The Treatment of Generic Task Elements in Human Factors Critical Task Reviews, Competence Management, and Procedures

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In the UK, sites governed by the Control of Major Accident Hazard (COMAH) regulations are required to identify COMAH-critical tasks, analyse them to identify where they are vulnerable to human failure, and the factors that might make those failures more likely. This analysis process can be time consuming, therefore it is important to identify areas where time savings can be made whilst maintaining the rigour of the analysis. One area where efficiency might be improved is in the treatment of task elements which are repeated in different tasks. For example, maintenance preparation tasks are frequently selected for analysis as they involve breaking containment. Whilst each task of this type will be different, and often rarely performed, many of the task elements will be performed on a frequent basis (e.g. operation of valves, isolation proving, purging, and control of work activities).

HRA, in collaboration with National Grid, is trialling an approach to COMAH-critical task analysis where these Generic Task Elements (GTEs) are treated in a modular manner. Under this approach, an initial analysis of a GTE (e.g. nitrogen purging) is completed. Then, when this GTE is encountered in a subsequent analysis, the module is inserted and reviewed for difference (e.g. in terms of local Performance Influencing Factors or consequences). This creates a time-saving as it is not necessary to re-start the analysis from the beginning.

This approach also has potential benefits as an input to competence management and procedures. Whilst the concept of job aids, where the level of detail in in-hand procedures is appropriate to the task, user and consequence of failure, is now widely understood, there is a lack of a formal framework for determining the appropriate level of detail. Using the GTE approach as the basis for training standards (i.e. detailed task descriptions which are used as the basis for training and competence management) has the potential to reduce unnecessary detail in in-hand procedures, whilst providing a mechanism for ensuing that operators are competent in these tasks.

This paper discusses the trial application of this approach at National Grid's COMAH sites. It includes a description of the approach, the arguments for adopting it, and an example of its application.

Background and scope

In the UK, sites governed by the Control of Major Accident Hazard (COMAH) regulations are required to identify COMAH-critical tasks, analyse them to establish where they are vulnerable to human failure, and review the factors that might make those failures more likely (HSE, 2016). This process typically includes some form of task analysis, failure analysis, and Performance Influencing Factor (PIF) analysis. Ultimately, the aim is to optimise the performance of people undertaking COMAH-critical tasks, by ensuring, with reference to ALARP and Hierarchy of Control (HoC) principles, that control measures are appropriate and PIFs have been optimised (for more detail on this type of analysis, see, for example, Energy Institute, 2011).

This process is variously referred to as Human Reliability Analysis (HRA), Safety Critical Task Analysis (SCTA), Human-HAZOP, or Human Error Analysis (HEA). Our preferred term is Human Factors Critical Task Review (HFCTR), as this makes clear the discipline it relates to (Human Factors), and that it is to be applied only to the most important tasks (Critical). Task Review is used rather than Task Analysis, as task analysis is a sub-element of the process. Most versions of HFCTR, have their roots in the Systematic Human Error Reduction and Prediction Approach (SHERPA) developed in the 1980s as an HF analogue to qualitative engineering risk analyses (Embrey, 1986, 2018).

HRA has worked in this area for many years and carried analyses at different COMAH sites. The analysis process can be time consuming, therefore it is important to identify areas where time savings can be made, whilst maintaining the rigour of the analysis. One area where we have found an opportunity to improve efficiency is in the treatment of task elements which are repeated in different tasks.

For example, maintenance preparation tasks are frequently selected for HFCTR as they involve breaking containment. Breaking containment is necessary to provide access to plant and equipment for a range of maintenance purposes, but, if performed incorrectly, has the potential to result in a loss of containment. On a gas plant, maintenance preparation might be required, for example, to provide access for changing filters, changing orifice plates, or for inspecting seals. Tasks of this type are usually performed on a planned basis, but infrequently (it is not uncommon for a gap of several years before the specific task will be performed again). However, although the specific task is performed rarely, many parts of the task will be performed on a frequent basis as part of other tasks. Examples of these frequently performed elements include: operation of valves, isolation proving, purging, and control of work activities, such as the application of locks and tags.

HRA, in collaboration with National Grid, is trialling an approach to COMAH-critical task analysis where these generic task elements are treated in a modular manner. In this approach, an initial analysis of a Generic Task Element (GTE), such as nitrogen purging, is completed once, often as part of the first analysis of one of these maintenance preparation tasks. Then, when the GTE is encountered as part of a subsequent analysis, the module is inserted, where it is reviewed for difference (e.g. in terms of local Performance Influencing Factors or consequences of failures). This is possible because the relevant failure modes will be similar regardless of task context. For example, for purging, omitting the purge, failing to purge the full isolation envelope, failing to test at the correct points, or failing to use the test equipment correctly, will be likely to be relevant in every context.

This approach also has potential benefits in the translation of the HFCTR into procedures and competence management. Whilst the concept of job aids, where the level of detail in in-hand procedures is appropriate to the task, user and consequence of failure, is now widely understood, there is a lack of a formal framework for determining the appropriate level of detail, or for managing task elements where detail is omitted in order to make the in-hand document more usable for a trained operator.

Therefore, we propose using GTE HFCTRs as the basis for training standards (i.e. detailed task descriptions which are used for training and competence management) for these frequently performed task elements. It will then be possible to establish and maintain competence in these task elements without repeatedly describing how to perform these actions every time they are encountered in a procedure.

This paper discusses the trial application of this approach at National Grid's COMAH sites. It includes a description of the approach, the arguments for adopting it, and examples of its application.

Use of Generic Task Elements (GTEs) in HFCTR

Rationale for use of GTEs in HFCTR

HFCTR can be a time-consuming process, therefore, analysis effort should be directed where the risk is greatest. In the context of the UK COMAH regulations this is usually tasks that are related to Major Accident Hazards (MAH). The HSE's Inspectors' Guide describes the identification of tasks as a key success criterion (HSE, 2016).

Often, we find that several tasks of the same type are identified as part of a task identification exercise. For example, a site may have several different tanker offloading/loading tasks which, although different in detail, employ many of the same principles. Another example are maintenance preparation task-types discussed in the previous section. These are frequently identified during COMAH- critical task identification, as they involve preparing a system for a break of containment, and consequently have the potential, if performed incorrectly, to initiate a loss of containment. A site may have both a general process to follow for maintenance preparation where work is infrequently required (e.g. storage tanks, process vessels), and have more specific procedures, following the same principles but with specific valve and equipment references, for systems where work is more frequently required or takes place on a planned basis (e.g. for changing filters, carrying out routine maintenance or inspection).

Where several tasks of the same type have been identified for HFCTR, there is a risk of unnecessary repetition of analysis effort. We have encountered this issue in our client work, where tasks of a similar type have been analysed several times, with the same types of issues being identified repeatedly, to little additional benefit. In terms of general management of the HFCTR process, this shows the value of occasional reviews of HFCTR outputs, to determine whether they are continuing to add value, and to avoid the situation where the goal becomes to complete a certain number of reviews in a period of time, rather than to continue to make improvements. However, equally, it is not advisable to just analyse one task of a type, as there can be small differences between similar tasks which may create the conditions for important failures.

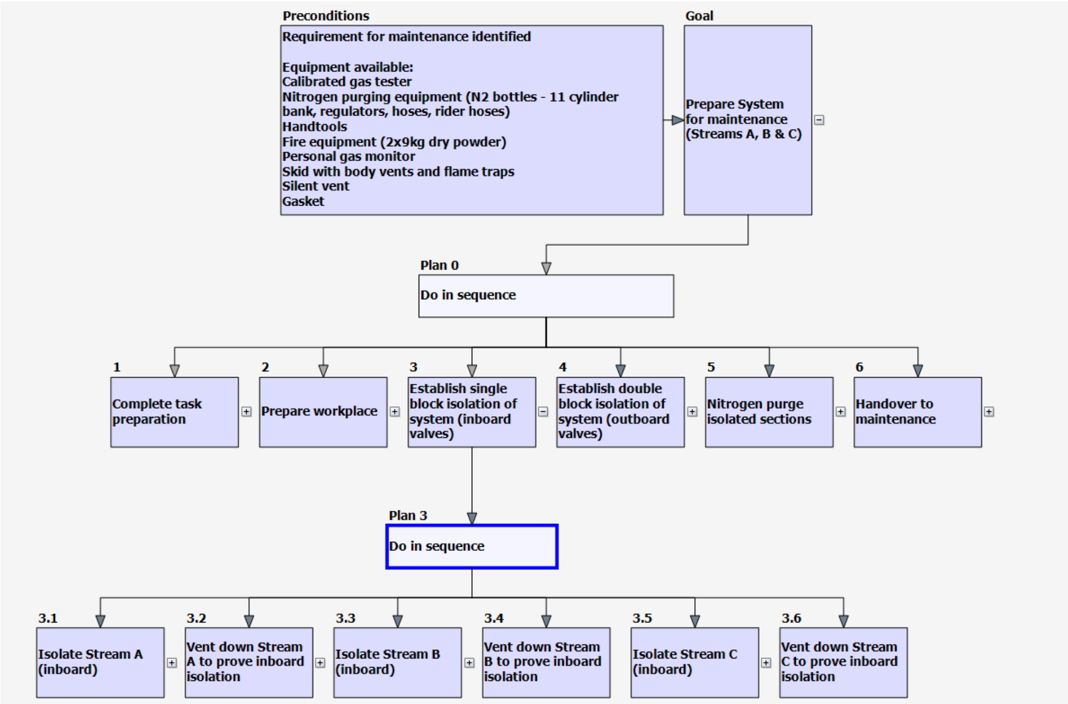
This is where GTEs have the potential to be useful. By developing a generic analysis of a frequently performed task element, it is possible to use this analysis as an input to a specific HFCTR, a possible way of doing this is discussed in the following section.

Potential treatment of GTEs in HFCTRs

The HFCTR process typically includes some form of task analysis, failure analysis, and Performance Influencing Factor (PIF) analysis. For reasons of space, we will not provide a description of the process in this paper (for more detail, see, for example, Energy Institute, 2011). Working with National Grid, HRA has been looking at the possibility of using GTEs to make the HFCTR process more efficient.

A typical example of a task analysis for a maintenance preparation task-type is shown in Figure 1, below. This has been generalised and simplified for this paper. The task involves the preparation of a high-pressure gas system for a maintenance activity. During the preparation, the system is isolated (to a double-block and bleed standard), with each isolated section vented-down (in order to depressurise the sections, and clear the bulk of the gas), and purged with nitrogen (to remove the potential for an explosive atmosphere). In this example, there are 3 streams (or sections) that each require isolating, venting and purging as part of the process to make them safe for the maintenance task. Many of the valves that are used for the isolation are double-seated, with an internal cavity, which also requires venting during the isolation.

Figure 1 Example of high-level of task analysis for maintenance preparation task-type



The issue, from an HFCTR perspective, is that whilst the task is a standalone activity, performed once every few years, many of the task elements are frequently performed by the operating team as part of other tasks (i.e. they are GTEs). These elements include:

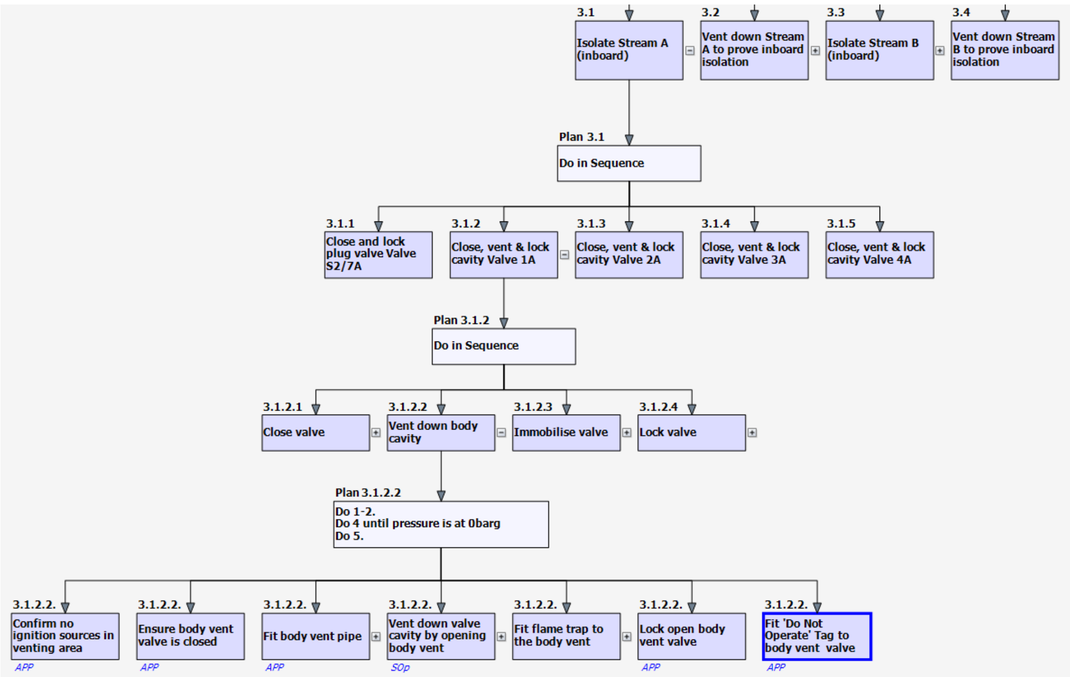
- Valve operation (including moving, cavity venting and locking).
- Venting down isolated sections.
- Purging of isolated sections with nitrogen.

This type of maintenance preparation task could, in theory, be performed almost anywhere on the site. At this site, the task identification process identified several different examples of this task-type (e.g. for changing filters, removing orifice plates, removing pigs, inspecting lines). Therefore, there is a risk of repeated analysis effort.

To help address this, we propose that following an initial analysis, GTEs could be re-used in subsequent analyses. For example, Figure 2, below, shows part of a more-detailed analysis for the step 'Close, vent & lock cavity Valve 1A'[1]. The step of closing (venting and locking) the valve is essentially the same for every valve of this type on site, and each time the step is performed, there are around 25 sub-steps which must be performed. Repeating the detailed task and failure analysis for this type of valve operation every time it is encountered in an analysis would be very time consuming. Therefore, we propose instead that the detailed analysis should be performed once (creating the GTE analysis: 'Close, vent & lock cavity valve'), and then referenced in subsequent analyses.

[1] Convention in Hierarchical Task Analysis (HTA) is to have one action per step. However, in this case the actions of closing, venting and locking were deemed to be so closely related that they have been grouped together. The more general goal description of 'isolate cavity valve' could be used as an alternative, but 'close, vent & lock' has been used to ensure that it is clear what must be achieved (i.e. 'isolate' could be interpreted in a number of ways).

Figure 2 Task analysis of valve operation GTE[2]



However, when carrying out the HFCTR for a specific maintenance preparation task (e.g. Replace filter A), it will still be necessary to consider failures related to valve operation (e.g. shown as level 3.1.1, 3.1.2, etc. in Figure 2), as these are particular to specific being considered (e.g. what would happen, in the context of this task, if only 2 of the 4 cavity valves are closed). In addition, during the task walkthrough, the specifics of the valve operation (i.e. the local Performance Influencing Factors) must also still be considered, as these may vary from task to task. For example, in a different maintenance preparation task, the cavity valve(s) may be difficult to access, or may be poorly labelled, or their displays may be difficult to see due to their position in relation to the sun. To assist this, a list of specific PIFs to consider for each GTE could be developed.

The same type of process could be followed for other task elements. However, for some of these (e.g. venting, nitrogen purging), it may be more appropriate to use the GTE as a building block in the task analysis, which should then be tailored to the specifics of the task being analysed, rather than just cross-referencing it in the analysis. This is because the specifics of how the task element is performed will vary from task to task (unlike the previously discussed valve operation GTE). For example, in the case of nitrogen purging, whilst the general approach to purging should be the same wherever it is performed, there will be variations in, for example, where the nitrogen will be injected, where it will be vented, where the gas test will be performed, and in the PIFs which will need to be considered as part of the analysis.

Use of Generic Task Elements (GTEs) in procedures and competence management

Rationale for use of GTEs in procedures and competence management

The development and enhancement of procedures to support performance in the context of COMAH-critical tasks is one important output from the HFCTR process, but experience indicates that it is a difficult area to get right (for a detailed analysis of factors affecting the use of procedures, see, Embrey, 2000). One specific issue we have seen many sites wrestle with is the balance between comprehensiveness and usability. There is an understandable desire, particularly for COMAH-critical tasks, for comprehensiveness in procedures. However, where procedures are comprehensive, they can also be difficult to use, as they contain a level of detail that many experienced operators find excessive.

To address this, it has been suggested that the detail in procedures should be determined by factors such as task criticality, complexity and familiarity (see Embrey 2000). Therefore, a frequently performed, simple task might require less detail than an infrequently performed, complex task. In practice, for COMAH critical tasks, this type of approach may require two documents, a detailed training-standard (containing all the task steps, risk and competence information) and a shorter in-hand job-aid, designed to support task performance for a trained operator.

In the UK, some of this thinking has made its way into available guidance. The HSE document Revitalising Procedures (HSE, undated), suggests that different types of procedures may be required for some tasks: "those used for training new users will differ from those used in the field by 'old hands'…It is important that the procedure provided be fit for purpose". This is supported by a decision-tree which suggests when a step-by-step procedure should be used and when a job-aid would

[2] Note that there is more detail not shown in this figure. Steps with + signs next to them indicate that there is additional analysis at a lower level in the task analysis.

be appropriate (with reference again to criticality, complexity, familiarity and experience)[3]. The more recent HSE Delivery Guide (HSE, 2016), is less specific, but states “The level of detail (should be) appropriate to the task, user and consequence of failure”.

However, one issue that is not addressed in the available guidance, is what to do with tasks that are infrequently performed, but that contain elements which are frequently carried-out. Most of the guidance treats tasks as single entities, which means a binary decision between a detailed step-by-step procedure or a job aid. *Our experience is that, in practice, some parts of a task (infrequently performed, complex) may need a lot of detail, whereas other parts (frequently performed, simple) may require less.*

An example to demonstrate potential issues around level of detail in procedures

As an illustration of this, another of HRA’s clients (not National Grid), a batch chemical processing site, made a range of different products in batches. Each different batch had a detailed procedure describing the recipe and the process to be followed. However, as every batch had certain common elements, frequently performed by the operating team, these were not described in detail in the procedures. Therefore, for example, the procedure would say ‘Add 200 litres of water’, but not describe the process for adding water, as the operating team were very familiar with this, even though it involved several steps. During an inspection by the Competent Authority, the company was challenged on the lack of detail on these steps in their procedures. Their (incorrect) assumption was that this meant they should be including this level of detail in their in-hand procedures.

These types of issue are also relevant to National Grid. At one of their sites they have several different types of actuated-valve. To close one of these valves as part of an isolation requires numerous individual actions. Therefore, whilst at one level the step description in a procedure could be as simple as ‘Close, lock & isolate valve A’, at another level, if one were to list all of the actions performed in order to achieve this goal (see Figure 2 for an example for an electrically actuated valve), there may be 20 or 30 individual steps covering the valve movement, the venting down of the valve cavity, the immobilisation of the valve by disconnecting its power source, and the application of locks and tags. Clearly, as they operate these valve-types on a frequent basis, the experienced field operator is likely to favour the simpler description. However, from a management point of view, it may feel more comfortable to include the additional detail.

The main danger with overly comprehensive in-hand procedures is that they lose credibility with experienced users. If this happens, there is an increased risk of these users failing to refer to procedures whilst carrying out tasks, and, therefore, missing critical actions (e.g. if there is an unusual variation in practice in one section of the task). However, based on the available guidance (see previous section), and the questions that would be asked in the event of something going wrong, there is an understandable tendency, across industry, to err on the side of including too much detail. Presumably, the intention of the challenge to the batch chemical processing site, was not to encourage this detail to be added to the in-hand procedure but to establish how the site ensures competence in these steps. The question is not ‘*why isn’t this detail in the procedure?*’ but, instead ‘*given that the detail is not in the procedure, how do you ensure that operators are competent to carry out these actions*?’

Potential use of GTEs in procedures and competence management

Therefore, it may be helpful to consider the problem of how to establish the appropriate level of detail in procedures as an issue not just for procedures management, but one that must be addressed by an integrated procedure and competence management system. Working with National Grid, we have extended the GTE concept described in the previous sections for use in procedures and competence management. This uses GTEs to support task performance, with inputs from both procedures and competence management, and gives a clear method for managing the level detail in in-hand procedures.

Firstly, it does require that two documents be developed for COMAH-critical tasks. The first is the *Training Aid.* This is a detailed description of how the task should be performed, including a summary of the primary MAHs, along with an additional column including ‘Knowledge and training requirements’ for the task (see Figure 3, for an example excerpt). This can be used as the basis for training and competence management for the task. The second document is the in-hand procedure, or *Local Work Instruction*. |Currently, this is largely the same as the Training Aid, but with the ‘knowledge and training requirements’ column removed, and the addition of check boxes to record task progress.

Secondly, the approach accepts that even infrequently performed tasks may have elements which are very familiar to the users, and therefore do not need to be described in detail in a procedure every time they are encountered. The ‘Knowledge and training requirements’ column in the Training Aid is used to indicate GTEs that the operator must be competent in, in order to perform the task. For example, in the excerpt (See Figure 3) steps related to detailed operation of electrically actuated valves and venting are not described in this Training Aid. This is because, in turn, these GTEs have their own Training Aids, in which an operator must be competent in order to perform the maintenance preparation task. In the related Local Work Instruction, competence in these GTEs is a precondition for an operator to perform the task.

[3] As an aside, the first question in this decision-tree is “Is the task safety critical?”. If the response is no, then the tree suggests that a step-by-step procedure should be used. However, in our experience, it may be the case that even a safety critical task may benefit from the use of a job aid.

Figure 3 Excerpt from Training Aid for a maintenance preparation task

Step	Notes and key-points	Knowledge & training requirements
1. Isolate Stream A: *a)* Close & lock plug valve S2/7A *b)* Close, vent & lock valve V1A *c)* Close, vent & lock valve V2A *d)* Close, vent & lock valve V3A *e)* Close, vent & lock valve V4A	**Potential Major Accident Hazard:** Failure to close valves could result Loss of Containment (LOC) when task handed over to maintenance. All valves to be physical locked and tagged in position. Electrically-operated valves to be also locked and tagged in switch-house.	**Knowledge:** Can explain why the inboard valves are isolated first (in order to prove both the inboard and outboard isolation valves). **Training:** Task step detail not included as operator must be competent in 'Operation of Electrically-actuated valves' GTE1 to perform this task [4]
2. Vent down Stream A using Section Vent	**Potential Major Accident Hazard:** Failure to vent down stream will result in trapped gas at pressure when task handed over to maintenace. • Use marked silent vent location on Road 4 • Silent vent connected to V1234 • Monitor for Pressure Build-up for 30 minutes • Attach section vent with flame trap to V1234 after completion	**Training:** Task step detail not included, as operator must be competent in 'Venting Down of Isolated Section using Section Vent' GTE2 to perform this task.

[4] In practice, National Grid has their own competence management system which they refer to in the Training Aid, but these GTE references have been included here for simplicity.

Thirdly, this means that, in parallel to the procedures system, a site must include these GTEs in their Competence Management System (CMS). Competence in these frequently performed tasks must be established and maintained using the Training Aids for these GTEs. For example, an operator working on a site which uses electrically-actuated valves must be trained and assessed to be competent in this task, with reference to the GTE Training Aid for electrical valve operation. This training will need to be refreshed periodically. Competence in these GTEs is then a precondition for carrying out any task which includes the use of electrically-actuated valves, and is what enables the detail of how to operate these valves to be removed from related procedures.

In practice, there may be some local variations in how the knowledge acquired in GTE training will need to be applied. Any variations of this type could be described in the Local Work Instruction to which they apply and/or be covered in the training process. For example, at National Grid, we are proposing to supplement the GTE Training Aids with a list of relevant PIFs to be discussed as part of the training. This will cover variations that that operator should be aware of, such as how to work on valves where access is difficult, variations in position indication on the valves, and exceptions, such as valves where the motion stereotype is different than for other valves of the same type. These types of variations and exceptions should also be captured in the specific Local Work Instruction to which they apply.

Summary

Therefore, in the context of COMAH, important outputs of an integrated HFCTR, procedures and competence management system will include:

1. A COMAH-critical task register. Essentially a list of tasks which have been identified because they have a potential relationship to MAHs on-site (e.g. that they might initiate a MAH, or are related to prevention or mitigation of MAHs).
2. HFCTR analyses of the tasks on the COMAH-critical task register. This will include task, failure and PIF analysis, and will identify areas for improvement in terms of Hierarchy of Control and Performance Influencing Factors.
3. HFCTR analyses of Generic Task Element (GTE): Over time, frequently arising task elements will be analysed as part of the HFCTRs (e.g. in the case of National Grid: cavity valve operation, nitrogen purging, gas venting). These can then either be referenced in future HFCTRs (e.g. 'detailed analysis of cavity valve operation has not been performed for this HFCTR as it has been previously analysed, see GTE analysis 1'), or used as building blocks for new HFCTRs (e.g. a GTE for nitrogen purging may be inserted as part of a new analysis and modified as appropriate).
4. Training Aids for Generic Task Elements (GTE): These GTEs will require Training Aids to establish and maintain competence in these task elements. This competence will then be a precondition for carrying out any task which include task elements covered by the GTEs, and is what enables the detail of these task steps to be removed from related procedures.
5. Training Aids for COMAH critical tasks: There will also need to be Training Aids for each COMAH-critical task. However, detail covered by GTE Training Aids will not need to be reproduced. The Competent Authority Delivery Guide for Human Factors (HSE, 2016), includes the expectation that 'the CMS (must be) clearly linked to local MAHs'. Therefore, it is important to be able to demonstrate that training and competence management is in place for each COMAH-critical task. For example, a site should be able to demonstrate that an individual working in an area has been trained and is competent in all COMAH-critical tasks identified for that area.
6. Local Work Instructions for COMAH critical tasks: Each COMAH-critical task will also need to have a supporting in-hand procedure. Ideally, this will be tailored to the nature of the task (e.g. more detail for more complex, less frequently performed tasks). The amount of detail in these documents should be kept at a level that is useful for its users. GTE Training Aids will assist with this, by providing a process for establishing and maintaining competence in these task elements.

To summarise, GTEs can be used in both HFCTRs and the related area of procedures and competence management. For HFCTRs, they provide a mechanism to re-use previous analysis effort and, therefore, to reduce the risk of repeated work. For procedures, they can help to set the level of detail in in-hand procedures so that they are both usable for operators, but also so that there is an audit trail demonstrating how competence in frequently performed task elements has been acquired and maintained. Figure 4 (below) illustrates these potential uses, demonstrating how previously analysed GTEs can be re-used for two different COMAH-critical tasks at a site, and how they can then be used to support training, competence management and the development of usable procedures.

Figure 4 Illustration of use of GTEs in an integrated HFCTR, procedures and competence management process

COMAH Critical Task Identification	Human Factors Critical Task Review	Training & Competence Management	Procedures
Task 1 – Replace Orifice Plate X	HFCTR 1 – Remove Orifice Plate X *Using inputs:* GTE HFCTR A - Electrically-actuated valve operation GTE HFCTR B – Venting down isolated section GTE HFCTR C – Nitrogen purge of isolated section	*In order to carry out task, must be trained and competent in:* Training Aid 1 – Remove Orifice Plate X *And also the following GTEs:* Training Aid GTE A - Electrically-actuated valve operation Training Aid GTE B – Venting down isolated section Training Aid GTE C – Nitrogen purge of isolated section	*When performing the task must use:* Local Work Instruction 1 – Remove Orifice Plate X (Note that steps related to supporting GTEs, see previous column, are not described in detail in this LWI)
Task 2 – Replace Filter Y	HFCTR 2 – Replace Filter Y *Using inputs:* GTE HFCTR A - Electrically-actuated valve operation GTE HFCTR B – Venting down isolated section GTE HFCTR C – Nitrogen purge of isolated section	*In order to carry out task, must be trained and competent in:* Training Aid 2 – Replace Filter Y *And also the following GTEs:* Training Aid GTE A - Electrically-actuated valve operation Training Aid GTE B – Venting down isolated section Training Aid GTE C – Nitrogen purge of isolated section	*When performing the task must use:* Local Work Instruction 2 – Replace Filter Y (Note that steps related to supporting GTEs, see previous column, are not described in detail in this LWI)

References

Embrey, D.E. (1986) *SHERPA: A systematic human error reduction and prediction approach*. Proceedings of the international topical meeting on advances in human factors in nuclear power systems; Knoxville, TN (USA); 21-24 Apr 1986.

Embrey (2000) Preventing Human Error: Developing a Consensus Led Safety Culture based on Best Practice. Paper available at http://www.humanreliability.com/downloads/Consensus-based-Approach-to-Risk-MANagement.pdf

Embrey, D.E. (2018) Addressing human reliability quantification issues in COMAH reports using the SHERPA and SLIM methodologies *Proceedings of Hazards 28 Conference, Edinburgh, Institute of Chemical Engineers*

Energy Institute (2011) *Guidance on human factors safety critical task analysis*, 1st Edition. Web version available at: https://www.energyinst.org/technical/human-and-organisational-factors/scta (accessed January 2019).

Henderson, J. E. (2014) *Task identification for COMAH*. Proceedings of Hazards 24.

Henderson, J.E., Hunter, N, & Embrey, D. (2017) *Human Factors Issues in Control of Work Systems*. Proceedings of Hazards 27, Birmingham.

Health & Safety Executive (2016) *Inspecting Human factors at COMAH Establishments (Operational Delivery Guide)*. Web version. Available at: http://www.hse.gov.uk/comah/guidance/hf-delivery-guide.pdf (accessed January 2019).

Health & Safety Executive (Undated) *Revitalising Procedures*. (accessed January 2019). Available at: http://www.hse.gov.uk/humanfactors/topics/types.pdf