

CHAPTER 7

Human Factors

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This chapter explains what human factors are and how they influence people's interaction with equipment, processes and other people. It provides ship and terminal personnel with specific guidance on safe operations, but also includes information for companies, management and designers.

7.1 General

Human factors are the characteristics that affect human interaction with equipment, processes and other people. They can include physical, psychological and social factors. The guidance in this chapter and throughout the publication shows how human factor considerations are used to improve safety through task and equipment design, leadership and SMSs. Humans contribute to most incidents and wherever people are involved in design, construction or operation of equipment and processes there is the likelihood for human error. This might lead us to think that people cause incidents, but they do not.

Human error, actions and decisions are often the result of the way the workplace is set up, i.e. how work, equipment and safeguards are designed and how leaders influence the culture in an organisation.

Incidents start as mistakes or workarounds that stem from:

- Problems with tasks.
- Unclear procedures.
- Difficult to use equipment.

- Workload fatigue.
- Lack of resources.
- Low quality or insufficient training.
- Improper communication.
- Improper situational awareness.

Tackling underlying conditions and hard to use systems that influence human error, actions and decisions can reduce the likelihood of incidents. People in leadership play an important role in this (see section 7.6), including ship's officers, supervisors and terminal management.

Human factor influences are summarised in the following principles:

- People will make mistakes.
- People's actions are rarely malicious and usually make sense to them at the time.
- Mistakes may be due to conditions and systems that make work difficult.
- Understanding the conditions under which mistakes happen helps to prevent or correct them.
- People know the most about their work and play a critical role in identifying solutions.
- Facilities, equipment and activities can be designed to reduce mistakes and manage risk better.
- People in charge of activities help shape the conditions that influence what other people do.
- It matters how those in charge respond when things go wrong and that they take the opportunity to learn.

7.2 Identification and analysis of Safety Critical Tasks

Where the actions or decisions of a human are the only protection against a serious incident, it may be only a matter of time before there is a mistake.

A Safety Critical Task (SCT) is a task related to the ship's main hazards where human error, action or inaction may cause or fail to avoid a serious incident.

Ships and terminals should:

- Identify which tasks are safety critical.
- For each task, identify opportunities for error and conditions that make human error more likely or the consequences more serious.
- Design tasks to eliminate or minimise error and error-producing conditions.
- Identify barriers for the SCTs to reduce the likelihood or consequence of human error.

The following areas of operation may include tasks where error has the potential to lead to a serious incident:

- Berthing and mooring operations.
- Cargo transfer operations.
- Double banking operations.
- Non-cargo related operations, including tank cleaning, bunkering, storing, tanker/terminal access, tending of mooring lines, hot work and maintenance activities.

Having identified SCTs, ships and terminals should use an SCTA approach to identify possible errors, the things that make error more likely and ways of making tasks more resistant to error.

The background conditions that increase the likelihood of human failure include:

- Tasks that are complex, difficult to understand or hard to perform.
- Insufficient training.
- Parts of a task that are inefficient to do in reality or where there is insufficient time available.
- Tasks or steps that are boring, trivial or repetitive, unusual, infrequent or involve unfamiliar situations.
- Inaccessible or hard to use controls, valves, platforms, steps or emergency stops along with access, operation and maintenance challenges from hazardous or moving equipment.
- Difficult system or equipment interfaces, labelling, controls or alarms.
- Unclear signs, signals, instructions or other information.
- Reliance on error-free communications in prevailing noise and light conditions.
- Working environment: noise, heat, lighting, ventilation, ease of access, visibility, line of sight.
- Over-reliance on recognising emerging hazards, risk or change in a dynamic situation.
- Multi-tasking or potential for interruptions or distractions.
- Fatigue, stress and preoccupation.

Ships and terminals should identify ways of eliminating a task or re-designing it to reduce the likelihood of error and increase the likelihood of detection and recovery.

When selecting ways of adapting a task to reduce error, the preference is to use the more reliable control measures at the top of this hierarchy of control (see section 4.2.3):

- Elimination (of hazard or task).
- Substitution (with less hazardous material or process).
- Engineering controls (such as reconfiguring a complex pipe manifold).
- Administrative controls (such as control of work procedures, signs, etc.).
- PPE.

This hierarchy of control recognises that eliminating a task altogether may provide the best protection against the risk from that task, especially when compared to the less effective controls of additional procedures or signage.

7.3 Design

Both ships and terminals can reduce risk by reviewing their design or considering the opportunities during modifications, but this is largely outside the scope of this publication.

Taking the viewpoint of people operating equipment and controls can help to make them intuitive and resistant to error. Human-centred design ensures that human factors are considered at each stage of the design and implementation of a piece of equipment including MOC (see chapter 4). Human-centred design aspects that may be considered include:

- The usability of permanent equipment used in the ship/terminal interface.
- Layout and equipment issues that emerge from the combination of tanker and terminal equipment (e.g. landing areas, gangway placement, manifold access).
- The modification of any piece of equipment.
- The introduction of automation or technology.

For ease of use, the right information needs to be available to people operating equipment and making operational decisions. Controls need to be intuitive, minimising the potential for confusion or mistakes. When designers are updating or modifying an existing design, they should consult

users. Where users report that existing equipment seems to be leading to mistakes or difficulties, design can include ways of reducing or detecting errors or minimising the consequences.

When introducing automation and technology, the impact on users should be carefully considered. While automation can bring considerable advantages to tanker and terminal operators, the side-effects of introducing technology should also be considered (see chapter 8).

Humans may be better than machines for several reasons:

- People can reach conclusions and make decisions based upon little data or unusual/unexpected circumstances.
- Equipment designers cannot foresee all future situations and operating conditions that their equipment may be used in, but skilled operators can complement the design and make it work in practice.

Automation and technology can have unintended consequences, for example:

- Simplifying or eradicating one task may increase the number and complexity of other tasks.
- Reducing workload may:
 - Reduce the operator's monitoring of a situation or system.
 - Reduce the crew's manual skills or their ability to effectively manage when things go wrong.
 - Lead to boredom and lack of engagement in the task.
 - Trigger over-reliance on the new technology or automation.
 - Lead to lost opportunities arising from human involvement, i.e. suggestions for optimising or improving a task.

7.4 Risk assessment

Risk assessments are an important part of safe operations and maintenance. Ship and terminal risk assessments should address the possibility that even competent and experienced people make mistakes that could:

- Lead to hazards or risk situations.
- Reduce the effectiveness of a control/safeguard relied on by the risk assessment (use the hierarchy of controls, see chapter 4).

7.5 Procedures

Shipboard and terminal procedures are instructions that help trained and competent personnel to conduct tasks. To improve the effectiveness of procedures, ships and terminals should consider:

- Involving the people who will be using the procedures in the creation and updating of them. This will improve accuracy, ownership, compliance and conformance.
- Well presented procedures are more effective. A procedure should help users, but cannot replace training or experience.
- Essential hardware and task step components of an operation should be covered, highlighting key critical issues and hazards.

Procedures should highlight steps where an error could:

- Occur.
- Be detected.
- Be recovered from.

Where a ship or terminal has a problem with procedural compliance or conformance, efforts should address the following:

- Are important SCTs covered by procedures?
- Are procedures available, accessible and usable?
- Are there multiple or conflicting procedures for a task?
- Are procedures clear and understandable?
- Are procedures accurate/correct/complete and workable?
- Are procedures current and valid?
- Have procedures been communicated to, or trained for by, the workforce?
- Is the requirement to follow procedures clear?

7.6 Leadership

Leaders have a significant impact on the safe operation of ships and terminals. Evidence shows that incidents of all types are reduced when those in leadership work to build trust and respect between themselves and the workforce, by:

- Promoting speaking up.
- Respecting and acting on concerns of junior team members.
- Encouraging everyone to resolve safety issues.
- Promoting, supporting and communicating continuous proactive improvement.
- Encouraging learning when things go wrong, not reacting with blame.

Those with leadership roles should be alert to junior crew or team members being unwilling to challenge those in senior positions, or those in senior positions ignoring the challenges of junior members. This is particularly relevant because of:

- The strongly hierarchical tradition in shipping and terminal operations.
- The different cultures when a tanker engages with a terminal.
- The multinational nature of ships' crews, with varying degrees of willingness to speak up or challenge.

Everyone who works on a ship or terminal has a responsibility for their own and their colleagues' health and wellbeing at work. Poor health and wellbeing can cause incidents and accidents. Healthy and happy crews and teams are more likely to identify opportunities to enhance the operation through improvements in equipment design, improved controls or safety management procedures.

Those with leadership roles on ships and terminals can address these issues by:

- Making themselves available to the workforce. This could be through walkabouts and discussion where they set expectations and standards, but also listen and learn what makes work difficult.
- Collaborating with those who do the job, tackling the problems they encounter.
- Resisting the temptation to blame, and instead looking for the systems and conditions that set the stage for people to make mistakes (see section 7.12 on investigation and learning).

7.7 Confidence to stop work or speak up

Tanker and terminal operators should emphasise to their personnel that everybody has SWA (see chapter 4).

There are many reasons why a person might not speak up or stop work:

- They see others not acting and think they have a reason.
- More experienced people around them are not doing anything.
- They think they have misread the situation.
- They worry about upsetting a co-worker by calling attention to an unsafe situation.
- They think they do not have authority.
- They feel if they are wrong it could get them into trouble.
- They think they could make a situation worse.

Those with leadership roles on ships and terminals should build people's confidence to act by:

- Taking action themselves to step back, slow, pause or stop.
- Encouraging people to ask for help and work as teams to solve problems.
- Always supporting a decision to step back, slow, pause or stop.
- Thanking and recognising even when it turns out that there is not a problem.

7.8 Fatigue

Fatigued people are more likely to make mistakes due to mental and physical impairment. Fatigue can be caused by lack of sleep, poor quality sleep or being awake for too long. It can accumulate over time with unsociable working hours or shift patterns. Fatigue can be caused by a lack of staffing, poor adherence to work/rest periods and extended operations (for example, from lengthy river passages/port approaches/long loading operations/terminal operations at unsociable hours).

Workload can increase due to extended in-port operations, poorly planned work and/or difficult to use equipment/tools. High or low temperature extremes, or exposure to poor lighting, noise and inclement weather can also contribute to performance impairment. Additionally, a fatigued person may be a poor judge of their own level of fatigue or impairment.

Ships and terminals should:

- Determine operational workload and required competencies and match manning levels and support resources.
- Manage workload, hours of work and rest.
- Understand and safeguard tasks where fatigue could increase mistakes.
- Consider the scheduling of SCTs or duties to avoid times when people may be less alert due to fatigue.
- Train personnel in the causes and effects of fatigue.
- Ensure there is sufficient opportunity to rest when planning work.
- Maintain a healthy exercise, nutrition and stress-aware environment.
- Monitor fatigue symptoms.
- Investigate fatigue-related causes of accidents and incidents.
- Consider suspending complex or extended operations to make sure that people, especially those most heavily involved, get enough rest.

The *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1979 (STCW)* and the *Maritime Labour Convention (MLC)* require ships' crews to have enough hours of rest to be fit for duty and able to carry out their duties safely. Ships are also required to maintain individual records of hours of work and rest for everyone on board.

Detailed guidance on how to mitigate and manage fatigue is contained in the IMO's *Guidelines on Fatigue*.

Terminals are not subject to global regulation on hours of work and rest, but local legislation often ensures that personnel are rested and fit for duty.

7.9 Manning levels

Not having enough people available on board or at the terminal can lead to accidents or incidents. Marine regulations require:

- Flag States to issue ships with a minimum safe manning document.
- Ships to be appropriately manned to undertake all aspects of safe operations on board.

Terminals are not subject to global regulation on manning, but local legislation often requires a minimum safe manning level to be maintained at all times (see OCIMF's *Manning at Conventional Marine Terminals*).

Both ship and terminal should consider how many people are needed for both regular operations and any emergency that might be encountered.

7.10 Individual training, experience and competence

With ship/terminal operations, the competence of the other party may be unknown. Demonstration of competence requires four things:

- Training and familiarisation for knowledge.
- Practising in order to build skills.
- Accumulating experience.
- Demonstration of being able to apply these in real life.

Both ship and terminal need to account for the possible limitations of the other party during the operation. Competent people can, and do, make mistakes. The assumption that we may have to detect and recover from others' mistakes is an important aspect of staying safe.

For ships, international conventions establish standards of training and competence for seafarers. STCW Chapter V contains specific requirements for personnel serving on oil tankers, chemical tankers and gas carriers, which define the training and experience needed by officers, ratings and personnel involved in cargo handling and this includes tanker familiarisation.

Terminals are not subject to global regulation on training and competence, but local legislation often requires minimum training and competence levels.

It is recommended that ship and terminal operators have a Competence Management System. For terminal operators, this would be the *Marine Terminal Operator Competence and Training Guide (MTOCT)* (see chapter 15). For ship operators, this would fall under the STCW Convention. These systems would include the following to develop and assure competence:

- Underpinning knowledge of the job (e.g. awareness and familiarity of operations).
- Technical competencies, which are task related and enable the job to be functionally completed. They are typically job or occupation specific and the objective is to meet minimum standards of performance (e.g. ship or company specifics regarding each piece of equipment). SCTs may be an input to this.
- Non-technical competencies, which are skills that enable delivery of the role. Examples include the ability to plan effectively, work well with other team members, coach or motivate others, and communicate effectively.

7.11 Practising team skills

In the marine industry, while regulations and guidance provide important boundaries, ship crews and terminal teams are often dealing with dynamic situations influenced by weather, sea state, and equipment and process changes.

Teams need to learn and practise the skills that help them to work effectively as a team, including:

- Communication.
- Understanding and decision making.
- Team problem solving.
- Balancing formal authority and assertiveness – confidence to put forward views and speaking up.

Building these skills involves practising dynamic, realistic, scenarios together as a team, learning and practising tools and techniques that aid team performance. The mechanisms to deliver this can range from desktop exercises, discussing hypothetical scenarios, through to drills or highly accurate simulation.

Tankers and terminals should regularly exercise teams to practise the skills described above.

7.12 Human factors in investigation and learning

Human factors can be the reason why an incident or accident has happened, but the investigation may miss this by focussing on what happened and how.

To get into the real 'whys', an investigation needs to understand what was going on in the world of those involved. The investigator should understand the context of people's actions. To get to this level of understanding requires both:

- Well trained investigators who understand human factors.
- A culture where those involved in an incident feel that they can cooperate fully with an investigation.

It is important that investigations are undertaken post incident and that they dig deep enough to understand the human factors that influenced the undesired event. However:

- Most investigation reports describe 'what' – what happened, what broke, what was the outcome.
- Some investigations reveal 'how' – this rule was broken, that procedure was not followed, this person pressed the wrong button (human error was to blame).
- Very few investigations get to the 'why' – why did the Master press the wrong button on the console, why did the crew feel they couldn't follow that procedure, why did an error occur?

SCTA techniques can also be viewed as a way of learning about the errors and workarounds that eventually lead to incidents, so are an effective way of getting ahead of incidents.

Guidance on improving human factors in investigation is available from IOGP Report 621 – *Demystifying Human Factors: Building Confidence in Human Factors Investigation*.

Further advice on learning from incidents is available from IOGP Report 552 – *Components of Organizational Learning from Events*.