Raising Awareness of Human Factors

A collection and summary of current best practices and guidance.

Spring 2019.

CIA Chemical Industries Association

Working for chemical and pharmaceutical businesses

The purpose of this Information Note is to raise awareness of the importance of Human Factors as an essential element in managing major hazard safety in chemical and pharmaceutical businesses. It also highlights the expectations of the regulator and provides links to the available guidance and other information that can help businesses ensure their procedures meet 'best practice' for managing operations safely.

Human factors refer to environmental, organisational and job factors, and human and individual characteristics, which influence behaviour at work in a way which can affect health and safety. Because human factors in the context of safety in the chemicals sector is a complex mixture of operational, individual and organizational aspects, the topic requires a broad-based approach involving all job levels in the organization. Managing human factors at a major hazard site requires an understanding of these interactions, a clear focus on the most critical tasks and operations, support of leadership in ensuring the necessary priority and resource, and appropriate expertise available to the organisation to ensure that embedding human factors at the operational level is effective.

CIA's Responsible Care Strategy Group has discussed human factors and agreed an action to help raise awareness for the benefit of CIA member companies. The discussion was prompted by the prevalence of human factors in many accidents and near-miss incidents in the chemicals sector both historically and internationally; and in the context of information about increased concern from the regulator about whether the topic is effectively managed by sites in the UK. In response to these concerns, CIA has arranged for the topic to be discussed more broadly and for information to be shared more widely through CIA meetings for businesses. In February 2017 human factors was the principal safety topic at CIA's Annual Safety, Health & Environment Conference; it has been the focus at CIA Process Safety Network meetings where various companies have shared their different site approaches to managing human factors; and it has been covered in presentations at the majority of Responsible Care Cell meetings across the UK. In most cases, HSE staff – either Human Factors Specialists, or inspectors appointed as Human Factors Champions – have kindly given their input on this so that industry has had the benefit of first-hand information and the opportunity to raise questions on specific aspects.

Human Factors is now one of HSE's Strategic Inspection Topics – superseding a previous similar initiative on Competence Management. This note references below the HSE guidance for inspectors ('Operational Delivery Guide', which is freely available online), on how this topic will be addressed by the regulator at COMAH sites. Companies should be aware that HSE can be expected to be challenging during inspection visits, and sites are strongly recommended to ensure they are fully familiar with what is expected. However CIA's advice is that businesses should not regard this as simply something to achieve legal compliance with, and to manage regulator visits. Sites can expect significant business benefits from lower downtime, fewer incidents and better operational performance if human factors and the associated behaviours are fully embedded in the organisation. Sites have a duty to provide evidence to demonstrate the assured performance of humans engaged on safety critical tasks which may have an influence on the initiation or mitigation of a major accident. Having clearly defined procedures and a structured and systematic approach to do this will facilitate the necessary demonstration. The following guidance referenced and summarized below, provides information on what sites need to address in order to adequately consider human factors.

The HSE's Human Factors Strategic Topic Delivery Guide
http://www.hse.gov.uk/comah/guidance/hf-delivery-guide.pdf

This explains that the following topics are key to managing human factors:

- Managing Human Performance
- Human Factors in Process Design
- COMAH-Critical Communications
- Design and Management of Procedures
- Competence Management Systems
- Managing Organisational Factors

It explains the regulator's approach to inspection on the topic of human factors. Success criteria for each topic area are clearly listed.

HSE Human Factor resources and guidance documents are available online via:

http://www.hse.gov.uk/humanfactors/

The HSE provide a toolkit for inspectors on Human Factors here:
http://www.hse.gov.uk/humanfactors/toolkit.htm. The items listed within this toolkit are briefly summarized later in this document.

HSE's Human Factors Road Map

http://www.hse.gov.uk/humanfactors/resources/hf-roadmap.pdf

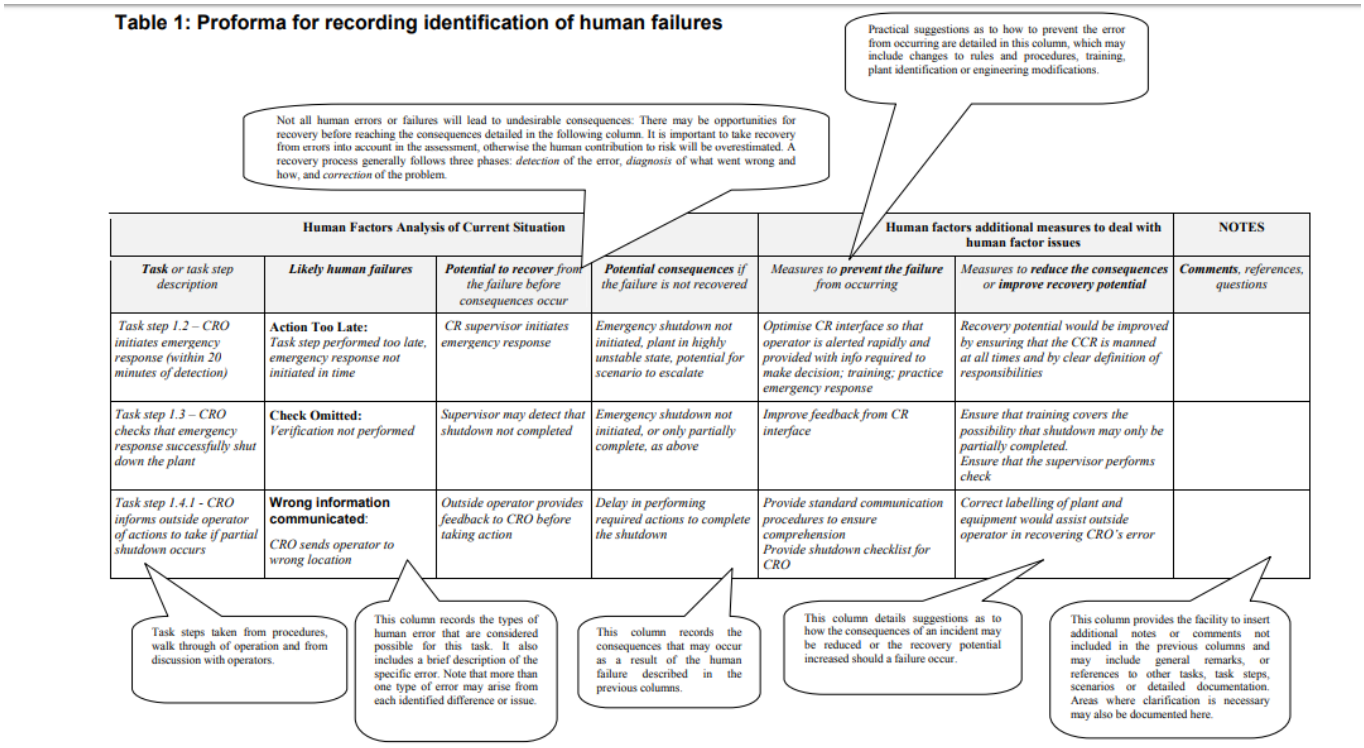
This document summarises a human factors roadmap for the management of major accident hazards. It explains that sites should start with the identified major accident hazard scenarios, or in the case of non-COMAH sites, the site's main hazard scenarios. Taking each of these in turn, a site should look at the human tasks around each scenario and determine which tasks undertaken by people, may either initiate the scenario or fail to mitigate it. These are thus identified as safety critical tasks.

Once safety critical tasks are identified, each of these can be rigorously tested by a combination of task analysis and human error analysis. This is similar to a HAZOP but applies human factor guidewords (see Core Topic 3 in the HSE's HF toolkit). This type of analysis is also known as a human HAZOP or human reliability assessment (HRA).

Suggested guidewords are given below and are followed by a suggested proforma for use in the analysis, both taken from the toolkit guidance:

Action Errors		
A1 Operation too long / short	A2 Operation mistimed	A3 Operation in wrong direction
A4 Operation too little / too much	A5 Operation too fast / too slow	A6 Misalign
A7 Right operation on wrong object	A8 Wrong operation on right object	A9 Operation omitted
A10 Operation incomplete	A11 Operation too early / late	
Checking Errors		
C1 Check omitted	C2 Check incomplete	C3 Right check on wrong object
C4 Wrong check on right object	C5 Check too early / late	

Information Retrieval Errors		
R1 Information not obtained	R2 Wrong information obtained	R3 Information retrieval incomplete
R4 Information incorrectly interpreted		
Information Communication Errors		
I1 Information not communicated	I2 Wrong information communicated	I3 Information communication incomplete
I4 Information communication unclear		
Selection Errors	S1 Selection omitted	S2 Wrong selection made
Planning Errors	P1 Plan omitted	P2 Plan incorrect
Violations	V1 Deliberate actions	



During this analysis, operational performance influencing factors (ie what would make it more or less likely that the human should fail to complete the task correctly) should be considered such as control screen visibility, task complexity or ergonomics. A hierarchy of controls approach should then be demonstrated to reduce the risk of human failure. For example, installing a high level alarm and trip on a critical level indicator.

In such cases, sites should acknowledge that taking this course of action moves the safety critical task from an operational event to one related to inspection, testing and maintenance (IT&M). Thus a similar human HAZOP analysis should subsequently be performed on the IT&M activities.

Once all this work is complete, it is likely that opportunities for improving both procedures and training will have been identified. Following the introduction of new or updated procedures and

training, a period of consolidation would be expected. A competency management system (CMS) should provide verification and assurance of competence.

The site's management of change process should address impacts of subsequent changes on the safety critical tasks, human HAZOPs and the CMS. The site's safety management review process should regularly assess the effectiveness of all the above activities within the site's safety management system to identify to senior management teams where improvements may be needed.

Reducing error and influencing behaviour (HSG48)

http://www.hse.gov.uk/pubns/books/hsg48.htm This is the key document in understanding HSE's approach to human factors. It gives a simple introduction to generic industry guidance on human factors, which it defines as: 'environmental, organisational and job factors, and human and individual characteristics, which influence behaviour at work in a way which can affect health and safety'.

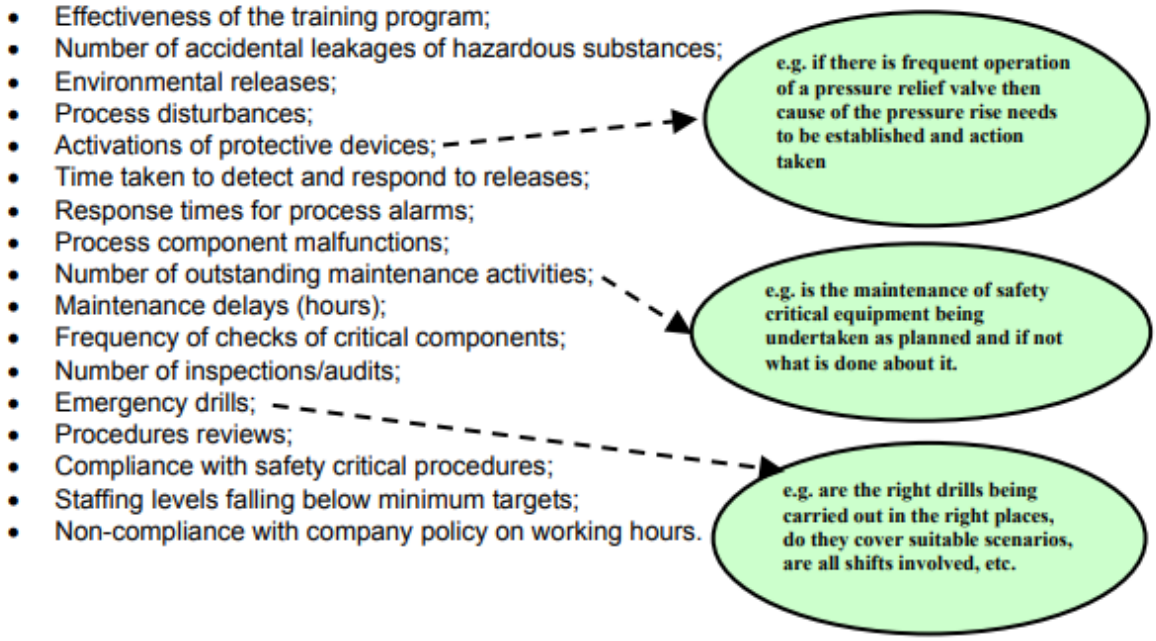
Additional Guidance from the HSE's Human Factors Toolkit:

Introduction to human factors

http://www.hse.gov.uk/humanfactors/topics/toolkitintro.pdf

Includes an overview of the scope of human factors, categorizations of human failure, an explanation of common pitfalls and concerns around management of human failure. The importance of having performance indicators related directly to major accident hazards is emphasized, as is the importance of good safety culture.

Examples of suggested performance indicators taken from the document follow:



Competence assurance

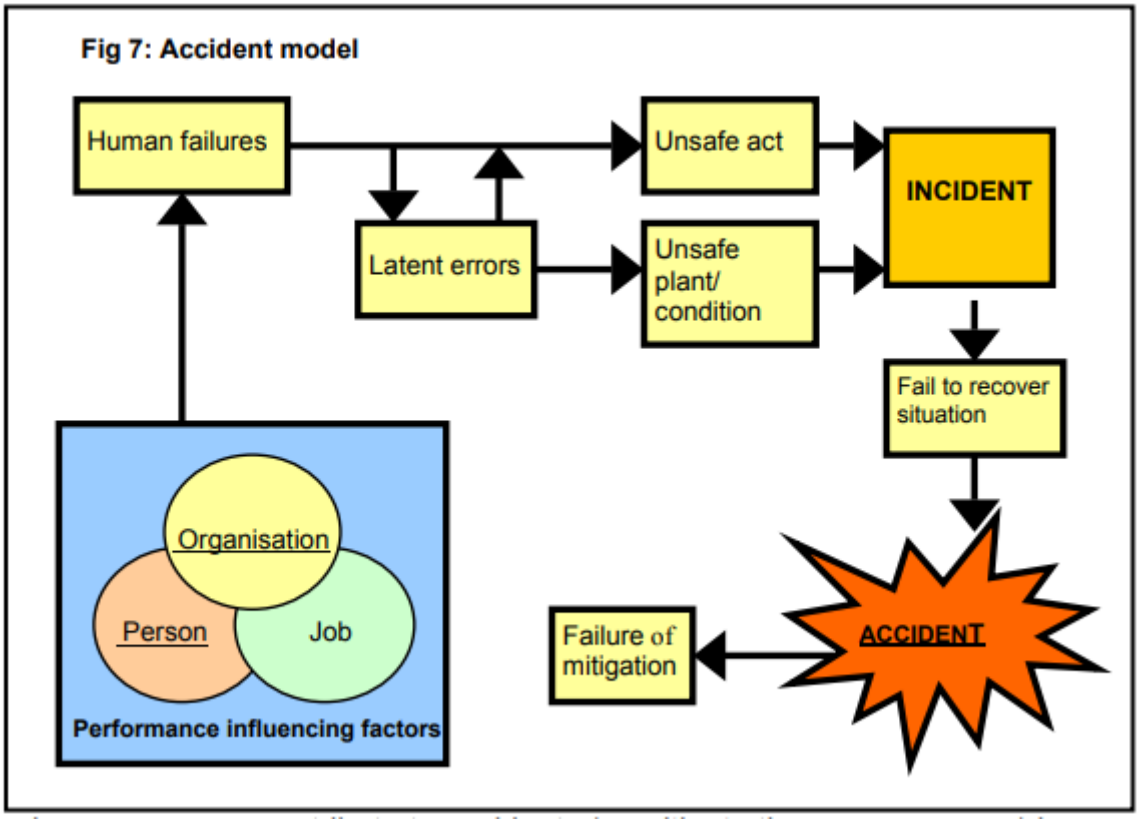
http://www.hse.gov.uk/humanfactors/topics/core1.pdf

Includes an explanation of how the site's competency management system (CMS) should link to the site's major accident hazards (MAHs), the scope of the CMS and a set of questions designed for inspectors to use which would be useful for sites to use as a self-assessment protocol.

Human Factors in Accident Investigation

http://www.hse.gov.uk/humanfactors/topics/core2.pdf

Considers the human contribution to accidents: Active failures and latent conditions. Finding out what the human failure was after an accident together with why the failure occurred is encouraged given that understanding both the immediate and the underlying cause is key to preventing similar accidents. A question set is included for inspectors which would be useful for sites to use as a self-assessment protocol. The following accident model is referenced:



Identifying Human Failures

http://www.hse.gov.uk/humanfactors/topics/core3.pdf

Discusses Human Reliability Assessments (HRAs). Clarifies the steps required for a human HAZOP. Promotes the importance of culture, leadership and a strong safety management system. A question set is included for inspectors which would be useful for sites to use as a self-assessment protocol.

Reliability and usability of procedures

http://www.hse.gov.uk/humanfactors/topics/core4.pdf

Outlines key requirements of operating procedures with tips for increasing their effectiveness. Procedures should be clear, appropriate, accurate, followed, relevant, easy to access, comprehensive and reliable. Additional recommended guidance is referenced. Includes a question set intended for inspectors which would be useful for sites to use as a self-assessment protocol.

Emergency Response

http://www.hse.gov.uk/humanfactors/topics/common1.pdf

Focusses on the need for documented emergency response procedures that are well planned with good employee awareness, training, drills and liaison with emergency services. Includes a question set intended for inspectors which would be useful for sites to use as a self-assessment protocol.

Maintenance Error

http://www.hse.gov.uk/humanfactors/topics/common2.pdf

Encourages site operators to approach maintenance in a structured way linked directly to major accident hazards (MAHs) and facilitate avoidance of errors. Safety critical equipment should be identified by considering MAHs. Additional guidance is suggested together with common failures seen at major hazard sites and examples for where enforcement should be considered. Includes a question set intended for inspectors which would be useful for sites to use as a self-assessment protocol.

Safety Critical Communications

http://www.hse.gov.uk/humanfactors/topics/common3.pdf

Encourages the use of communication aids, taking sufficient time to ensure clarification, developing communication skills and identification of critical communication activities. Additional guidance is referenced.

Safety Culture

http://www.hse.gov.uk/humanfactors/topics/common4.pdf

Explains that this topic should only be inspected where there is a poor safety record and sites will be receptive to advice.

Safety culture is defined as follows: *The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures*.

For effective safety culture, management commitment, visible management, good communications between all levels and active employee participation are all recommended.

Alarm Handling

http://www.hse.gov.uk/humanfactors/topics/specific1.pdf

Alarm handling (or alarm management) is an issue for any site or process where there is claimed reliance on human response to an alarm to control major accident hazards. Assuring human response to alarms through for example, good interfaces and system design, appropriate monitoring and review, competency arrangements and procedures. It is noted that reviewing existing alarm systems using the recommended EEMUA guidance is both time and resource intensive. It fits within issues related to the whole control room environment and should attract continual management and improvement activities. Alarm categorisation and acceptable occurrence rates are suggested in the checksheet at the end of the document.

Managing Fatigue Risks

http://www.hse.gov.uk/humanfactors/topics/specific2.pdf

The suggested approach for sites on this issue is to focus more on the system for controlling

excessive or fatiguing working hours, rather than individual, one-off instances. Sites should be reminded that the legal duty is on employers to manage risks from fatigue, irrespective of any individual's willingness to work the extra hours. Fatigue results in slower reactions, memory lapses, absentminded slips, 'losing the picture', lack of attention etc.

Changes to working hours need to be risk assessed. One way of doing this is to use HSE's Fatigue and Risk Index. This Excel spreadsheet has been developed as a simple tool to enable comparison of differing shift patterns and to identify when fatigue risks are excessive. Good practice guidance related to shift patterns is given, as is an evaluation checksheet.

Organisational Change

http://www.hse.gov.uk/humanfactors/topics/specific3.pdf

The key issue is the identification and assessment of effects (direct and indirect) on the control of MAHs on site from a proposed change, and during the transition to the new structure. In order to inspect on this topic, HSE are guided to request the following documents:

1. Management of (organisational) change policy and/or procedure;

2. Risk assessments from previous or current change process.

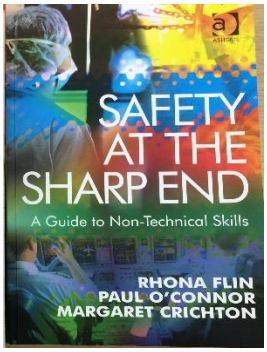
Additional guidance is referenced and a checksheet is provided.

Other resources:

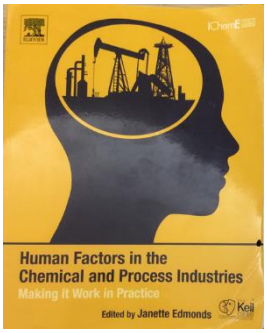
- The HSE's Safety Report Assessment Manual (SRAM) Appendix 12 D http://www.hse.gov.uk/comah/sram/docs/s12d.pdf - This is the HSE's COMAH assessment criteria for human factors. Clear requirements are given for each area of technical criteria together with reference guidance.
    - For example, under Section 10.2, the technical criteria and associated guidance are given as follows:
        - The safety report should contain estimates of the probability (qualitative or quantitative) of each major accident scenario or the conditions under which they occur. This should include a summary of the initiating events and event sequences (internal or external), which may play a role in initiating each scenario.
        - To meet this criterion the Safety Report should show that: When quantitative human reliability assessment (QHRA) is used to determine human error probabilities (HEPs) - e.g. for initiating events and layers of protection:
            - The process has been carried out by a competent human factors assessor (competent in both human factors and the methodology used);
            - All assumptions are grounded on a thorough and systematic qualitative assessment (e.g. by describing the qualitative assessment methodology or by including sample documents which explain the assumptions made);
        - Use of generic HEP data is unacceptable unless it has been qualified to reflect the local circumstances or is more than or equal to an HEP of 0.1.
- http://www.keilcentre.co.uk/products-services/safe-people/general-human-factors-consultancy-and-training/human-factors-awareness-training/ - To improve competency and understanding of human factors, the Keil Centre offer training courses which will help site personnel be able to effectively analyse for human factor risks. They also offer a human factor analysis tool designed to be used specifically with incident investigations. This tool is fully licensed for use once the training course has been attended.
- https://www.icheme.org/human-factors The IChemE also offer a number of courses on

human factors which were developed in partnership with the Keil Centre.

- https://www.iogp.org/bookstore/product/human-factors-engineering-in-projects/ This report, number 454 from the International Association of Oil and Gas Producers (IOGP) includes a competency framework on page 56 specific to human factors. This defines human factors competence levels 1-5. Sites should be aware that the regulator will expect certain levels of competency in human factors for certain tasks in the toolkit and should ensure that where work is done in-house, the competency levels are appropriate.
- https://www.iogp.org/bookstore/product/iogp-report-621-demystifying-human-factors-building-confidence-in-human-factors-investigation/ This report from IOGP provides information on using human factors in incident investigations.
- https://publishing.energyinst.org/topics/human-and-organisational-factors The Energy Institute have many publications freely available on human factors, including 23 different briefing notes on how human factors relate to topics such as leadership, pressure and stress, alarm handling, task analysis and performance indicators. The QHRA guidance is recommended as a useful benchmark in the HF SRAM Appendix 12D (link provided above).
- https://new.abb.com/uk/about/our-businesses/industrial-automation-division/consulting/training-events ABB provide a 3 day training course on human factors and a 1 day workshop which prepares people to lead Human Reliability Analyses.
- https://www.amazon.co.uk/Safety-Sharp-End-Non-Technical-Skills/dp/0754646009/ref=sr_1_1?ie=UTF8&qid=1543179481&sr=8-1&keywords=safety+at+the+sharp+end Recommended reading



- https://icheme.myshopify.com/products/human-factors-in-the-chemical-and-process-industries-1st-edition Recommended reading



- https://epsc.be/Products/PRISM.html

  From 2001 to 2005, the European Process Safety Centre (EPSC) acted as the coordinator for the EU funded network, PRISM (Process Industries Safety Management), which focused on human factor approaches to major accident safety. As the PRISM network website is no longer accessible, the collected materials are made available at the above link.