

# PREVENT ACCIDENTS BY MANAGING HUMAN FACTORS



**MR AMIT BHATNAGAR**  
Process Safety Manager  
Singapore Refining  
Company Pte Ltd

**“Human rather than technical failures now represent the greatest threat to complex and potentially hazardous systems.”**

**James Reason, 1995**

Human error has frequently been attributed as cause of catastrophic accident and these accidents often resulted in serious injuries or even fatalities. Some of these human errors include errors in design, construction, operation or maintenance of the facility.

## What Is Human Error?

Human error is an action or decision which was not intended, which involved a deviation from an accepted standard, and which led to an undesirable outcome.

As humans, we are prone to making mistakes (errors), no matter how well trained and motivated we are. These errors can be execution errors by frontline staff or decision errors by management, plant/process designers and others who are away from the frontline. Human error can happen at all levels of the organisation.

Some common examples include:

- Wrong decisions made or actions taken due to inadequate hazard assessment,
- Wrong decisions made or actions taken due to incorrect or inadequate information,
- Incorrect operations due to Inadequate design/construction of the equipment,
- Misdiagnose process upset and inappropriate corrective actions taken.

## What Causes Human Error?

Humans have the tendency to make mistake or errors. Our attention span is limited. We overlook crucial evidence when making decisions. Some of these errors may lead to serious or catastrophic accidents. Understanding the causes of human error helps us prevent these errors and resultant accidents.

## What Are Human Factors?

The factors which impact human behaviour while working in an organisation and cause human errors are called human factors. With good understanding of human factors, it is possible to reduce the likelihood of human error, improve productivity and quality of work, and reduce accidents with serious consequence impacting health, safety, environmental and reputation.

It is important for an organisation to take human factors into consideration, as its success depends on the performance of humans. Organisations should proactively integrate human factors principles throughout the lifecycle of a facility: from the design, through commissioning, operation and maintenance and de-commissioning

stage. This in turn motivates employees to be proactive in resolving the issues rather than being reactive to an accident.

The UK Health and Safety Executive (HSG48, 1999) defines human factors as:

**“...environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work. Careful consideration of human factors can improve health and safety by reducing the number of accidents and cases of ill-health at work.**

**Organisation** - Organisational factors have the greatest influence on individual and group behaviour in an organisation. These include safety culture, management commitment, communication, job design etc.

**Job** - Tasks should be designed in accordance with principles to consider limitations and strengths in human performance. Matching the job to the person will ensure that they are not overloaded and that the most effective contribution to the business results.

**The Individual** - People bring to their job personal attitudes, skills, habits and personalities which can be strengths or weaknesses depending on the task demands. Individual characteristics influence behaviour in complex and significant ways.

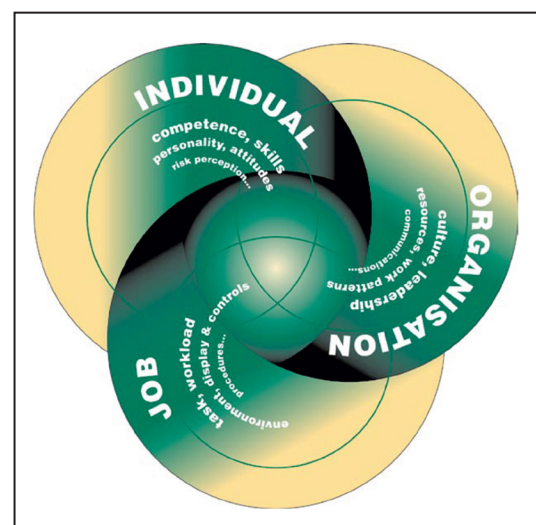


Diagram taken from 'Reducing Error And Influencing Behaviour, HSG48', by UK Health And Safety Executive (HSE).

## Human Factors Applicable In Industry

Multiple Human Factors impact human behavior in industry as shown in figure below (list is not exhaustive). Improper implementation of these factors leads to increased likelihood of occurrence of human errors. Various levels in an organisation have different controls on these human factors.

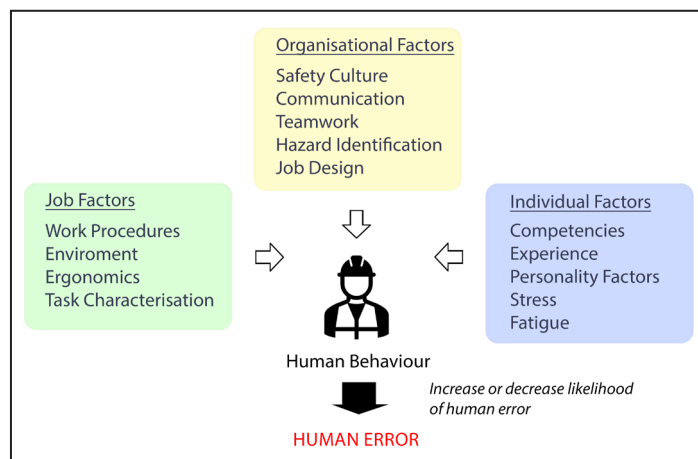


Figure on the examples of organisational, job and individual factors affecting human behaviour and human error.

Table below list two accidents in chemical industry in Singapore in past decades where human error played a significant role in accident causation.

Accident Details	Injuries/Fatalities	Causation Factors	Associated Human Factors
Two workers deployed by a contractor were overcome by Hydrogen Sulphide (H <sub>2</sub> S) gas which leaked from a relief valve when they were trying to remove it. One of the workers fell to the ground from a five-storey scaffold but survived, while the other worker on the scaffold became unconscious due to inhalation of the leaked gas. The latter worker subsequently died of H <sub>2</sub> S poisoning.	1 serious injury / 1 fatality	Flange bolts of the wrong relief valve were uncrowded leading to loss of containment of H <sub>2</sub> S. The following were not carried out before start of the job: <ul style="list-style-type: none"> <li>Conduct checks on the name/ label on the relief valve before removal.</li> <li>Obtain Permit-to Work (PTW) before commencing work.</li> </ul> Supervisor had assumed workers knew the location of the relief valve	<ul style="list-style-type: none"> <li>Procedures</li> <li>Communication</li> <li>Hazard Identification</li> </ul>
Three workers were trying to restart a steam utility boiler during night shift when an explosion occurred inside the furnace of the boiler. The explosion ripped open the boiler, causing damage to the water tubes and subsequent release of high-pressure steam. Two workers eventually died due to severe burns and the third worker was badly injured.	1 serious injury / 2 fatalities	Large amount of flammable gas was introduced into the boiler furnace which led to this explosion. Contributing factors that led to the accident included: <ul style="list-style-type: none"> <li>Use of unauthorised bypass method to restart the boiler which was earlier used by the boiler start-up team.</li> <li>Failure to adhere to safe work procedures.</li> </ul> The unauthorised bypass method process was used by the workers in past to overcome the unsuccessful boiler firing situation.	<ul style="list-style-type: none"> <li>Safety Culture</li> <li>Task Characterisation</li> <li>Hazard Identification</li> <li>Procedures</li> </ul>

Note: The accidents were extracted from "[Case Studies – Chemical Industry](#)" published by the Workplace Safety and Health Council, 2013.

## Key Principles in Managing Human Error:

- Human error is normal and is predictable. It can be identified and managed.
- Managing human errors should be integral part of safety management system of the organisation.
- A poorly designed activity can be prone to a combination of human errors and more than one solution may be necessary.
- Involve workers in design of task and procedure as they are carrying out the work.
- Risk assessment should identify where human error can occur in tasks, the human factors which might make it more likely to occur, and the safeguards necessary to prevent it.
- Incident Investigations should seek to identify how the work was done leading to human to fail rather than stopping at 'human error'.

## Resources

For more resources on human factors, please refer to the below:

- [Introduction to human factors](#) by UK Health and Safety Executive (HSE)
- [Reducing error and influencing behaviour \(HSG48\)](#) by UK Health and Safety Executive (HSE)
- [Guidelines on Managing Human Factors in Major Hazards Installations](#) by Ministry of Manpower (MOM)
- [Safety Case Technical Guide, Safety Case Assessment Guide \(Chapter 8\)](#) by Ministry of Manpower (MOM)

### Contributed By:

**Amit Bhatnagar**, Process Safety Manager at Singapore Refining Company Private Limited has a vast work experience of more than 36 years in Oil & Gas and Petrochemical industry at different role functions. He also teaches Human Factors in Process Safety and Process Hazards Analysis related modules under M Sc (Safety, Health and Environmental Technology) Programme at National University of Singapore.