Chartered Institute
of Ergonomics
& Human Factors

# How to carry out human factors assessments of critical tasks

## Guidance for COMAH establishments

# Introduction

## What is this guidance about?

This guidance provides advice to those with responsibility for developing and delivering human factors assessment programmes. It has been written by UK practitioners focusing on responsibilities under UK regulation and, in particular, on compliance with the Control of Major Accident Hazard Regulations 2015 (COMAH). However, the guidance will be applicable to human factors assessment programmes carried out in high hazard industries not covered by this legislation around the world. Where the term "COMAH Operator" is used, this can be substituted for the corporate entity that manages the major hazard site or installation where other legislative regimes are in place. It may also be relevant to industries with a high dependence on human performance to manage risk. The document presents guidance on a task-based, qualitative assessment process which involves:

1. Identifying and prioritising Major Accident Hazard (MAH) Critical Tasks
2. Carrying out Task Analysis
3. Identifying human failure modes and Performance Influencing Factors (PIFs) (also known as Performance Shaping Factors and Error Producing Conditions) for task steps with MAH consequences
4. Identifying existing control measures which prevent the failure, the consequence of the failure or allow recovery
5. Identifying and recommending improvements, applying the hierarchy of control where further risk reduction is required and improving PIFs to reduce risk as low as reasonably practicable (ALARP)
6. Recording the assessment.

The process is also commonly called:

- Human Reliability Analysis (COMAH Competent Authority, 2016)
- The Seven Steps Approach (Health and Safety Executive, 2005)
- Human Factors Safety Critical Task Analysis (Energy Institute, 2020); and
- Human Error [or Failure] Analysis (e.g. Kirwan, 1994).

## Why have we published it?

Human factors practitioners identified a lack of guidance and consistency in performance of human factors assessments. There is freely available guidance on what should be done, but less guidance on the practicalities of how to do it. This guidance focuses on **how** to carry out assessments, from planning to acting on recommendations, rather than on **what** should be done. It contains practical tips and ideas to assist in carrying out a thorough assessment.

## Who is this guidance aimed at?

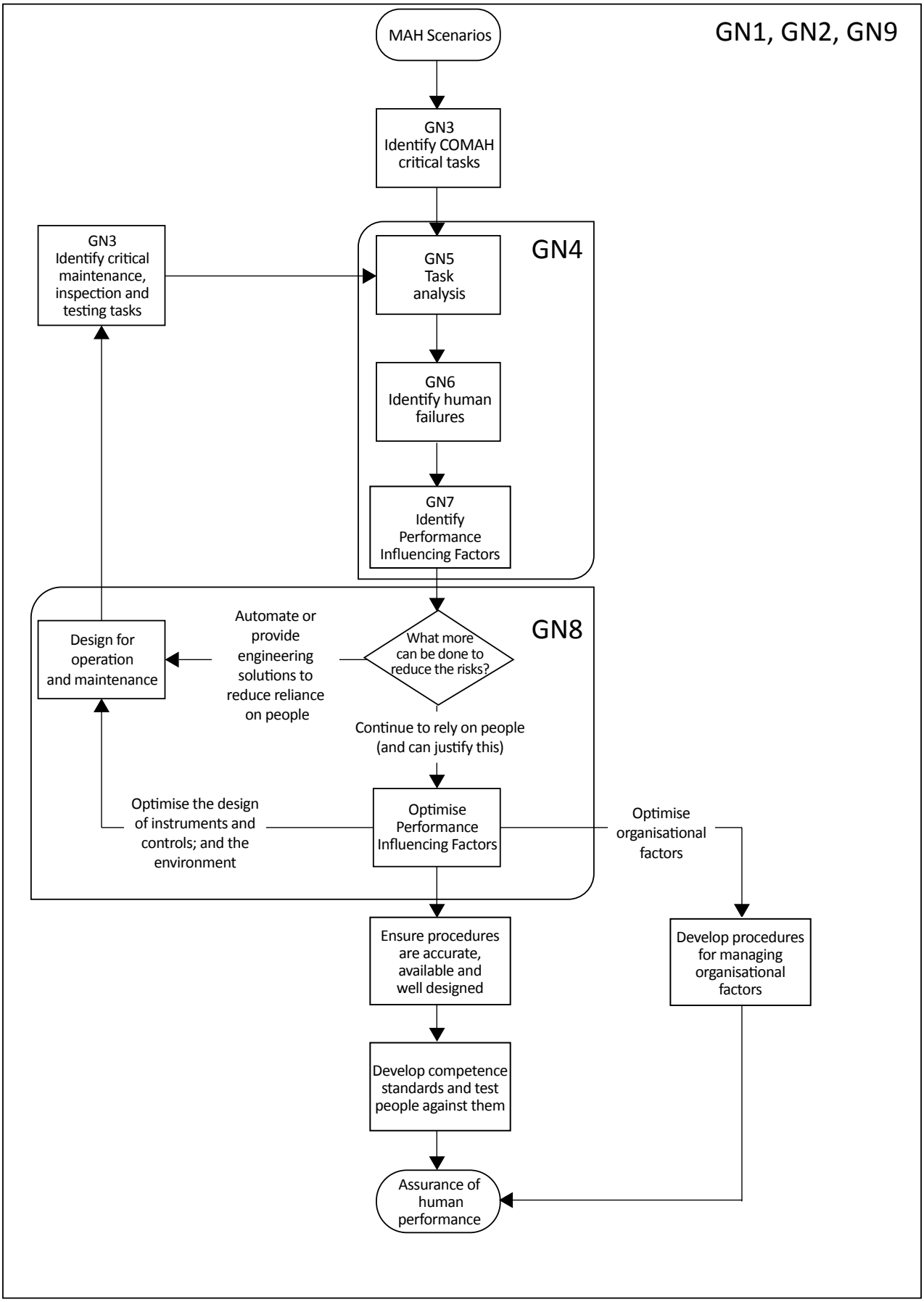
This guidance is aimed at people who have responsibility for managing assessment programmes on MAH establishments and competent human factors practitioners who are leading assessment work.

## How should this guidance be used?

While this guidance is presented as a single document, each section is a standalone Guidance Note (GN). The aim was to provide concise advice on each stage of the assessment process. However, in reality, many of the stages are interlinked.

# Contents

# HSE's Human Factors Roadmap and the Guidance Notes



# GN1 Managing human factors assessment programmes

## What does GN1 cover?

This guidance addresses the management of human factors assessment programmes.

## Why have an assessment programme?

Integrating human factors into risk management is key to more efficient, productive and high-quality operations as well as to safety and offers many advantages to the COMAH Operator. However, it can require a cultural shift, especially when organisations are unfamiliar with human factors.

Since 1999, the COMAH Competent Authority (CA)'s guidance on the COMAH Regulations (L111) sets out their expectations as follows:

> *Where reliance is placed on people as part of the necessary measures, human factor issues should be addressed with the same rigour as technical and engineering measures.*

The COMAH CA's expectations are further set out in the Inspecting Human Factors at COMAH Establishments (Operational Delivery Guide). Topic 1 of the Delivery Guide, Managing Human Performance, sets out the success criteria for human factors assessment programmes as follows:

> *The COMAH Operator has developed, and is actively implementing, a programme of HRA that is suitably representative of the full range of MAH scenarios at the establishment…*

There is a clear expectation on HSE inspectors that when a COMAH Operator has failed to develop and implement a programme of human factors assessment that is consistent with latest good practice, enforcement action should be taken in line with the Enforcement Management Model.

The HSE reports a number of problems with assessment programmes. This guidance sets out good practice to address these issues.

## Who owns the assessment programme?

There can be a tendency for COMAH Operators to see assessment programmes as projects or add-ons carried out in response to external challenge. Human factors assessment should be seen as 'business as usual', in the same way as other major hazard risk assessments, such as Hazard and Operability studies (HAZOPs), Process Hazard Reviews (PHRs), etc, which are regularly reviewed.

It is common for COMAH Operators to rely on external consultants, which can reinforce the idea that such assessments are a project rather than business as usual. Once the external pressure is removed, resources and activity are not sustained. To overcome this sporadic approach, it can be helpful to ensure that all managers in the organisation have awareness of human factors and its role in COMAH major accident management so that they understand the importance of resourcing such programmes.

## What does an assessment programme involve?

Tables 1-3 show the tasks involved in managing and organising human factors assessment programmes. Typically, such programmes benefit from having a lead person who takes responsibility for ensuring that the programme of work runs according to plan. Human Factors Leads typically sit within Quality, Health, Safety and Environment (QHSE) departments or Process Safety teams. The COMAH Operator should take a view on whether there is sufficient in-house competence to proceed with the programme without external assistance, or whether a source of competent advice is needed – see GN2. To facilitate the assessments, a qualified and experienced human factors practitioner will be required.

In addition to arranging for competent input, arrangements should be made for keeping a critical task register, scheduling assessments, keeping track of progress against plan and in implementing actions, and reporting to the senior management team. A key requirement is that resources are released from relevant departments to take part in and support the assessments.

## What resources do you need?

The following specifies a baseline for a typical programme of work to carry out human factors assessments. It is not intended as a definitive requirement but COMAH Operators should aim to achieve or exceed this. Where this is not practical, the company needs to recognise potential weaknesses in its approach and have plans in place to overcome these.

**Table 1: Developing a prioritised list of tasks for assessment**

| Activity | Resource requirement |
|---|---|
| Collect information to assist task identification and prioritisation<br><br>(Some time may be spent collating the MAH scenarios or developing a draft list of tasks) | Human Factors Lead (one person)<br><br>People from the work area to assist with accessing documents and providing additional background information about gaps and other issues |
| Meeting/workshop to agree prioritisation. Duration will depend on size of area and approach being taken. Range from one hour if brainstorming (pick a couple of tasks to get the process started) to more than one day if formal scoring is being used to develop a longer term plan (e.g. OTO 092) | Task Identification Facilitator (one person)<br><br>Participants representing the following disciplines as a minimum: Operations, Mechanical Engineering/Maintenance, I&E Engineering/ Maintenance. Also, Projects and Process Control may be relevant<br><br>Process Safety (part-time/on call) |
| Develop the plan with dates for workshops<br><br>Contract a competent facilitator, typically a human factors practitioner (if required) | Human Factors Lead (one person) |

**Table 2: Conducting assessments – per task**

| Activity | Resource requirement |
|---|---|
| Collect information about task in preparation for workshop (procedures, P&IDs, vendor documents, photos, etc) | Assessment Facilitator (one person)<br>OR Human Factors Lead if external Facilitator being used (one person) |
| Optional – Prepare draft HTA. Only considered if good information is available and person preparing the HTA has a good knowledge of the task, hazards and issues | Assessment Facilitator (one person) |
| Walk-Through Talk-Through (WTTT) | Typically, this will involve the Assessment Facilitator and the workshop participants. It must include the Subject Matter Experts (SMEs) who conduct the task |
| Plan workshops | Assessment Facilitator (one person)<br>OR Human Factors Lead if external Facilitator being used (one person) |
| Assessment workshop. Facilitator and attendees should be available to attend the full duration. Can be face to face or remote. Can qbe split into shorter sessions (two hours) but the full length of the workshop will depend on the complexity and length of the task under discussion | Assessment Facilitator (one person)<br>Participants:<br>• SMEs who provide the practical experience and technical knowledge of the task<br>• Optimum three to four people but fewer is acceptable if they can contribute the knowledge and experience required, or it is possible to validate the results with others at a later date (e.g. someone from another shift team)<br>• Involving more where considered advantageous and Assessment Facilitator is confident to manage the workshop<br>• Process Safety or relevant technical expert – preferably full time but can work part time or on-call.<br>Scribe (optional) |

**Table 3: Assessment follow-up**

| Activity | Resource requirement |
|---|---|
| Record assessment output – as a rule of thumb this will take as long as the workshop itself, sometimes up to double that time | Assessment Facilitator (one person) |
| Review assessment report and feedback regarding the accuracy of the assessment and whether actions are appropriate | Assessment Team<br>Human Factors Lead |
| Evaluate recommendations and arrange implementation using a suitable action tracking system | Human Factors Lead<br>Process Safety<br>Management |
| It is typical to find that both procedures and competence standards need to be updated after the assessment to account for changes resulting from the recommendations. This should also be tracked | Persons responsible for procedure and competence assurance |

## How do you integrate assessment programmes with SMS?

Assessment programmes should be part of the establishment's Safety Management System (SMS). Typically, this will involve setting out the establishment's:

- Policy on human factors, including the roles and responsibilities for ensuring human factors assessments are carried out, integration with periodic safety reviews, the means of establishing and maintaining competency, and arrangements for monitoring, audit and review
- Procedure for carrying out human factors assessment, setting out the method to be used for carrying out assessments, the resources required and how these will be released, recording and reporting requirements.

The findings from assessments may well indicate the need for management systems for common PIFs – factors such as alarm management, fatigue, competence arrangements and so on – which can best be addressed by a management system. This is illustrated in Figure 1.

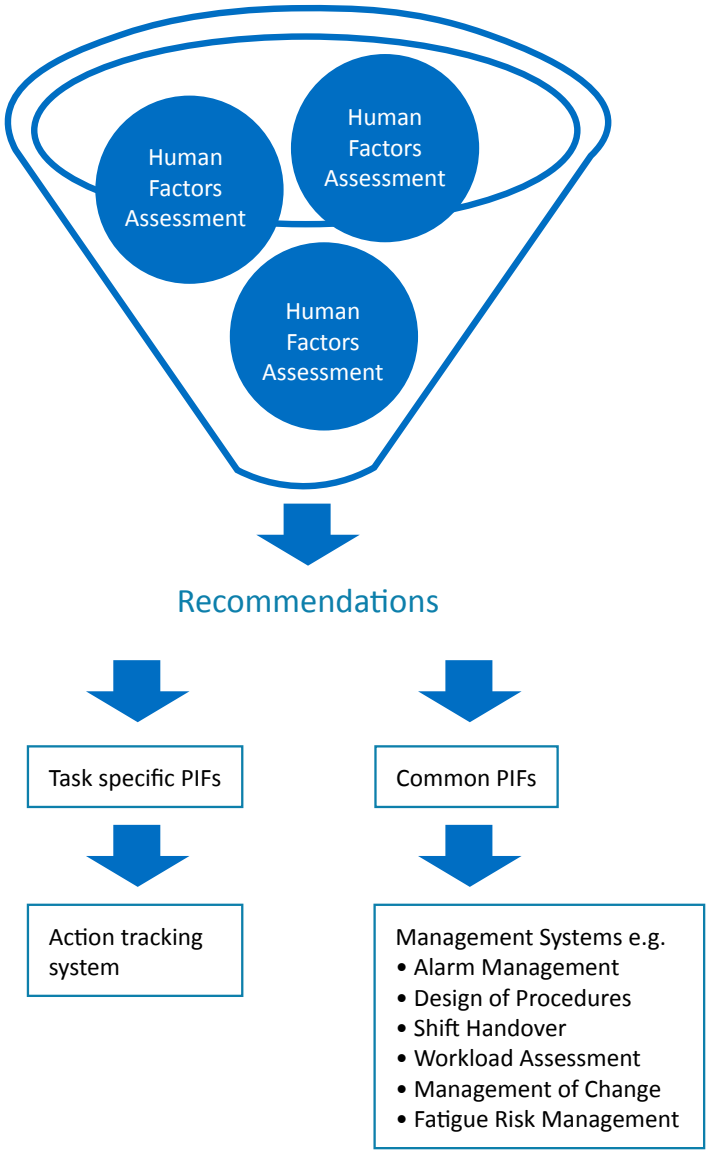



**Figure 1: Relationship between Human Factors Assessments and Human Factors Management Systems**

## How do you track progress on human factors assessments?

Progress on human factors assessments should be tracked as part of the establishment's Process Safety Performance Indicators (PSPIs). Some common PSPIs are shown in Table 4.

**Table 4: Common PSPIs for Human Factors Assessment of critical tasks**

| Human Factors Assessments | | |
|---|---|---|
| **Indicator** | **Number** | **Percentage** |
| Live critical tasks i.e. the number that are currently being performed at the establishment | Reported by priority i.e. Number of High, Medium and Low (see GN3 for prioritisation methods) | |
| Progress in year | Planned assessments for year<br>Completed assessments<br>Cancelled assessments<br>Pending assessments | Percentage of planned<br>Percentage of planned |
| Reasons for cancellations | | |
| **Actions arising from Human Factors Assessments** | | |
| Assessments are identifying improvements | Accumulated total of actions | |
| Actions are being progressed in a timely fashion | Closed actions<br>Overdue actions<br>Unassigned actions | Percentage of accumulated<br>Percentage of accumulated<br>Percentage of accumulated |
| Actions are appropriate | Rejected actions | Percentage of accumulated |
| Reasons for overdue and unassigned actions | | |
| *It can be useful to report actions arising by team, department or plant area depending on the size and complexity of the establishment.* | | |

# GN2 Competence requirements

## What does GN2 cover?

This guidance note sets out the competence requirements for successful delivery of assessment programmes on COMAH establishments. It provides information about roles and responsibilities within the programme.

## What resources are required to deliver assessment programmes?

A programme relies on resources across the organisation to ensure that the SMS effectively considers the MAH risks associated with human interactions with the process. Experience shows that unless the senior management team understand this and commit the resources, particularly from operations, maintenance, engineering and safety management, programme leads can struggle to access the resources they need. It is recommended that the site nominates a senior leader as the Human Factors Champion who has the authority to ensure that the required resources are made available to support the programme.

The senior management team will be responsible for ensuring their respective departments provide appropriate resources to the programme. As such, it is advisable to provide general human factors awareness training to all department managers and other stakeholders which describes the benefits of improving task reliability for efficiency and production gains, as well as safety. The training can introduce the assessment method to emphasise the importance of having the right people involved to deliver benefits.

## What are the roles and responsibilities in assessment programmes?

This section sets out the key roles and responsibilities required to deliver and maintain the programme of work. COMAH establishments differ in size, complexity, organisation and maturity in managing human factors. Depending on the size and complexity of the organisation, some of the roles described may be fulfilled by a single individual e.g. the Human Factors Champion and Human Factors Lead might be the same person; similarly, the same person may facilitate both the task identification process and lead the assessments for the individual tasks. Alternatively, each different role may be carried out by more than one person in more complex organisations. This guidance cannot accommodate all these variations but rather puts forward the competencies for carrying out the roles, however they are allocated. In all cases, it is strongly recommended that these roles and responsibilities are documented and linked to job descriptions.

## What are the competence requirements for each role?

Competence may be defined as **the underpinning knowledge, application of skills, and suitable behaviours required to perform a particular role or activity.**

The HSE reports that companies who attempt to deliver a programme of assessments without the correct competencies rarely succeed in achieving the required standard. It is therefore recommended that operators secure a competent source of advice to facilitate and lead the assessment and develop competence of designated employees over time in leading assessments in-house. Chartered or Technical Members of the CIEHF with experience of carrying out Task Analysis, Human Failure/Reliability Analysis and identifying PIFs, and knowledge of COMAH industries and process safety management practices will be able to provide this advice.

Many companies prefer to develop in-house competence. It is rare for organisations who are new to human factors to directly employ Chartered or Technical members of the CIEHF. Some thought is needed therefore in how to obtain, develop and sustain the correct competencies. It is recommended that the COMAH Operator appoints an employee to the Human Factors Lead role who will work towards Technical Membership of the CIEHF. To achieve this, the individual should attend either a CIEHF-accredited course in carrying out assessment, or bespoke training from a CIEHF registered member. Consolidation of learning from the course will be required, and this is best done under supervision of a CIEHF-registered member who can provide on the job training, mentoring and quality assurance that the assessments meet the required standard.

## *Human Factors Champion*

Human factors assessments require a continuing programme of work to keep studies up to date and relevant. The Human Factors Champion ensures that the necessary resources are provided and monitors progress against the plan. They provide ongoing support to the Human Factors Lead.

**Competence requirement:** An awareness of human factors principles and a basic understanding of the regulator's expectations of managing the risk of human failure in a COMAH environment.

**Suggested training:** Human factors awareness; Process safety management for leaders.

## *Human Factors Lead*

The Human Factors Lead is responsible for developing and delivering the assessment programme, including determining the analysis method to be used. They will be the owner of the critical task register with responsibility for identifying and prioritising tasks for assessment, and for keeping it up to date as part of change management. They will also have responsibility for ensuring that outputs from the assessment programme feed into the wider process SMS. For each assessment, they will identify the required SMEs, collect informative materials, organise site visits, record the output and feed agreed recommendations into the company's action management system. The Human Factors Lead will be responsible for keeping the programme of work on track, and reporting progress to the Human Factors Champion. They should ensure that the person(s) designated to lead the Task Identification Workshop and/or the subsequent assessment workshops are competent to do so.

**Competence requirement:** A good understanding of human factors principles and regulator's expectation of management of human factors in a COMAH environment. Basic understanding of the assessment process, required resources and how it contributes to the overall management of process safety risks in a COMAH environment. Possible development path towards leading assessment workshops directly.

**Suggested training:** Human factors training leading to Technical Membership of CIEHF; Human Reliability Analysis training.

## *Task Identification Facilitator*

The Task Identification Facilitator is likely to be involved in developing the identification method and prioritisation criteria. They will advise the business on the personnel required to attend the task identification workshop(s). Supported by the Human Factors Lead, they will gather the relevant information from which the tasks are to be identified, e.g. MAH scenarios. The Facilitator will then lead the identification and prioritisation of tasks for further assessment in accordance with the site methodology, to ensure all relevant tasks are identified across the different MAH scenarios.

**Table 5: Required Competence for the Task Identification Facilitator**

| Pre-requisites: | | |
|---|---|---|
| Attended detailed training on human factors | | |
| **Knowledge** | **Skills** | **Behaviours** |
| ● Makes the connection between critical tasks and MAHs<br>● Understands the site process for the identification and prioritisation of tasks<br>● Can define what is meant by a critical task in the context of the site process<br>● Appreciates the range of tasks which may be applicable to a COMAH site (i.e. maintenance or emergency response tasks as well as operational tasks)<br>● Can identify PIFs and explain their impact on human reliability | ● Defines/prepares information, people and resources for conducting an effective Task Identification workshop<br>● Introduces the Task Identification and Prioritisation process to the workshop participants<br>● Draws out the relevant tasks from the source information which meets the site definition of a task<br>● Ensures that the full range of tasks are identified across different disciplines<br>● Creates a report detailing the identified tasks with priorities for assessment for handover to the Human Factors Lead | ● Demonstrates analytical thinking<br>● Demonstrates strong meeting facilitation skills: e.g. ensures everyone feels free to contribute, avoid meeting fatigue<br>● Demonstrates active listening and questioning skills |

## *Assessment Facilitator*

The Assessment Facilitator will lead the assessment workshops in accordance with relevant good practice (RGP), providing human factors insight, consideration of PIFs and engineered control measures, encouraging team participation while challenging team members on false assumptions about human reliability. They will ensure a consistent and proportionate approach, including linking the assessment to the original task prioritisation criteria and the source material. They will also capture the output from the assessment and issue the report.

**Table 6: Required Competence for the Assessment Facilitator**

| Pre-requisites: | | |
|---|---|---|
| Attended detailed training on Human Factors principles and topic. The training should be either a CIEHF-accredited training course or delivered by Chartered Human Factors Practitioners<br>Received training or coaching on assessment techniques (CIEHF accredited)<br>Participated in a defined number of assessment workshops | | |
| **Knowledge** | **Skills** | **Behaviours** |
| • Understands process safety management approaches to be able to make the connection between Critical Tasks and MAHs<br>• Understands the different types of human failure, including the failure modes and failure mechanisms to be used in the assessment<br>• Identifies appropriate types of corrective actions for different failure mechanisms<br>• Understands the process for conducting assessments (Hierarchical Task Analysis (HTA), Human Failure Analysis and PIFs)<br>• Can construct an HTA<br>• Describes how to perform a Human Failure Analysis<br>• Can identify PIFs and explain their impact on human reliability<br>• Understands basic engineering design principles to evaluate control measures<br>• Understands the principle of ALARP in managing process safety risks<br>• Knows Human Factors Relevant Good Practice (RGP) | • Prepares information and resources for conducting an effective assessment<br>• Introduces the assessment process to the team members<br>• Operates the software (where used)<br>• Constructs an accurate HTA<br>• Conducts an effective WTTT to validate tasks and assess local PIFs<br>• Conducts an effective Human Failure Analysis focused on high consequence events<br>• Develops effective corrective actions applying the hierarchy of control<br>• Creates an assessment report identifying further workstreams, actions and recommendations for handover to the Human Factors Lead.<br>• Can apply ALARP principles to determining adequacy of risk controls and acceptability of residual risk<br>• Can apply RGP when identifying recommendations | • Demonstrates analytical thinking<br>• Demonstrates strong meeting facilitation skills: e.g. ensures everyone feels free to contribute, avoid meeting fatigue<br>• Demonstrates active listening and questioning skills<br>• Challenges the team's assumptions and encourages thinking about human factors principles<br>• Demonstrates curiosity in human factors thinking and shows a desire to widen understanding<br>• Challenges whether residual risk is ALARP and whether further risk reduction is needed<br>• Keeps knowledge of RGP up to date by continuous professional development |

## *Subject Matter Experts*

The analysis requires the participation of people with knowledge of how the task is performed, how the equipment operates, technical good practice and operational/maintenance safety requirements. These people, termed Subject Matter Experts (SMEs), are likely to include operators and maintenance staff, team leaders/supervisors and possibly also facility managers. As a minimum, it is important to have at least one person (a supervisor or operative) who is very experienced in carrying out the task, but it may be helpful to have a trainee as part of the group.

Safety representatives may also be involved to ensure that safe systems of work are understood. Engineers who are involved in design or technical support of the system under discussion can contribute the technical knowledge of the process or equipment being operated and what good practice looks like.

SMEs are representatives of their group and are responsible for providing feedback from the assessment workshops back to their group to elicit further information for the assessment if required.

**Competence requirements:** Knowledge and experience of their subject area. A basic understanding of human factors would be beneficial.

**Suggested training:** Human factors awareness.

## *Process Safety Engineer*

The role of the Process Safety Engineer is to advise on the possible consequences of identified human failures and control measures. They will provide much of the baseline information used to develop the task register. They are also expected to ensure that the assessment output is integrated into the process SMS.

**Competence requirements:** Basic awareness of human factors principles and their contribution to a robust process SMS.

**Suggested training:** Human factors awareness; Process safety management.

## *Scribe*

Practitioners report that it can at times be helpful to have a dedicated Scribe to capture discussions in assessment workshops. This can be helpful in ensuring detail is appropriately noted. The Scribe can provide a sounding board for the Facilitator in documenting the outputs of the assessment. The role can also provide a useful learning opportunity for people who are training to be Facilitators. It provides opportunities to learn from more experienced facilitators and to consolidate knowledge and skills.

**Competence requirements:** Basic awareness of human factors and the assessment process to enable them to capture the salient information.

**Suggested training:** Human factors awareness.

Table 7 provides the competence requirements for the other roles involved in assessment programmes with suggestions for training.

**Table 7: Required Competence for other roles involved in assessment programmes**

| Role | Competence Requirement | Suggested Training |
|---|---|---|
| Senior Management Team | An awareness of basic human factors principles and how assessment can improve task reliability to achieve efficiency and production gains as well as safety | Human factors awareness<br><br>Process safety management for leaders |
| Procedure Writers | An understanding of how the output from the assessment process is used in the development of new or updated procedures | Human factors awareness<br><br>Training in RGP in design of procedures |
| Training Developers/ Competence Assessors | An understanding of how the output from the assessment process is used in the development of training material and competence assessment criteria | Human factors awareness<br><br>Train the trainer<br><br>Competence assessor |
| Line Managers | An awareness of basic human factors principles and how assessment can improve task reliability to achieve efficiency and production gains as well as safety. An awareness that the assessment will only be effective if the right people are made available to attend | Human factors awareness |
| Engineering Team/ Project Engineers | An awareness of basic human factors principles and working knowledge of the assessment documentation to enable an interpretation of the recommendations to reduce the risk of human failure | Human factors awareness |

More information on CIEHF-accredited training courses and consultants can be found at **ergonomics.org.uk**

# GN3 Identifying and prioritising critical tasks

## What does GN3 cover?

Identifying and prioritising tasks as part of an assessment programme will ensure a focus on tasks where the greatest benefit will be achieved.

This guidance gives advice on:

- Identifying the right tasks
- Prioritising the order in which tasks should be analysed, tailoring prioritisation methodologies to your establishment's hazard profile and range of activities.

## What is a critical task?

A critical task is **a task in which human action or inaction could initiate, fail to control or fail to mitigate a major accident,** including operations, maintenance and emergency response. Critical tasks may be undertaken by any worker on an establishment or installation including employees and contractors.

Companies should clearly define what they mean by critical task. For example, some companies choose to include hazardous tasks that pose a fatal accident risk to individuals (such as work on high-voltage equipment). This is not required under UK legislation but can deliver opportunities for additional risk reduction.

## Who should be involved in identifying critical tasks?

Identifying (and later prioritising) critical tasks works well in a workshop format. Different functions should be represented in the workshop including representatives from operations, instrumentation and mechanical teams. The people involved should have a good understanding of what tasks are carried out, or should be carried out, and the MAH hazards on the plant under consideration. Often this means people with a line management or supervisory role in operations and maintenance as well as process safety specialists.

## How do you identify critical tasks?

MAHs can be identified by reviewing site Safety Reports, for Upper Tier COMAH establishments, and/or risk assessments (e.g. HAZIDs, LOPAs, Bow-Ties). This has the advantage of linking the outputs of this exercise directly to the establishment's MAH identification and risk assessments.

The assessment team should work through the MAHs to identify operational, maintenance, inspection, testing and emergency tasks. The Task Identification Facilitator can prompt task identification by discussing initiation, prevention and mitigation. Control measures may be described in existing risk assessments, which can be useful in prompting task identification. For example, if a Bow-Tie includes a high-level trip as a barrier, then the associated proof test will be a critical task.

Emergency tasks can also be identified during exercises. The tasks required to complete the emergency response should be clearly identified, e.g. manually starting the deluge system or operating the penstock valve are clearly defined emergency response tasks, 'emergency response' is not.

A list of task types for use as prompts in each of the definition areas (initiation, failure to control, failure to mitigate) may support task identification. For example, initiation-type tasks might include: start-ups/shutdowns, maintenance preparation, bulk material movements, loading/offloading and routine process operations.

Tasks may also be identified as a result of incident investigation or a change to the process, plant or organisation. If tasks are created, changed or withdrawn as a result of change, the Management of Change procedure should direct that the task list is updated.

## What do you do when you have many similar critical tasks?

It is often the case that an establishment will have many similar critical tasks. A good strategy is to identify and select a representative set of tasks to assess in detail. For example, the task of removing a pressure relief valve for calibration or maintenance and reinstatement afterwards will include many generic steps. Carrying out a full assessment for one representative example will generate useful information on how to improve performance on this task which can be generalised to similar tasks, provided a suitable example is selected. In this case, a pressure relief valve on a critical process that is considered to be more complex than others (as identified by the maintenance team) would be the ideal candidate.

Assessment of maintenance of other pressure relief valves at the establishment should then focus on any significant differences. A significant difference might be valve design, pipework arrangements or access requirements.

In the case of control room operations, which may also have numerous similar critical tasks, it would be good practice to assess a sample of start-up and operational procedures for each plant area, including an alarm response task where the COMAH Operator has taken credit for them in risk assessment. This should be sufficient to identify the main PIFs specific to that control interface. Compliance checks on the design of the control room and interface against relevant standards, and managing alarms in line with RGP, will also support human reliability assurance.

For emergency response, it is good practice to assess the response to a representative range of major accident scenarios for the plant in the first instance. Where sites have scenarios with different responses (e.g. toxic release vs fire and explosion), then the human aspects of at least one scenario for each outcome should be assessed.

## How do you prioritise tasks for assessment?

The MAH critical tasks identified should be prioritised for assessment. The highest priority tasks are those that make the greatest contribution to the risks of major accidents.

Most establishments and installations will benefit from adopting a simple prioritisation method and applying it consistently. A three-level prioritisation hierarchy (low, medium, high) is sufficient in most contexts, but COMAH Operators may prefer to apply a pre-existing prioritisation hierarchy.

Prioritisation should involve people with the same capabilities as those involved in task identification and they can be done at the same time.

While prioritising tasks, it is helpful to have access to the following types of information:

- MAH scenario descriptions
- Safety studies and risk assessments
- Risk matrices
- Procedure databases
- Investigation data related to major accident pre-cursor events and major accidents.

The prioritisation criteria used should consider the specific hazards and tasks at each facility. Example methodologies for prioritising tasks are available, e.g. Energy Institute (2020), Health and Safety Executive (2000), and can be used to develop your own criteria if required. However, it is essential that the criteria chosen focus on the human contribution to the risk of a major accident.

When using an existing method, tailoring one to your own requirements or developing your own, it is important the criteria will prioritise tasks where assessment will be most beneficial in terms of evaluating the human contribution to the risk of MAH. As a minimum, the prioritisation criteria should include consideration of:

**Consequence severity –** the outcome of the human failure. The consequences of MAHs vary considerably between different industrial sectors, different processes and the scale of operations on different establishments. Establishments will have defined the consequences of scenarios in their safety reports and/or risk assessments. Most COMAH Operators have existing consequence scales that can be applied in this context. If there isn't a pre-existing scale, it is best to define a consequence severity scale (e.g. low, medium, high) according to the MAHs under consideration.

**Degree of human reliance –** the extent to which safety relies on human action. The highest scoring tasks in this dimension will be those which rely most on people and have less engineered protection. Lower scoring tasks will have more engineered and automated layers of protection including passive safeguards.

**Vulnerability to failure –** the degree to which the task is felt to be vulnerable to human failure. This is a high-level exercise looking at features of the task which can be known without further assessment. For example, tasks are more vulnerable to failure if they are complex, involve multiple people, are infrequently carried out or involve over-riding engineered or automated safety systems.

## How do you record your task lists and prioritisation?

Establishments should keep a register of critical tasks. The register has a number of uses:

- To capture the list of identified critical tasks along with the reason why the task is critical, and other information that may assist in prioritisation
- For use in planning the assessment programme and on-going review based on priority
- To identify critical roles for consideration in the management of organisational change and staffing levels
- To demonstrate to regulatory authorities that the COMAH Operator understands where it relies on people as part of its necessary measures.

Critical task registers should be live, reviewed regularly and kept up to date. They should reflect the following for each critical task:

- The MAH scenario the task is linked to
- Status of the assessment
- Next review date of completed assessments.
- Critical task registers should be readily accessible for reference in order to facilitate management processes such as:
- Management of change – identification of critical procedures as part of change risk assessment
- Management of procedures – understanding which procedures or parts of procedures are critical
- Competence Management – understanding where training and assessment should be focused.
- If the critical task register is visible to everyone on site it helps to embed the use of the critical task information as part of managing site operations.

# GN4 Gaining a real-world understanding of the task

## What does GN4 cover?

A good assessment requires the Assessment Facilitator and workshop participants to have a rich understanding of the task. An assessment based solely on an existing procedure will never be sufficient, as a procedure is not designed to capture all of the information that will be relevant to an assessment and, frequently, the task description it provides differs from actual practice. Therefore, Walk-Through Talk-Through (WTTT) and open discussion in workshops are important for deepening task understanding.

## What is the purpose of a Walk-Through Talk-Through?

The WTTT is used for a number of purposes:

- To establish a step-by-step description of how the task is carried out or verify the Task Analysis
- To establish what must happen and what should happen for successful task completion (may also require reference to technical drawings)
- To capture any variation from the documented procedure, and the reasons for it
- To collect information about PIFs which affect human performance in carrying out the task.

## How do you prepare for a Walk-Through Talk-Through?

Assessment Facilitators should prepare by reviewing relevant documentation. This is to scope the task, carry out an initial high-level breakdown of the structure, and identify sections of the task which have major hazard implications (to focus the analysis). Relevant documentation might include the documented procedure (where there is one), Piping and Instrumentation Diagrams (P&IDs), Process Flow Diagrams and risk assessments. The Assessment Facilitator uses this information to understand both what has to happen in the task for it to proceed (e.g. offloading hoses must be connected) and what is expected to happen, usually as expressed by the procedure (e.g. the system should be purged). This will help in the identification of important variations in practice (e.g. if the purge is omitted).

Assessment Facilitators should be aware that all the aforementioned documents may be inaccurate due to poor change management, or having been developed without end user involvement in the first place. Identifying such inaccuracies is one useful outcome of the assessment process.

To establish understanding, it can be helpful to talk through these documents with the SME, typically an experienced supervisor or operative, who will be demonstrating the task before starting the WTTT.

## When should a Walk-Through Talk-Through be carried out?

A WTTT before the detailed Task Analysis is useful for task familiarisation, develops shared task understanding in the workshop team, and can help focus subsequent discussion on important issues. It is also in line with the COMAH CA's recommendation. A WTTT post-Task Analysis can be used to confirm the detail and allows for focused review of those sections of the task with MAH consequences, in particular, consideration of PIFs that might influence MAH-related failures.

The timing of a WTTT will depend on a number of factors, including availability of access to the task area, the level of experience of the facilitator, whether pictures or videos of the task are available, and whether there is a need to clarify points raised in the analysis. In practice, this means that WTTTs are often iterative, taking place before, during and after an assessment, at the discretion of the Assessment Facilitator.

**Caution: It can be dangerous to carry out a WTTT on a live task (i.e. with the operator making changes to the plant status) because the assessment team is a significant distraction. Since the task has been selected because of the major accident potential of failure, this should be avoided.**

## What if you can't carry out a WTTT in situ?

On rare occasions, it has been found that it is unsafe to carry out a WTTT in situ, e.g. due to the hazards inherent in the task or the environment in which it is carried out. In this case, other means of understanding the task environment will be required. Photographs of control interfaces and key parts of the plant and equipment used in the task, videos illustrating particularly complex parts of the task, or 3D computer models may facilitate a virtual WTTT.

## Who should be involved?

WTTTs are typically led by the Assessment Facilitator and require a task demonstrator. This is typically someone who has experience of carrying out the task. Sometimes critical tasks are carried out infrequently and therefore it is not possible to identify an experienced person to demonstrate the task. In this case, it should be demonstrated by someone who could be asked to carry it out in future. In any case, the level of experience of the demonstrator should be noted. This is to help with reflections on competency requirements.

It can be helpful to have a second observer acting as a scribe to document the WTTT, as typically a large volume of information is captured in the process. More rarely, and particularly for infrequently carried out tasks, it can also be helpful to have other technical experts involved, e.g. engineering support from SMEs who understand the system being operated.

## What resources do you need?

To carry out a WTTT, you need:

- Any relevant documents including documented procedures and P&IDs
- A means of capturing the WTTT. This could be as simple as a notebook and pen but, if possible, videoing the WTTT can be very helpful. It can also be helpful to have a camera to photograph plant and equipment during the WTTT to aid analysis later.

## What does it involve?

Most WTTTs involve observation and talking through a task as if it is being performed, rather than observing it live due to the inherent hazards and the risk of distracting workers. The demonstrator acts out the task while discussing each step with the Assessment Facilitator. This might include donning PPE (to understand how it affects physically demanding tasks) and fetching task-specific equipment. Observing the demonstrator's movements between task locations provides useful information about how much to-ing and fro-ing there is and the distances involved. The Assessment Facilitator's role is to develop a deep understanding of what the demonstrator is doing and what affects their ability to do it.

## Where do you start?

A clearly defined start and end point for the task should be agreed (see GN5). Start by explaining the goal of the WTTT to the demonstrator. Make it clear that the purpose is not to make judgements about the individual, but to understand the task from the demonstrator's perspective. It's also helpful to make it clear that you don't understand the task and that they should not assume any knowledge on your part.

## How do you encourage open discussions?

Many stages of the assessment process require open discussion. Some participants can feel uncomfortable because they are being asked about where they don't follow documented procedures and where they and their colleagues have erred. If participants don't feel able to fully contribute, then important information for the assessment may be lost. Box 1 suggests how to establish an open and honest discussion.

Cognitive bias can affect the way workshop participants contribute information and Assessment Facilitators should watch out for some of the more common ones, including:

- Fundamental Attribution Error – this is a tendency to underestimate the contribution of external factors to someone's behaviour (such as poor design) and overestimate the contribution of the individual's behaviour. Pointing this out as part of the briefing prior to the assessment can help people think about what affects their own behaviours more broadly.
- Hindsight bias – this a tendency to find explanations for events by looking backward from the outcome. Once the outcome is known, it is much easier to distinguish both the information that pointed to the outcome and what decisions led to it. This can lead people to assume that the salient information was equally prominent before the incident, which is rarely the case. Advise participants to put themselves in the position of the person carrying out the task at the time – what choices were available to them?
- Recency effects – people more easily recall recent events, especially if they have led to misfortune. This can lead them to over-emphasise recent failures. Prompt people to think back over their whole work experience on the task.
- Over-estimation of own performance – people don't want to appear weak and don't always recognise their own failings. This is often expressed as "I would never do that". Point out that everyone is different. If they would never do that, is it possible someone else would? Be prepared to challenge the reality of what is said.

**Box 1: Encouraging open and honest discussion in workshops**

| | |
|---|---|
| **Selecting participants** | Some employees will feel inhibited from speaking up if their line manager is present. Try to avoid this situation if possible. |
| **Setting the stage** | Make sure all participants understand what you are trying to achieve and why.<br>Explain human factors, if participants are unfamiliar with the discipline, using examples of how failure has contributed to major accidents. Personal anecdotes of errors and mistakes can help establish rapport and invite trust.<br>Be clear about participants' roles in the conversation, e.g. "you are the expert on what it is like to carry out this task". |
| **Agreeing meeting guidelines** | Agree with participants what acceptable behaviours look like, e.g. welcoming all contributions, avoiding judgement. You might want to agree that discussions in the group are not discussed outside. |
| **Promote inclusion** | Make sure people who are quiet and reflective are given opportunity to share their thoughts and opinions. |
| **Support diversity of thought** | Welcome differing views, including the common "that would never happen here", and respond positively: "That's interesting, can you tell us why you think that?" or "That's good news, can we test it though, sometimes things change?" |
| **Reward risk-taking communications** | Thank people who dare to tell you where they have got things wrong and when they don't know or understand something; this is very valuable information. |
| **Don't get stuck** | If you can't agree on something, agree to explore it further outside of the workshop. |
| **Start and end on time** | Participants often have other work and may become impatient if you do not start and finish on time. |

Facilitators report that using Chemical Safety and Hazards Investigation Board (CSB) videos can be helpful in this respect, see https://www.csb.gov/

# GN5 Using Hierarchical Task Analysis to represent tasks

## What does GN5 cover?

GN5 covers the most commonly used method for capturing a graphical representation of task goals and steps, and its application to Human Failure Analysis and development of recommendations, namely Hierarchical Task Analysis (HTA).

## What Task Analysis method is recommended?

Before further analysis, the task should be described in sufficient detail. This means breaking the task down into discrete steps so that critical steps can be identified and analysed.

HTA is a widely used method for representing tasks. It can be recorded in graphical or tabular form (or both). It works particularly well for planned, sequential tasks which are common in the context of COMAH (e.g. start-ups, tanker off-loading). There are many other Task Analysis techniques. However, given the widespread use of HTA, its regulatory acceptance in the UK, and its accessibility to users, it is the recommended method for most occasions. This does not preclude the use of other Task Analysis methods, such as Time Line Analysis, where beneficial and carried out by a competent practitioner.

The graphical representation of HTA is recommended because it is an effective communication tool in that:

- It helps people understand the overall structure of the task and how different parts of the task relate to each other
- It presents all the different parts of the task to the participants at the same time, so that there is less need to rely on memory of what came before or after a task step
- It supports a common understanding of how a task is performed in practice
- It helps to identify gaps and errors in supporting documentation.

For the purposes of subsequent human failure and PIF analysis, the graphical representation of the HTA is typically converted into a tabular format. The methodology for carrying out HTA is described in detail elsewhere (see for example EI, 2022). This guidance note considers practical aspects of carrying out HTA.

## Which tasks are amenable to Hierarchical Task Analysis?

HTA is most effective for tasks that have a defined start and end point, and which consist of a series of discrete steps. It is usually applied to operational, maintenance and emergency response tasks and is not usually applied to management activities. Examples of applicable tasks include:

- Isolation of plant for maintenance and reinstating after maintenance
- Lining up a material transfer
- Off-loading material from a tanker
- Proof testing a Safety Instrumented System (SIS)
- Respond to a loss of hazardous material in a specific plant or area.

## Which tasks require a different approach?

In some cases, it can be beneficial to analyse tasks using methods other than HTA. This includes tasks which involve a significant degree of decision-making or are continuous in nature.

| Task type | Guidance on different approaches |
|---|---|
| Responding to alarms | HTA is most useful where the response to an alarm is singular and requires step-by-step operations to resolve the situation, such as responding to a high-level alarm when filling a storage tank. Where the response involves diagnosing problems within complex, tightly coupled systems such as central control rooms of a refinery, the use of decision trees or flowcharts to capture the decision-making may be more useful. In addition, alarm systems should be evaluated and managed against RGP guidance i.e. EEMUA 191. |
| Monitoring plant from a control room | Reliability in monitoring can best be analysed by evaluating the usability of the control system, human machine interfaces and workload in the control room. |
| Permit to work (PTW) | While it is possible to carry out HTA for specific tasks (e.g. issue a permit), a system review would better support improvements to the PTW system as a whole. |
| Supervision of employees or contractors | For general line management and oversight activities, improvements to supervision are more likely to be achieved through line management training, supported by structured coaching and mentoring, and ensuring sufficient time for the supervisory function. Where supervisory checks are part of a task procedure, such as verifying isolation of a system or verifying integrity of plant prior to return to service, these tasks should be included in the HTA of the task. |
| Multi team tasks, such as multiple teams enacting emergency response | Team task analysis and task network diagrams can be used to provide a description of tasks involving multiple people and/or multiple teams. |

Engineering Equipment and Material Users' Association (2013) Alarm Systems: A guide to design, management and procurement (3rd Edition).

## Who should be involved?

The aim of developing the HTA is to develop a representation of the task for further assessment. It is important to understand both how it is done and how it should be done. Participants should include:

- The Assessment Facilitator who is competent in HTA
- SMEs who have experience of carrying out the task. When possible include people from more than one team or shift (if applicable). If that is not possible, be sure to validate your findings with members of other shifts. It can also be helpful to include people who are relatively new to the task. If the task is carried out infrequently, then people who are experienced in operating the plant and equipment, and who would normally be expected to carry out the task, should be involved
- SMEs, who understand the hazards associated with the task, can verify the validity of the system of work and can advise on whether there are ways to make the task safer for those carrying it out and less likely to lead to a major accident.

A key task of the Assessment Facilitator is to get participants to open up about their experience of how they and others carry out the task. Sometimes it can be helpful to have supervisors and technical experts in the room at the same time as operators; sometimes it can hinder participants' willingness to discuss variations in how the task is carried out in reality. If in doubt, try to ensure that those involved at any one time have parity in the organisation. Elements of the task description can be checked by supervisors/managers and technical experts later if necessary.

## What tools are required?

Creating a HTA can be an iterative process. This means that it frequently changes during the process. For this reason, practitioners find starting out by recording the process in a changeable format (e.g. Post-it notes, paper and pencil, whiteboard, drawing tools, or specialist software) is beneficial. However, proficiency in the chosen method is important to avoid disrupting the flow of the analysis. Once completed, the HTA can be captured in tabular format, though it is good practice to keep a copy of the graphical format e.g. by photographing it.

## Where do you start?

The Assessment Facilitator should remind participants about the reason for carrying out the assessment. A task will have been selected for assessment because it has the potential to contribute to one or more major accident scenarios. These scenarios should be described at the beginning of the workshop. Assessment Facilitators may need to remind participants of this on occasion during the process.

A procedure does not equal a task. A single procedure may consist of multiple tasks and may not reflect how the task is carried out in practice. Using an existing procedure as the sole source of information for a HTA should be avoided, although it can be a useful starting point. The collaborative development of a HTA, with the input of people with practical experience of doing the task, is essential.

Assessment Facilitators should agree the scope of the assessment with participants to ensure the focus is on MAHs and a discrete task. The Task Analysis should have a clearly defined start and end point which requires:

- Clearly defined preconditions
- A clearly defined task goal.

For example, the task goal may be “transfer acid from road tanker to storage vessel”. For complex sites which have multiple bays where such transfers can take place, it will be important to understand how the tanker gets to the right location. For simple sites, this may not be important. In both cases, ordering the right material may be important, but is clearly a distinct task carried out by a different organisational team. Identifying the correct start point requires a skilled Assessment Facilitator working with people who understand the task and MAH scenarios fully.

## Where do you stop?

A typical HTA is made up of sub-tasks that are each broken down in a number of hierarchical levels. The number of sub-tasks and levels varies according to the complexity of the process. However, if the HTA becomes very large it will become difficult to manage and interpret. It might indicate that the overall task should be broken down into smaller tasks for analysis.

Assessment Facilitators should continue to break down tasks and sub-tasks when:

- The sub-task consists of more than one operational step, and
- Failure on the tasks and sub-tasks could result in one of the identified MAH scenarios, or
- There is any doubt about the consequences of human failure in the task or sub-task.

Otherwise, there is no need to continue for the purpose of this assessment.

There are benefits to breaking down the full task to its constituent sub-operations for quality assurance, production benefits and efficiency. The Human Factors Lead should be explicit about the purpose of the HTA so that Assessment Facilitators can determine when to stop. If the HTA is also intended to underpin procedure, design improvements and/or training development as well as further analysis, then more detail may be beneficial.

## What if participants disagree?

It is normal for participants to carry out a task in different ways. Part of the overall process of assessment is to capture these variations and understand why they occur. The first step is to agree how the task should be done, with specialist advice if required. The HTA should then describe the agreed way of carrying out the task and the reasons for any differences should be documented in the assessment. Don't forget to feed back to the participants and the workforce when the preferred way has been determined.

## How do you draw up a HTA where there are no written instructions*?

Performing HTA does not rely on having an existing written instruction. If the task is already being carried out, the HTA should be developed with the input of the people who carry it out. One of the benefits of carrying out HTA is to verify written instructions and to update and restructure them. If there is no written instruction, the HTA can provide an excellent basis for one to be developed.

## How do you draw up a HTA when the task does not exist yet?

HTA assists greatly with identifying design requirements to support human reliability. It should be started as early in the process as possible, typically at Front End Engineering Design (FEED) phase once design information and concept of operations is available. It can be particularly beneficial to involve experienced operations and maintenance technicians in HTA at this stage.

HTA at the design stage can be achieved by a desktop walkthrough of a process with the process engineers, eliciting from them the operational and maintenance tasks. This can be aided by use of process flow charts, equipment and room diagrams, and P&IDs. It can also be useful to engage with operators and maintainers of similar systems to talk through how comparable tasks have been performed previously.

The HTA should be limited according to the information available, which at FEED may be the first order of sub-tasks. As the design continues, the HTA can be reviewed, expanded and made more detailed as more information is available.

The HTA can also be a helpful tool in understanding the implications of plant and process modifications as part of the management of change processes.

*There are many different names for written instructions, including: standard operating procedures, manuals, batch methods, method statements, recipes, task sheets, job aids, etc.

# GN6 Identifying the potential for human failure

## What does GN6 cover?

This note focuses on identifying potential human failures in task performance. Although this guidance sets out Task Analysis and failure analysis as separate parts of the process, practitioners often find participants provide useful intelligence on potential failures during the Task Analysis process. It is good practice to note these comments for reference when developing a Human Failure Analysis.

## Preparation

The HTA provides a detailed description of the task being examined. Participants in the analysis who are unfamiliar with the task should have the opportunity to WTTT the task prior to the analysis. Photographs of control interfaces and key parts of the plant and equipment used in the task can also be helpful, as can videos illustrating particularly complex parts of the task.

The HTA should now be recorded in tabular format (if it has not already been done so), typically using a spreadsheet, to facilitate recording the subsequent failure analysis.

## Minimum recording requirements

The information recorded on the spreadsheet should include sections detailing:

- Task step
- Failure mode and description – what is the potential failure?
- Consequences of the failure
- Performance influencing factors
- Existing control measures
- Recommendations for improvement.

## Other relevant information

Assessment Facilitators may also wish to record additional information to assist in the analysis. The recording of task characteristics may support assessment of failure likelihood and vulnerability to human failure, as well as help identify relevant PIFs. Consequence, likelihood and pre-post risk ratings may be useful if there is a need to determine:

- If risk has been reduced ALARP
- The priority of risk reduction measures for implementation
- If the risk assessment should be updated (see GN9).

**Table 9: Other relevant information**

| | |
|---|---|
| **Task characteristics** | How often is this task performed? How simple or complex is the task?<br>Is the task performed under time pressure?<br>What feedback on performance is provided by the system?<br>Are there any checks on performance and how independent are these?<br>Is the task a highly manual activity or one involving judgements and decision-making? What support is available to assist in making judgements and decisions?<br>What time of day or night does it take place? Is it carried out inside or outside?<br>Is PPE required to carry out the task safely, and will this impede the operator?<br>Is the task performed by an individual or a team? Are communications between team members required?<br>This information will suggest a number of failure modes and PIFs for consideration. |
| **Human failure mechanism** | The UK regulator recommends recording the human failure mechanism(s) that underlie the failure mode, and may expect to see these recorded in the table – see 'How do you record potential failures' section on page 29. |
| **Consequence rating** | Rating the consequence of failure on this step, typically against the organisation's pre-determined risk matrix. |
| **Likelihood rating** | Qualitative rating of the likelihood of failure based on consideration of existing control measures and the influence of PIFs. |
| **Qualitative risk rating** | Consequence and likelihood (consequence x likelihood) to indicate which are the highest risk steps and therefore those that should be targeted first. |
| **Pre- and post-risk ratings** | The consequence, likelihood and qualitative risk rating may be considered before implementing additional control measures and after to show the effect of improvements. |

## Scope of assessment

Assessment Facilitators should familiarise themselves with the reasons why the task has been selected for assessment, i.e. the major accident scenario(s) that potential failures on the task could contribute to. The Assessment Facilitator should also be clear on what the company is seeking to achieve through the assessment. The legal requirement is to understand how the duty-holder relies on people as part of its "necessary measures" and whether it has assured human performance in these areas, and it is recommended that Assessment Facilitators focus on major hazards. However, the assessment can also be used to address personal risk, production reliability, quality and efficiency. This will directly impact how much of the task is subjected to detailed failure analysis.

## Who should be involved?

Human Failure Analysis and PIF identification is best carried out in a workshop, led by an experienced and skilled Assessment Facilitator. As with Task Analysis, SMEs are essential. This means:

- Practical experts: People with experience of carrying out the task. Where a shift system is in place, having representatives from more than one shift team can assist in capturing variability in the ways tasks can be carried out, and wider experience of problems that can occur. It can also be helpful to include people who are relatively new to the task or have experience from other sites
- Technical experts: People who understand the technical requirements of the system
- People who can advise on the major hazard consequences and engineered control measures
- It can be helpful to have a scribe in addition to the facilitator to record the assessment. This provides a good learning opportunity for people training to carry out assessments in future.

## Where do you start?

Failure analysis requires participants to be open about their task experiences, including failures and workarounds they have seen. The Assessment Facilitator can help to support this by:

- Explaining the purpose of the analysis, and the benefits that can be gained
- Explaining the process
- Gaining agreement from the group that contributions and confidences will be respected
- Sharing the recording of the analysis directly so that people can see what is being written down
- Actively managing the discussion to make sure that everyone is heard.

Having established ground rules for the running of the workshop, ensure the team fully understand the reason why the task has been selected for assessment. Refer to the relevant major accident scenarios in doing so.

## Which task steps do you analyse?

The failure analysis should focus on the parts of the task that are associated with the risk. For COMAH establishments, these will include the steps which could contribute to the identified major accident scenario. Analyse sub-tasks and individual task steps that:

- Have potential major accident consequences regardless of whether there are existing passive or active engineered safeguards in place (including the loss of a layer of protection, or latent errors that could cascade later in the task); and
- Could feasibly occur in the judgement of an experienced human factors practitioner
- The second stipulation requires considerable care. Many people believe that they could not or would not perform a particular failure e.g. perform maintenance on the wrong piece of plant or equipment Experience teaches us such failures do regularly occur. If such a challenge is made, it can be helpful to:
- Give examples of near-misses and major accidents in which the failure under consideration occurred
- Ask if it is possible if someone else might make that error, even if they would not
- Ask them to explain why they think it wouldn't be possible.

## How do you identify potential failures?

Human failure guide words have been published elsewhere, e.g. the Energy Institute's (2020) *Guidance on Human Factors Safety Critical Task Analysis*, and are not repeated here.
First, determine the nature of the task step being carried out.

- **Actions** involve a physical operation, e.g. opening a valve, pressing a stop button
- **Checks** involve assessing the status of the situation, e.g. is the plant pressure within safe operating limits?
- **Information retrieva**l involves looking at or reading something for a specific piece of information, e.g. reading a level gauge
- **Communication** involves communicating with others, either to obtain information or to communicate a critical piece of information
- **Selections/Decisions** involve choosing from two or more different things, e.g. the correct parking bay for off-loading acid
- **Planning** involves ensuring that the right preconditions are in place, and that the task is carried out in the correct order
- **Diagnosis/Decision-making** involves applying knowledge of how the plant, process or system works to information retrieved from the system to determine what to do next.

Then, apply the relevant human failure identification guide words for that type of activity – action failures for actions, checking failures for checks, and so on. Planning failure guide words can be applied to the plans identified in the HTA or to the whole task. Record only credible failures that could lead to a major accident (ignoring any existing control measures), e.g. if the operator fails to press a button and nothing happens as a result, there is no need to record it.

The expectation is that analyses, carried out as part of a suitable and sufficient risk assessment in process industries, are rigorous. Therefore, it is recommended that Assessment Facilitators make sure that participants have ready access to human failure guide words during the analysis. However, it can be more effective to ask “what can go wrong?” than to laboriously rehearse the list for each task step. Assessment Facilitators can assist participants by identifying the most helpful guide words for the task step under consideration based on the type of activity.

The published guide word lists typically include violations. It is recommended that this is not used as a prompt word during the analysis since it is a potential reason for a failure rather than the failure itself. In some cases it is possible for almost every guide word to apply. Remember that the list of guide words is only a tool to assist in the identification of potential human failures. Concentrate on identifying the human failure scenarios which are significantly different from each other. It can be helpful to separate these out on to individual table rows to be sure that control measures are appropriate for each scenario. Pay attention to any adjectives in procedural instructions, e.g. “open valve slowly” indicates that speed is important and that therefore “operation too fast or too slow” may be a relevant guide word. For communications, simply capturing that communication could fail in some way is the most important thing.

## How do you record potential failures?

A good failure description helps with identification of appropriate control measures. Where possible, and in keeping with the task step under consideration, be clear as to who does what to what (actor-action-object). Some examples include: Driver parks acid tanker at caustic tank; Operator opens valve V14528 too quickly; Operator retrieves wrong value from pressure gauge. Ensure that the error description only states the behaviour associated with the step and does not include reasons for the error at this point.

When thinking about improvements, the Assessment Facilitator should consider possible reasons for identified failure modes. One framework for doing this is the human failure taxonomy set out in HSG48 Reducing Error and Influencing Behaviour (p.12, HSE, 1999). This taxonomy does not include all failure mechanisms such as those arising from perceptual error and motor control, but does cover slips, lapses, mistakes and violations. HSE has recommended recording these failure mechanisms as part of the analysis because it can help the Assessment Facilitator to avoid common pitfalls, such as recommending procedural improvements to address slips and lapses which are unconscious failures. Procedures and training can help prevent mistakes, in addition to good design, but are ineffective for unconscious failures, for which redesign is the most effective solution.

Practitioners report variable success with addressing human failure mechanisms in a workshop context. Some report that it can be very helpful to participants, particularly when it comes to thinking about additional risk reduction measures; however, others report that this can add unnecessary complexity to workshops, where the differences between failure modes and mechanisms needs to be explained to participants. The receptiveness of participants to human factors and the amount of time the Assessment Facilitator has to work with them will be factors in deciding whether to explicitly address this in the workshop. In any case, the Assessment Facilitator should ensure that any proposed improvements address the failure mechanism.

In some cases, multiple mechanisms can be credible for a given failure mode. For example, a valve may be left open because the operator forgot (lapse), didn’t know (mistake), or didn’t think it important (violation). In such cases, any proposed improvements should address all the different failure mechanisms:

- Using a single safeguard, e.g. by interlocking the valve so that the next stage in the process cannot be carried out until the valve is closed (and so the failure whether slip, lapse, mistake or violation is recovered), or
- Using multiple safeguards, e.g. positioning the display in the direct field of view of the operator (to prevent misreading), changing the display units so they are the same as those used on the rest of the plant (to prevent mistakes), and requiring the operator to record the value on the work instruction (to reduce the likelihood they forget to check the reading).

Priority should be given to engineered safeguards over administrative safeguards.

# GN7 Identifying Performance Influencing Factors

## What does GN7 cover?

Performance Influencing Factors (PIFs) are the factors that influence human performance in carrying out a task. They are also sometimes referred to as Performance Shaping Factors or Error Producing Conditions. Understanding how PIFs affect a specific critical task is an essential part of identifying improvements.

## How do you identify relevant Performance Influencing Factors?

The identification of relevant PIFs requires human factors knowledge and experience. Human performance has been shown to change for better or worse:

- At certain temperatures
- In particular lighting scenarios
- With respect to the reliability of instrumentation and the positioning of displays among other displays
- When working as part of a group or a team
- In the presence of supervision
- When the procedure is one page or 200 pages
- At 2pm or 3am.

A PIF list can support the Assessment Facilitator by acting as a prompt to ensure that relevant PIFs have been identified. Various lists are available. However, as with any list, caution needs to be taken in how they are used. A common pitfall is to list PIFs that could be an issue without relating them to the task step, failure or specific task context. Statements such as “Distractions may be an issue” could be true of any task or task step but do not add much value. The analysis should explain why distractions are an issue for this task or task step. For example: Task requires focus over several minutes, but takes place in a busy thoroughfare, with significant potential for distraction. Finally, no list is fully comprehensive, and the analysis team led by the Assessment Facilitator should be alert to other issues that are not described in their list.

Human factors practitioners identify PIFs by understanding what is necessary to complete a task and so makes it vulnerable to failure, taking account of the task type. Examples include:

- Tasks that involve judgements and decision-making will be influenced by the extent and quality of available information, the number of different options, the person’s knowledge and the time available to think.
- Tasks that involve psychomotor skills, such as manually tightening a connection, will be influenced by the design of the connection, the ability to determine if the connection is tight, and the person’s experience in this task.
- Tasks that involve reading a gauge will be influenced by the legibility of the gauge, meaningfulness and legibility of labelling, knowing which gauge to read, consistent use of units, ability to interpret the reading as well as potential for task interruption and anything that impairs vision such as wearing protective goggles, reflections and glare.
- Verbal communication tasks may be influenced by the level of ambient noise, the reliability and quality of communications equipment, whether a verbal protocol is used to avoid “sounds like” errors as well as verify communication by “call and response”, and generic factors such as task interruptions and competence in what needs to be said.

These examples illustrate how PIFs can be identified by considering the demands of a task, the task environment and the people performing the tasks as well as the nature and potential causes of identified human failures. The key to identifying relevant PIFs is a real-world understanding of what the task involves, the types of competencies required, the system which the person is interacting with, and the environment in which it is carried out. Information drawn from WTTT and practical experience of carrying out the task are essential (see GN4).

Some PIFs will affect the performance of a single step, or a sub-task; others will affect the performance of the whole task and these should be treated differently, as discussed below.

## How do you capture PIFs that affect a sub-task or task step?

PIFs which affect a sub-task or task step should be relevant to the identified failure mode(s). If the failure mode is 'Right Action, Wrong Object', then the identification of the equipment becomes more important than if the failure is 'Action Omitted'. Miscommunication may be related to environmental noise or the lack of a communication protocol.

## How do you capture PIFs which affect the whole task?

Some PIFs will apply at every task step. Examples include:

- The quality of the procedure
- The competence of the person carrying out the task
- The environment in which the task is conducted if it is conducted in one place
- Fatigue
- Staff morale.

It is recommended that such PIFs are captured and analysed separately to avoid unnecessary repetition. Participants in the assessment can be asked, for example, to what extent they are involved in developing and reviewing procedures, or how familiar they are with the task.

Practitioners suggest either capturing whole-task PIFs in a separate, covering report or in the first lines of the analysis table, rather than recording them against every single task step which clutters the table. This does not preclude recording where a task step is more heavily affected by that PIF. For example, if the operative has to carry out a calculation without support, it would be useful to flag that the competence standard for the task needs to cover this specific skill. Or if the operative has to monitor a system for a period of time, use the analysis to consider appropriate timing of the task (so as to avoid times of day when alertness is known to be low).

## What information should be recorded in the analysis table?

It is good practice to record sufficient information about the PIF to support identifying any additional improvements which may be required. For example, compare the two lists of PIFs in Table 10. In both cases, the PIFs which might affect calculation of ullage on a tank farm are recorded:

**Table 10: Comparison of two ways of recording PIFs. List One provides limited information, List Two provides more detailed information**

| List One | List Two |
|---|---|
| Procedures | No instructions on how to calculate ullage in the procedure. |
| Competence | Ullage calculation is not covered in training. |
| Display units | Level indicator is in different units from tanker delivery note. |
| Position of indicator | Level indicator is positioned so that it is easy to read. |
| Weather | Level indicator is obscured when raining (water on panel and on face visor). |
| Time of day | Task only occurs between 8 and 9am when operator is at less risk of fatigue. |

Clearly List Two conveys more salient information than List One, which will significantly assist the Assessment Facilitator in explaining why corrective action is (or is not) needed. It will also assist the team when the analysis comes up for review in a number of years' time.

## Do you record PIFs that affect task performance positively?

Most PIF issues recorded in an analysis are problems that increase the likelihood of a failure. For example, a valve without a label may increase the likelihood of a 'right action on wrong object' failure. However, there are occasions when recording positive PIFs can be useful.

One reason for doing this is to enable the Assessment Facilitator to demonstrate that relevant PIFs have been considered. For example, if an operator has to close a valve in response to a change in pressure, then noting that there is a local gauge, easily visible from the valve, helps to demonstrate that the analysis has covered relevant factors. Some Assessment Facilitators prefer to record these as existing control measures rather than positive PIFs, which is equally acceptable.

A second reason is that there may be beneficial PIFs that are not currently formally recognised or managed by the organisation. For example, if there is an important failure of delivering a pallet of chemicals to the incorrect charge point, but the operator in question only ever delivers to the correct location, then the likelihood of this failure will be lower than if they deliver chemicals all over the site. Identifying this factor enables the organisation to monitor this arrangement and address the situation if there are any changes.

Thirdly, it can assist the company in making and recording ALARP demonstrations by demonstrating that they meet RGP in human factors, and in supporting judgements of the likelihood of human failure when assessing the establishment's risk.

# GN8 Identifying improvements

## What does GN8 cover?

This note covers identifying additional risk reduction measures based on the findings of the analysis. It gives advice on how to apply the hierarchy of control (see Figure 5) and make judgements about whether additional measures are needed. The first step in making such judgements is to establish what existing safeguards are in place in order to determine what further measures may be required.

## When do you consider existing safeguards?

Good practice requires that the Human Failure Analysis should first identify consequences assuming that there are no existing safeguards. Existing safeguards should therefore only be considered after the human failures with potential to contribute to a major accident have been identified.

## What existing safeguards should be recorded?

The existing safeguards that should be considered include:

- Preventative measures to reduce or eliminate the hazards
- Control measures which keep the system within its normal/safe operating limits
- Mitigation measures which prevent the consequence being fully realised.
- The following existing safeguards should be recorded for each critical task step:
- Controls to prevent the identified failures for that task step
- Controls to help recover an identified failure
- Controls that prevent the consequence of an identified failure.

Both passive and active engineered safeguards should be considered. Any equipment that is identified as a safeguard in the assessment should be included in safety critical equipment registers for maintenance management purposes, and it is useful to check that maintenance tasks for the item have been identified in the Critical Task Register. If there is evidence of poor maintenance or functioning of an engineered safeguard, record this and make recommendations to investigate and improve the system.

Procedures and competence should not be listed as safeguards against a task step unless there is a specific competence standard for that task step (e.g. CompEx certification) and there is evidence that the company employ people with this competence for this task.

## How do you identify improvements?

There are a number of general principles that should be considered when recommending additional risk reduction measures:

### No single point human failures

There should be no tasks, sub-tasks or task steps where a human failure could result in a MAH scenario without engineered preventative or mitigation safeguards. This is the equivalent of a “single point failure” in engineering terms. This might be considered “a serious deficiency” by the regulator (which could lead to the process being prohibited). If this is found during the analysis, then improvements should be recommended in line with the hierarchy of control. In the first instance, this would mean consideration of whether the task can be redesigned to eliminate these task step(s), and only if this is not possible should engineered safeguards be considered. Administrative safeguards alone will not be sufficient.

Finding a reasonably practicable engineered safeguard may be outside the competencies of the workshop, so a recommendation for further investigation would be appropriate. Any recommendation made should be flagged as high priority.

## Apply the Hierarchy of Control

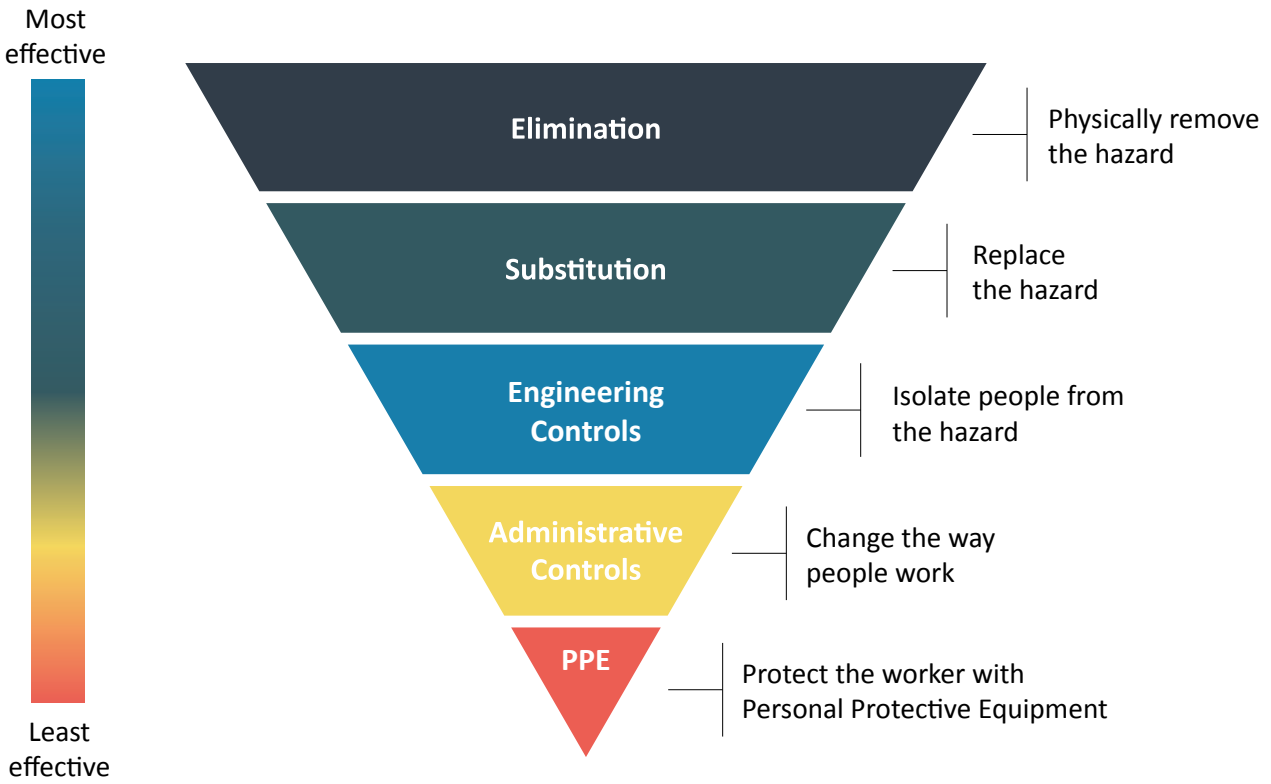



**Figure 2: Typical Hierarchy of Control (image courtesy of NIOSH)**

For each critical task step, determine where the existing safeguards are on the Hierarchy of Control (Figure 2). Typically, if they are at the bottom end of the hierarchy, further risk reduction measures will be required, and consideration should be given to ways in which the task can be redesigned to eliminate the potential failure or engineering safeguards can be used to help prevent or recover the failure. Assessments which recommend improvements to procedures and competence arrangements alone will have to demonstrate that appropriate engineered safeguards are in place, and that the overall risk assessment for the major accident scenario is in the broadly acceptable region.

There is a legal requirement to reduce risk to ALARP. The HSE categorises risk as “Intolerable”, “Tolerable if ALARP” risk or “Broadly Acceptable” (SPC47). The key implications include:

- Action must be taken for Intolerable risks
- Reasonably practicable risk reduction should be taken for Tolerable risk
- If the risk is in the Broadly Acceptable Region, then ALARP is achieved by meeting RGP.

The inclusion of human factors into risk assessments and ALARP assessments supports a number of decisions, including:

- What is the risk category after assuming the implementation of improvements?
- Do human factors improvements fulfil the requirement to show risk has been reduced to ALARP, or are further engineering changes required?

The site should have assessed the risk associated with the task. The application of the site’s risk assessment helps judge if further risk reduction is required or not, whether human factors improvements alone are an acceptable option, and whether the recommended human factors and engineering improvements achieve ALARP.

As summarised in Table 11, it is likely that:

- If the risk is in the Intolerable region or upper end of Tolerable, then solutions from the top end of the hierarchy of control should be considered first. An asserted reduction in human failure likelihood, such as by improved procedures and training, would not normally be accepted as a solution for Intolerable risks.
- If the residual risk was in the "Tolerable if ALARP" region, then human factors improvements such as improved interface design, competence and procedures may either reduce the risk to the lower end of "Tolerable if ALARP" region, or to the Broadly Acceptable region, depending on the judged reduction in failure likelihood. If engineered improvements are not reasonably practicable then this may be judged to reduce risk to ALARP.
- If the risk is in the Broadly Acceptable region, where meeting RGP is sufficient, then human factors solutions alone (the bottom of the hierarchy of control) may be sufficient. The human factors assessment needs to demonstrate that the human factors of the task either already meet RGP or will do so after implementation of improvements.

**Table 11: Meaning of risk categories for human factors and engineered improvements**

| | |
|---|---|
| **Intolerable risk** | If there is reliance on human actions to control risks because there are no engineered controls or engineered controls do not satisfy expected good practices then ALARP cannot be demonstrated and action must be taken to reduce the risk almost irrespective of cost. |
| **Tolerable if ALARP risk** | If risk controls satisfy expected good practices but options remain that may reduce likelihood or consequences of human failure then a case specific ALARP demonstration is required. The extent of the demonstration should be proportionate to the level of risk. |
| **Broadly Acceptable risk** | If all applicable codes, standards and established good practices have been achieved, are up-to-date and relevant to the task in question, then the ALARP demonstration may be simplified. This would require a very high quality human factors assessment to ensure all potential failures have been considered and all PIFs are optimised and sustainable. |

## Don't take too much credit for human performance

Systems that lack any engineered safeguards against potential major accidents may be assumed to be in the Intolerable risk region. Be wary of using human factors assessment to justify a lack of engineered safeguards.

## Consider the underpinning failure mechanism

If the underpinning failure mechanism has been identified as an unconscious error, such as a slip or lapse, perceptual error or psychomotor control error, then administrative safeguards such as training and procedures are unlikely to be sufficient to prevent the error. In these cases, if there are no engineered safeguards in place to prevent or recover the error, then a recommendation to investigate possible engineering safeguards should be made.

## Meet relevant human factors good practice as a minimum

Irrespective of the risk level, human factors RGP should be met for all critical tasks.

## How do you evaluate Performance Influencing Factors (PIFs)?

GN7 advises that human factors practitioners identify PIFs by understanding what is necessary to complete a task and so makes it vulnerable to failure, taking account of task types.

To demonstrate ALARP, the assessment should compare the PIFs to RGP, identify any gaps and recommend improvements as appropriate. In practice, this is often much simpler than it sounds, with improvements being obvious without further research. For example, if a critical item of plant is not labelled, it should be labelled. However, for more complex issues, the human factors expertise of the Assessment Facilitator will be essential to identifying RGP and interpreting how it should be applied in the specific circumstances of the task under consideration.

## How do you optimise Performance Influencing Factors?

Any PIFs identified during the assessment should be optimised for human performance. The term 'optimise' is used as shorthand for an array of different tactics to either reduce the negative effect of a PIF or turn it into a positive influence:

- There are some PIFs that cannot be controlled. For example, weather conditions affect performance on outside tasks. In these cases, consideration should be given to redesigning the task to remove the influence of the PIF on critical task steps. In the case of weather, this might include moving the task indoors or providing local shelter.
- There are some PIFs that either only act negatively or only act positively. Optimisation of these depends on whether they are discrete (they are either there or not), or act on a continuum, the latter often being more complex to address.
- Discrete PIFs with a negative effect should be removed. For example, if equipment is operated against the design stereotype such as opening a wheel-operated valve by turning it clockwise, it should be replaced with one that operates as normal. If you can't remove the PIF immediately then you should seek to mitigate the PIF as a short-term remedy.
- Discrete PIFs with a positive effect which are absent should be implemented e.g. if a parameter essential to critical decision-making is missing, it should be displayed.
- PIFs which act negatively on a continuum should be managed in line with RGP to minimise their effect. Fatigue, for example, always has a negative effect but the degree of effect depends on many other factors including individual susceptibility and time of day. An effective management system is therefore required.
- PIFs which act positively on a continuum should be managed in line with RGP to maximise their effect. Competency is an example of a PIF that acts positively on a continuum, but once again the degree of effect depends on many others factors and an effective management system is required.
- The final group of PIFs follow the stress curve: too little or too much are negative and a means of establishing how much is needed for best performance is required. Examples include workload and temperature. Typically, these PIFs will require additional investigation to determine appropriate improvements and the assessment should record and recommend that such an investigation is carried out.

## How do you find relevant good practice?

There are published human factors guidance documents and standards from authoritative organisations such as the HSE, Energy Institute, ISO and EEMUA, among others. While these are not comprehensive nor specific to every task, they can be drawn on to inform judgements. **Relevant references are given at the end of this document.**

In the case of critical tasks, minimum expectations include (but are not limited to) having a fit for purpose procedure, competent and experienced people, an adequate minimum staffing level, ergonomically designed equipment, effective control of work arrangements and supervisory support.

## How do you make recommendations?

It is important to understand how recommendations from the assessment will be used by the organisation. Recommendations are often reviewed or approved at a more senior level outside of the workshop to determine if the recommendation will be actioned. Recommendations should be reviewed with reference to the original assessment document to ensure the context is considered. It can be helpful to include the Assessment Facilitator when reviewing recommendations to make sure that a) the recommendation is fully understood and b) the relative importance of the recommendation is understood. Frequently, individual recommendations are entered in an action tracking system and allocated to someone who may have had little or no involvement in the assessment process. Take account of this when phrasing the recommendation.

Collate the recommendations at the end of the analysis and conduct a check that there is no replication and that they 'make sense' at face value. This is especially useful for large tasks when the analysis has been spread over multiple sessions.

Prioritise recommendations with the worst consequences and fewest existing safeguards. Report recommendations which are not related to MAHs separately, to make it clear which recommendations are the priority.

## Writing recommendations

Tips for writing helpful recommendations include:

- Address the required outcome e.g., “Ensure that the position of manual valve can be clearly identified”.
- Ensure the recommendation can be read in isolation and still makes sense e.g., document references should be included for procedure updates, or include specific equipment tag numbers.
- Reflect the consensus of the assessment team.
- Consider how quickly improvements can be addressed, and whether short term mitigation measures may be required in addition to longer term engineering improvements.
- Address all gaps. If you identify a hazard or risk not previously known, a recommendation should be made to address it.
- Address PIFs that affect the whole task.
- Deal with complex issues such as organisational PIFs by recommending further studies.
- Ensure all recommendations are numbered so they can be cross-referenced, and identify the steps in the task or PIF against which they are being made.

# GN9 Integrating Human Factors Assessment into Safety Management Systems

## What does GN9 cover?

This note summarises how to integrate human factors assessments into the establishment's overall risk assessment.

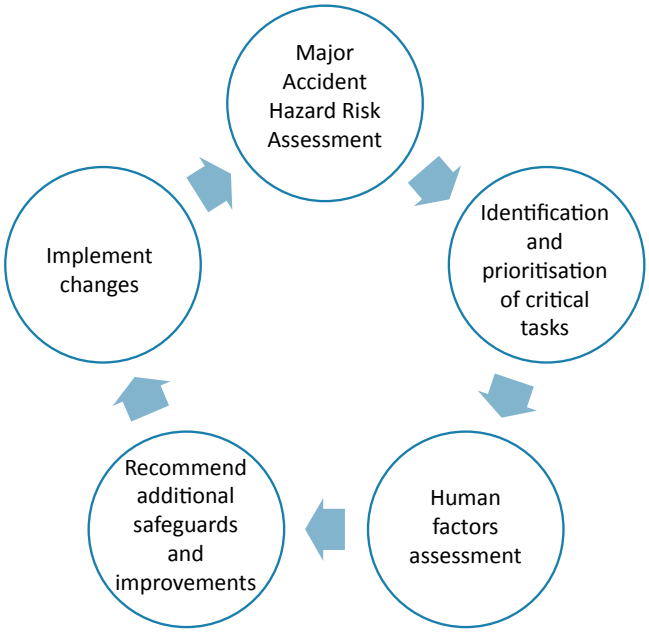



**Figure 7: How Human factors assessments integrate into Major Accident Hazard Risk Assessment**

## Where does human factors assessment of critical tasks fit?

Figure 7 shows the relationship between the establishment's Major Accident Hazard Risk Assessment (MAHRA) and human factors assessment of critical tasks. In reality, this is a more complex and iterative process than the diagram illustrates.

- The human factors assessment makes recommendations for additional engineered safeguards
- These are assessed in light of the overall MAHRA and either accepted or rejected
- If accepted and put forward for action, they should be risk assessed to ensure additional process (or other) hazards are not introduced as a result of the changes
- If not accepted, then the MAHRA should be amended to show that reliance on human performance cannot be considered an effective safeguard.

In addition, a human factors assessment team may occasionally identify major accident scenarios that have not been previously identified by the MAHRA process. Equally, detailed consideration of the task may reveal that it is not critical to the prevention, control or mitigation of major accidents. In both cases, the MAHRA should be amended to reflect these findings.

## What if no additional engineered safeguards are recommended?

The human factors assessment itself forms an important part of the establishment's ALARP demonstration. It shows:

- That the COMAH Operator knows when it is relying on human performance as part of its prevention, control and mitigation measures
- That when it relies on human performance, human reliability has been optimised by addressing potential human failures and PIFs in a systematic and thorough way
- Whether the safeguards work as assumed in the risk assessment.

As noted in GN8, if the risk is in the intolerable range, then optimisation of PIFs will provide insufficient risk reduction in the absence of engineered improvements.

## What if critical tasks have not been identified from a MAHRA?

On occasion, an establishment's MAHRAs will become outdated or inaccurate, or cannot be relied upon for reliable risk tolerability information. It is important to recognise that a human factors assessment of a critical task cannot replace a competent MAHRA. However, a human factors assessment can provide important information in two areas:

- By establishing if there are any critical tasks, sub-tasks or task steps for which there is no engineered safeguard and risk is likely to be intolerable. This is an indicator that a MAHRA should be prioritised for the relevant scenario
- By providing qualitative information on the likelihood of human failure as an initiating event, i.e. by providing evidence of the human failures that could occur, the number of existing engineered safeguards, and the effect of identified PIFs.

## Can you use qualitative assessment of critical tasks to indicate likelihood?

Many sites use qualitative risk matrices in their MAHRAs. Human factors assessment of critical tasks can be used to give a qualitative indication of the likelihood of human failure, which is important when human failure has been identified as an initiating event. Typically:

- Tasks that are infrequent, complex, time-pressured or unsupported by procedures are more likely to fail
- Tasks that are frequent/familiar, simple and proceduralised are less likely to fail
- The failure likelihoods are judged to be higher if the PIFs are poor. For example, a simple task that might otherwise be given a low failure likelihood may be rated higher if the PIF assessment finds high potential for fatigue, poor training and an adverse physical environment.

Equally, the assessment may find that a human failure identified in a MAHRA is not credible given the number of engineered safeguards preventing the **human failure** or assisting in recovering it.

It should be noted that where human performance has already been identified as a risk reduction measure, e.g. responding to an alarm, the purpose of the assessment is to demonstrate that the company is justified in making this claim. Unless additional engineering controls are implemented, no extra claim for risk reduction can be made as result of the assessment. However, when the human failure is the initiating event for a scenario, carrying out and acting upon the assessment can be used to demonstrate that the initiating event is less likely.

## How do you integrate human factors assessment into quantitative risk assessments?

There is no legal requirement under COMAH to carry out quantified human factors assessments and a well-executed qualitative approach is considered to be suitable and sufficient. However, many establishments use quantified risk assessment methods to determine whether they have reduced risk ALARP, which may take some credit for human reliability.

The human factors assessment of critical tasks method represented here is a qualitative method. Companies wishing to incorporate human factors into quantitative risk assessment methods should use a Quantitative Human Reliability Analysis (QHRA) tool such as the Human Error Assessment and Reduction Tool Plus (HEART+, Williams and Bell, 2023). Any quantification of human failure must be underpinned by a qualitative assessment of the task under consideration, in particular the PIFs that affect reliability on the task, and human factors assessment can meet this need.

There is existing guidance on QHRA and how to integrate it into quantitative risk assessment, including *Guidance on quantified human reliability analysis (QHRA)*. Energy Institute, 2nd Edition April 2022. https://publishing.energyinst.org

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Williams and Bell (2023) HEART+: *A manual for the Human Error Assessment and Reduction Technique Plus.* In press.

## Recommended Good Practice Guidance

The main guidance on how to conduct the qualitative assessment approach described in this guidance is issued by the Energy Institute:

**Guidance on Human Factors Safety Critical Task Analysis,** February 2020
Available at: https://publishing.energyinst.org/topics/human-and-organisational-factors/risk-management/guidance-on-human-factors-safety-critical-task-analysis2

The Energy Institute also provides a wide range of online guidance, including a set of briefing notes which can be found at: https://publishing.energyinst.org/

## United Kingdom Health and Safety Executive (HSE)

The HSE provides online guidance across the human factors topics relevant to managing major hazards, including the toolkits used for inspecting human factors on site.
www.hse.gov.uk/humanfactors/index.htm

The HSE also publishes section 12 of the COMAH Safety Report Assessment Manual 2015 – Human Factors criteria, available at: www.hse.gov.uk/comah/sram/docs/s12d.pdf

COMAH Competent Authority Inspecting Human Factors at COMAH Establishments
(Operational Delivery Guide)
www.hse.gov.uk/comah/guidance/hf-delivery-guide.pdf

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