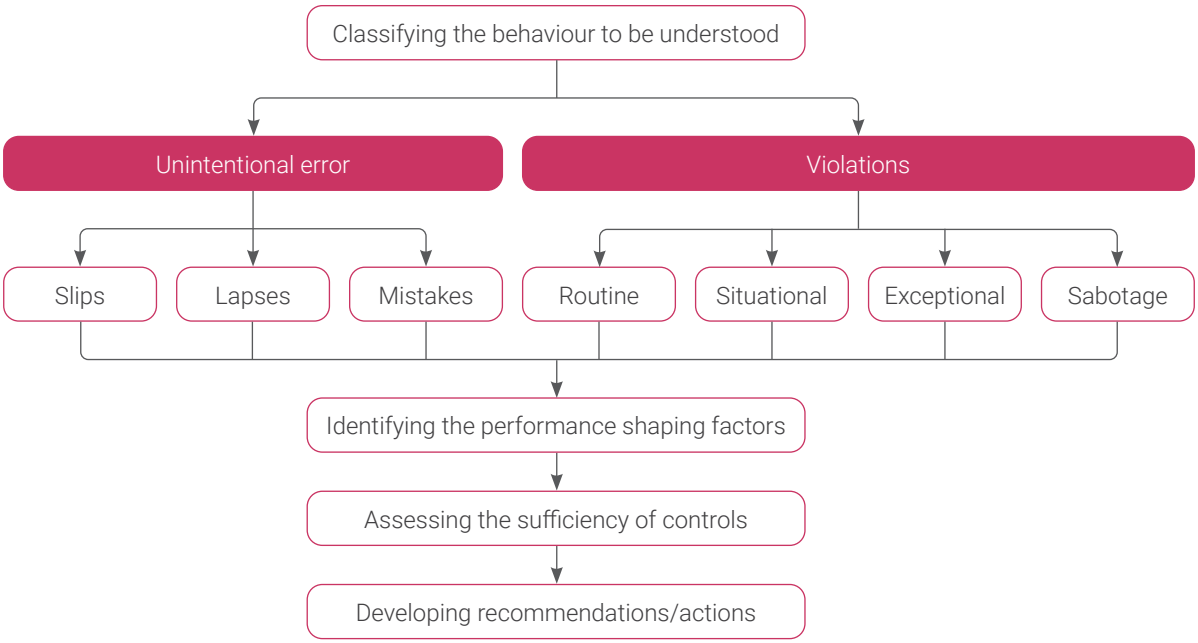

Figure 1 Human factors analysis framework

Classifying the behaviour

When human failure is identified as having contributed to the degradation of a control, the first step in the investigation should be to classify the type of failure that occurred. This is typically done using Reason's failure taxonomy[2] or a similar taxonomy, which is broken into four categories described below in Table 1.

It is important to distinguish between errors and violations (as well as between the different types of errors and violations) during an investigation as the underlying causes and remedies for these issues may be quite different depending on the type of human failure that occurred. It should be noted that acts of sabotage do not constitute human error and, following investigation, should be managed through the appropriate procedures.

1 *NSW Resource Regulator (2018). HOF: a regulator's perspective.*

2 *Reason, J (1990). Human error. New York: Cambridge University Press.*

Table 1 Human failure classifications

Failure type	Description	Example
Slip	Skill-based error occurring when a worker does something, but not what they were meant to do.	Maintenance worker isolated 'pump A' instead of 'pump B'.
Lapse	Skill-based error that occurs when a worker forgets to do something due to a lapse in memory, attention and/or concentration.	Maintenance worker misses a step in an isolation procedure after a co-worker interrupted to ask a question about a different task.
Mistake	Rule-based mistake that occurs because a worker misapplies a 'good' rule or applies a 'bad' rule.	Control operator ignores a critical alarm, following a history of false alarms.
	Knowledge-based mistake that occurs because there is no ready-made solution to a situation.	Maintenance worker isolates the wrong valve because they had insufficient knowledge about the plant layout.
Violation	Routine – deviating from rules and procedures is seen as the normal way of operating.	Plant operator undertakes work knowing they are not wearing the appropriate personal protective equipment for the task because that is how it is done by many workers.
	Situational – occurs when non-compliance is seen as best way to get the job done due to situational factors.	A supervisor signs off a job hazard analysis without reviewing it because they are under time pressure to get the associated task started.
	Exceptional – worker must deviate from rules and procedures to solve a novel problem in highly unusual circumstances. This type of violation is usually done with good intentions, but is misguided. It is often associated with perceived or actual messages from management which prioritise production over safety.	An operator ignores a pressure alarm, allowing the pressure in the pipeline to exceed the safe operating parameters outlined in the procedure, with the intent of helping the facility meet a critical production target.
	Sabotage – occurs when non-compliance is intended to cause harm or damage.	A worker knowing the consequences, intentionally damages plant equipment.

Identifying the performance shaping factors

The next step is to identify those factors which made the human failure more likely to occur. These factors are called performance shaping factors. Identifying the relevant performance shaping factors (PSFs) is critical to understanding how controls for a MAE were degraded or defeated.

Job factors:

- illogical design of equipment and instruments
- constant disturbances and interruptions
- missing or unclear instructions
- poorly maintained equipment
- high workload
- noisy or unpleasant working conditions.

Individual factors:

- low skill and competence levels
- tired/fatigued staff
- bored or disheartened staff
- individual medical issues.

Organisational and supervisory factors:

- poor work planning, leading to high work pressure
- lack of safety systems and barriers
- inadequate responses to previous MAEs
- poor supervisory communication
- deficient co-ordination of tasks and responsibilities
- poor management of health and safety
- poor health and safety culture.

To identify which PSFs influenced an event, investigators should have a sound knowledge of what was going on at the time the human failure occurred, including:

- What were the conditions like (this includes both long- and short-term conditions)?
- What was the order that the events took place?
- What was going on at the time (e.g. were there any distractions)?
- Was the task routine?

Understanding this should give investigators an insight into why an individual did what they did. The process involves breaking down the circumstances of the event into recognisable components in order to better understand how these components interacted to result in a major accident, incident or near miss event and, in so doing, points the way to corrective actions. The more times investigators ask why something occurred (i.e. the more levels of investigation) the more informative their findings will be. This process of continuing to ask 'why' is presented in Table 2.[3]

Table 2 Level of analysis of a human factors investigation

Poor ← Analysis → Better

Level 1	Level 2	Level 3	Level 4	Level 5
Description of a behaviour that contributed to an MAE (i.e. why the MAE occurred).	A description of the assumptions / decisions made by a worker (i.e. why the worker behaved as they did).	Explanation of the reasons leading to the assumption (i.e. why the worker assumed what they did).	Explanation of why the situation was created.	Explanation of more distant factors that created the conditions which led to an assumption which led to a behaviour.

3 *HSE (2008). Guidance on investigation and analysing human and organisational factors aspects of incidents and accidents.*

Example

A maintenance fitter working to replace an actuator valve on a spent acid line was sprayed with spent acid as he broke into the line. It was believed that the valve had been properly isolated and the line cleared prior to the work starting.

The fitter, correctly completed the initial stages of the first break procedure, opening the northern flange to the valve. It was observed that there was no acid drainage from the pipe at this point. Believing that they had successfully completed the first break procedure, the fitter downgraded their PPE and removed their overalls. They then continued to remove the valve by undoing the nuts on the southern flange. At this point, spent acid sprayed out, hitting the maintenance fitter in the face and torso.

Table 3 Example level of analysis of a human factors investigation

Poor ← Analysis → Better

Level 1	Level 2	Level 3	Level 4	Level 5
Worker thought the acid line had fully drained; however, valve was in false state, which wasn't recognised by the worker. Worker downgraded their PPE and was exposed to spent acid. Worker suffered serious injuries to their chest and abdomen.	Acid was observed to be draining out of one end of the pipe. Senior maintenance fitter (assumptions) Less experienced field operator (assumptions; i.e. authority bias)	Valve indicator (black/yellow) on top of the piping indicated the valve was open and draining. Acid was observed to be draining out of one end of the pipe.	Work was completed during night shift. Poor lighting in the work area. Valve indicator (black/yellow) position above the piping. Lack of supervision. Permit to work system allows workers to downgrade their PPE; however, does not specify to what extent the PPE should be downgraded. The closest emergency wash stations are located in hard to access locations within bund and outside of the bund.	Training and competency of all workers of breaking into lines, isolating valves. Design of the work environment (poor lighting, positioning of the valve indicator, and emergency wash stations). Safety culture and poor risk awareness among workforce. Scheduling of work during the night shift. Staffing baseline / resourcing during the day.

Analysis of controls

When PSFs increase the likelihood of human failure and contribute to a near miss or MAE by defeating or degrading physical barriers, it indicates the barriers and safeguards in place were not sufficient to control the risk.

Safeguards may include safety critical tasks (SCTs) which are considered to be safety critical elements or safety critical controls. A SCT is where human performance could cause or contribute to a MAE, or where the purpose of the task is to prevent or limit the effect of a MAE, including preventing and detecting initiating events, mitigating the risk, and emergency response.

Analysis of existing controls, including safety critical elements/safety critical controls, should be conducted to identify which barriers and safeguards were ineffective in controlling the PSFs and human failure, and to determine how the failure led to the degradation of the associated barriers.

Recommendation development

Recommendations should be based on the evidence gathered, and should aim to strengthen the overall integrity of the system's controls. If the findings go to the required depth (i.e. explore the true underlying causes) then the recommendations will be well focused. The exploration of the PSFs that contributed to a near miss or MAE should help in the formulation of specific and targeted human factors based recommendations. These recommendations should not focus on the individual workers who were involved in the failure.

The focus should be on creating a robust system which can withstand any degradation factors. This can be achieved through controlling the conditions and factors which impacted human performance by implementing new barriers and safeguards, and strengthening existing barriers and safeguards SFAIRP to support desired human performance.

Once the recommendations have been formulated they should be turned into measurable corrective actions. Appropriate change management processes should be applied to ensure that corrective actions can be tracked and, when complete, closed out. These processes should provide specific criteria for when an action is complete and require that sufficient evidence be demonstrated to show that this criteria has been met. As it is a regulatory requirement to maintain and review the effectiveness of controls, major hazard facility, petroleum and geothermal energy operations should conduct regular internal audits to monitor and determine the effectiveness of the controls.

Human factors investigation methods

There are a number of reliable and valid methods which can be used as part of the investigation of a near miss or MAE to identify the human factors aspects. The Energy Institute has conducted an evaluation of a number of these methods against set criteria.[4] The publication is intended to help users select an appropriate human factors investigation method suitable to the context of their particular workplace's requirements, preferences, and competencies.

Human Performance Oil & Gas provides guidance and templates to assist oil and gas operations with the goal of integrating human performance into investigations and the investigation process.[5]

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4 Energy Institute (2008). Guidance on investigating and analysing human and organisational factors aspects of incidents and accidents. London. Pp. 23-58.

5 Human Performance Oil & Gas. HP in investigations.

Additional information and resources

Department of Mines, Industry Regulation and Safety

- *Human factors fundamentals for petroleum and major hazard facility operators: guide*
- *Human factors self-assessment guide and tool for safety management systems at petroleum and major hazard facility operations*
- *Human factors: Usable procedures: information sheet*
- *Human factors: Five principles of human performance: information sheet*
- *Human factors: Integrating human factors into bowtie analyses of major accident events: information sheet*

Other guides

- Energy Institute (2008). *Guidance on investigating and analysing human and organisational factors aspects of incidents and accidents*
- Chartered Institute of Ergonomics and Human Factors (CIEHF), *Human Factors Foundation Training (Energy Institute)*
- NOPSEMA (2020). *Human factors in accident investigations*
- HSE (2008). *Guidance on investigation and analysing human and organisational factors aspects of incidents and accidents*
- Human Performance Oil & Gas. HP in Investigations
- International Association of Oil & Gas Producers (2018). *Demystifying Human Factors: Building confidence in human factors investigation*

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