

Task Risk Management – Practical Guide

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1 INTRODUCTION

This paper proposes Task Risk Management as a means of integrating the principles of task analysis into a wider risk management process. The paper describes methods and approaches that I have used and found to be very effective and practical.

1.1 Objective of this paper

Task analysis has been part of a human factors practitioner's toolbox for some time. My experience is that, if used wisely, it greatly improves the understanding of tasks and identifies many opportunities to improve the way the risks of human error and other failures are managed. But I am concerned that a lot of people see it as a paperwork exercise that uses a lot of resource for relatively little benefit, but may be required to keep the regulators happy.

I have used the term Task Risk Management to show the benefits of taking a task based approach, prioritised around process safety risks. I believe that done properly, the way human factors and process risks are understood and managed can be improved significantly.

Other terms are being used to describe similar processes. Critical Task Analysis is one example, but most people seem to feel this is restricted to identifying critical tasks, leaving a question about what has to be done next. Human Reliability Analysis is another term that can be used, but a lot of people seem to think this is more concerned with quantifying human failure rates.

1.2 Overview of the process

The key parts of the Task Risk Management process are summarised below. The subsequent sections of this paper provide more detail.

1.2.1 DEFINE THE SYSTEM

Deciding where to apply Task Risk Management. Choose a system where there are Major Accident Hazards (MAH) and tasks with error potential (i.e. complex system handling major hazards). Identify relevant accident scenarios.

Drawings can be very helpful for defining system boundaries.

1.2.2 IDENTIFY TASKS

Simple list of tasks associated with the system. Classify task types (e.g. routine operations, start-up and shutdown, response to events, maintenance). Structured brainstorm, working systematically through the system.

Don't expect your existing procedures to give you a comprehensive or accurate list of tasks.

Identify tasks in a workshop involving people familiar with the system and tasks. Expect to identify 50 tasks per hour, with a typical system involving 100 – 300 tasks.

1.2.3 PRIORITISE TASKS

A simple scoring system, consisting of five generic aspects that consider hazardousness of system and nature of tasks. Guidelines provided for scoring operations and maintenance tasks. Tasks with the highest total score are the most critical and hence priority for analysis. Expect 20% to be assigned high criticality. The scoring is rough and ready, but proven to be good enough for our purposes.

Generic process safety techniques (e.g. HAZOP, Process Hazard Review or Bow Tie analysis) can provide some structure, but do not address human factors sufficiently well to be of any great value for prioritisation.

Prioritise tasks in a workshop involving people familiar with the system and tasks. Expect to score 20 tasks per hour. Can be carried out at the same time as tasks are identified, in which case 100+ tasks can be identified and scored in a day.

1.2.4 ANALYSE TASKS

Describe how tasks are performed, identify potential human errors and their consequences, highlighting and major accident scenarios. Evaluate risk controls in a structured and systematic fashion. Hierarchical Task Analysis (HTA) and Task HAZOP are tried and tested methods that work well for most types of task. Also, an evaluation of Performance Influencing Factors (PIF) should be carried out.

Do not just review existing procedures. Expect to find that individuals and teams perform the same task differently; and that technically correct good practices do not actually work.

Analyse tasks in a workshop involving people familiar with the task, with technical input provided in a controlled manner so that the truth can come out. Expect to analyse between two and four tasks per day. However, it is better to analyse a small number of tasks really well instead of a large number of tasks badly.

Analyses should be verified for accuracy. The best way to do this is when the task is being performed. If this cannot be arranged, a 'walk through' the task on site can be effective. PIFs can be evaluated whilst doing this.

1.2.5 USE THE OUTPUT

All parts of the process can have an immediate impact, but there are opportunities for more fundamental and long term improvements in managing risks. Take an overview in order to identify opportunities to eliminate the opportunity for error, reduce the consequences or likelihood of error, and improve mitigation.

Task Risk Management can identify opportunities to reduce risks through good engineering and sets standards for procedures, training and competence.

The output has to be reviewed to keep it up to date and relevant. The best way is to use it and get feedback. Scheduled review and audit can identify at what point it is better to re-visit existing analyses for higher criticality tasks than to continue analysing lower criticality tasks. When things go wrong, the fact that a systematic process has been implemented for managing task risks will greatly assist in identifying systemic and root causes.

1.3 Getting Started

1.3.1 WHEN SHOULD THE PROCESS BE USED?

Task Risk Management is applicable at any time. During the design of a facility it can be particularly effective because there is the opportunity to build the risk controls into the design. The only issue to address is that detail and operational experience is not always available, but the hierarchical nature of the methods used allows it to develop as the design progresses.

Once a facility is operational, Task Risk Management can be carried out using practical experience of tasks. Whilst initial implementation may be treated as a one off project, I believe this should progress to form a living system.

1.3.2 WHO SHOULD BE INVOLVED?

It is essential to involve the right people. The most important are those that perform the tasks. I have found that involving them in workshop sessions is by far the most effective method of achieving a quality output. Other people with knowledge or non-practical experience of the tasks (e.g. supervisors, technical experts) do have a role, but it is important that they do not impose their 'theoretical' views in a way that stifles discussion about what happens in practice.

The process does need good facilitation during workshops and in collating the output. Management support is essential in both releasing the resources to carry out the process and to use the output in short and the longer term.

2 GETTING STARTED

Although very effective, Task Risk Management is a significant undertaking and it is rarely possible (or desirable) to assess every task performed on a site/facility. It is important that it is applied in areas where there is likely to be a benefit.

2.1 Initial prioritisation

The focus of time and effort should be on systems where:

- The consequence of tasks being performed incorrectly may be significant;
- There is a reasonable likelihood that tasks will be performed incorrectly.

Therefore, the priority for carrying out Task Risk Management is for systems that handle major hazards and have some degree of complexity. If a site/facility has a number of systems that have these characteristics, further prioritisation is required. This can be achieved by listing all systems and ranking them according to major accident hazard/process safety risk. The system at the top of the list should be considered first.

Reference should be made to other safety studies and reports when determining the initial prioritisation. A list of potential major accidents should be developed for cross-referencing when carrying out detailed task analyses.

2.2 Defining the System

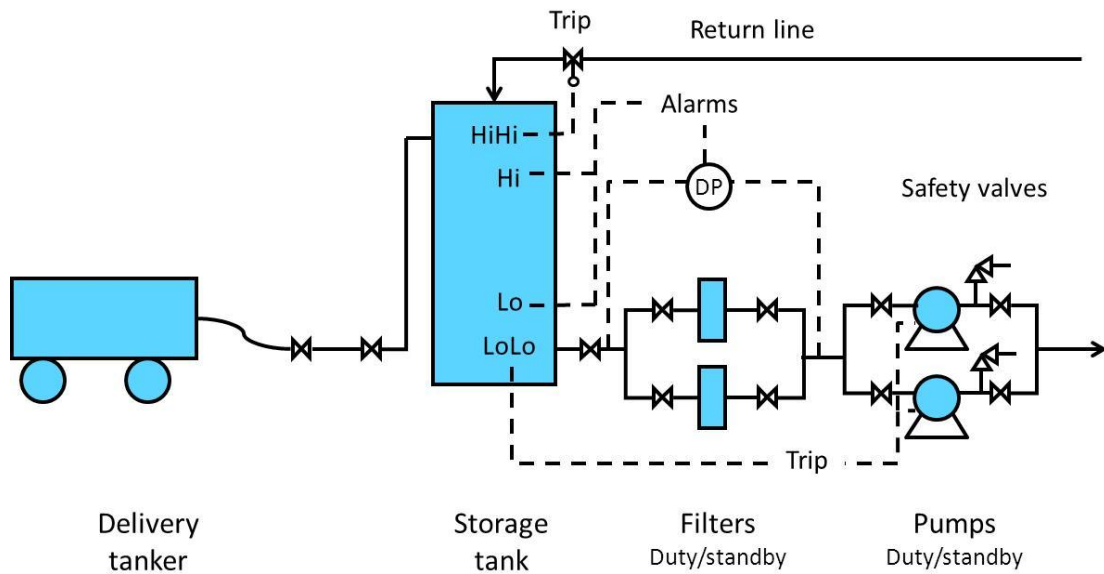
The system being considered needs to be defined in a way that will allow tasks to be identified. This is usually very easy if the people involved are familiar with the system.

The best way of defining the system is a drawing. This can be used to show the system boundaries. A process flow is useful, whilst a more detailed drawing showing items of equipment is probably better. Equipment lists can act as a useful prompt.

2.3 Hypothetical Example

The method proposed in this document is very practical, but not always so easy to describe in writing. I think that using a hypothetical system helps to demonstrate how to implement Task Risk Management in practice.

The drawing below defines a hypothetical system that shall be used throughout this document to illustrate the Task Risk Management process. The system consists of a storage tank, filters and pumps. Liquid is transferred from the tank to another system, with the option to return it to the tank. Fresh stocks are delivered by a road tanker.



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Other features to note include:

- Filters and pumps are spared so that one is online Duty and the other Standby;
- Alarms warn of high and low levels in the tank;
- A low level trip protects the pumps from running dry;
- High level trip protects against overfilling the tank when circulating material back via the Return line;
- A high differential pressure will warn of a blocked filter;
- Safety valve protects against high pressure in the pump discharge.

3 IDENTIFYING TASKS

Although the focus for Task Risk Management is critical tasks, I find it very useful to first start with a full list of all the tasks associated with the chosen system. The list is used to prioritise the analysis and management efforts; and does not take very long to generate.

3.1 Suggested Method

People often think that developing the task list simply means printing off a list of existing procedures. The problem is that procedures are rarely written in a systematic fashion. Some procedures will cover more than one task and some tasks will be covered by more than one procedure. Also, it is impossible to write a procedure for every task. I'm not saying that existing procedures should be ignored, but just advising that it is rarely an effective approach.

The key to success at this stage is to involve the right people and use a systematic approach. It is actually a very simple exercise, yet very effective, and does not take long to complete. Following a process from start to finish, referring to drawings if available, usually works well. It normally helps to divide task types, for example:

- Operations;
- Maintenance;
- Response to events and conditions.

3.2 Hypothetical System

I have used our hypothetical system to demonstrate how tasks are identified in a systematic fashion. I have divided tasks into:

- Routine operations;
- Start-up and shutdown;
- Routine monitoring;
- Response to events;
- Maintenance.

The full list of tasks is shown in the table in Annex A – Table 1

3.2.1 ROUTINE OPERATING TASKS

For our hypothetical system it makes sense to start working through the process at the road tanker connection and then follow the process flow. Therefore the first operating task we identify is tanker delivery.

The storage tank is next in the process. There may be some continual monitoring of level, but that is not really a task in its own right but part of a more general activity (which will be discussed later). However, manual dipping of the tank to determine level would be a routine task to add to the list.

The flow from the tank goes through filters. Given that there are two, duty and standby, there will be an operating task to changeover the filters. Cleaning the filter is another task, but would probably be maintenance (see below).

The flow from the filters goes to the pumps. Again there are two; duty and standby, and we will have a pump changeover task.

This covers the whole process, except for the return line. There does not appear to be any operating tasks associated with this for the system we are examining (i.e. there may be task associated with another system, which we would look at separately).

3.2.2 START-UP AND SHUTDOWN TASKS

One category of operating task that is usually worthy of separate consideration is start-up and shutdown. These tasks can apply to the whole system, plant or equipment; and in different scenarios.

For our hypothetical system we would have a 'normal' shutdown and subsequent start-up, where the system is shutdown for operational reasons but is left ready to re-start. We would have tasks to perform before and after maintenance, which may be described as shutdown for maintenance and return to service after maintenance. Also, we would have to restart the system after a trip.

There would be a start-up and shutdown task for the pumps. However, having included changeover in routine operations, there is probably no need to include these as separate tasks.

3.2.3 ROUTINE MONITORING AND CONTROL

All systems will be subject to some form of monitoring. This may include:

- Continuous monitoring and optimisation from a control room;
- Frequent plant checks and adjustments (e.g. every hour, shift or day);
- Scheduled checks (e.g. weekly or monthly);
- Shift handover.

These tasks are important, but sometimes a little difficult to define because what is actually done will depend on what the person finds when they look at the system.

3.2.4 RESPONSE TO EVENTS

It is important to remember that operators do not only perform tasks that they can plan, but may have to respond to unplanned events. It will never be possible to list every eventuality, but it is still worthwhile listing any that can be predicted.

There are broadly two types of event. The first applies to process conditions (e.g. temperature, pressure, level, flow) and the second may be described as emergencies (e.g. spill, fire, explosion).

For the process events it is tempting to focus on alarms, listing tasks such as 'respond to high level alarm.' This should be avoided because the alarms installed on the system may not be comprehensive or correct; and our aim should be for people to intervene before an alarm.

For our hypothetical system, the process events that would require a response would include storage tank low and high level, filter high differential pressure, and pump low flow and high discharge pressure. The main emergency scenario is a spill of liquid during tanker delivery or from the storage tank, filter or pump.

3.2.5 MAINTENANCE TASKS

Ultimately, every item of plant or equipment will require maintenance at some time. However, there are a few potential pitfalls that we need to be aware of if we are going to generate a sensible and useful list of maintenance tasks.

The first thing to avoid is too much overlap between operations and maintenance tasks. Normally, preparing equipment for maintenance and returning it to service afterwards will be an operations task, and the maintenance is work that takes place in between.

Also, we are not interested in one-off or infrequent tasks. For example the tank in our hypothetical system would require internal inspection at some time. This may only occur once every 10 years, and each time it happens it will go through extensive planning.

For our hypothetical system, the maintenance tasks will include replace filter element, repairs to pump, safety valve calibration, repairs to manual or actuated valve, checks and calibration of level and differential pressure instruments, and testing the function of the pump trip.

3.3 Other Methods of Identifying Tasks

I have already mentioned the pitfalls of generating task lists by simply reviewing existing procedures. Where a lot of procedures exist (i.e. thousands) people may be reluctant to 'ignore' them, and so it may be necessary to include some form of review as part of identifying tasks. My experience is that often a lot of documents described as procedures are not actually procedures. Therefore, the review can be used to classify the documents as procedure, guideline, training aid, information etc. Also, it is often the case that many are out of date or obsolete, and should be removed from the system.

Other methods such as job observation and 'time and motion studies' trend to be focussed on routine activities and so rarely give a comprehensive view of all the tasks associated with a system.

The reality is that this is a simple exercise, and a structured brainstorm is likely to be sufficient. Equally, it is worth noting that the task lists are likely to evolve over time, and so should be reviewed at intervals in order to identify any omissions or updates required due to changes to the system or the way it is operated or maintained.

3.4 Uses of the Task Lists

Whilst generating a task list is the first stage in applying Task Risk Management, the list itself can be particularly useful. For example, it can be used as the basis for:

- 'Gap analyses' of procedures, training and/or competence systems;
- Workload estimates;
- Managing organisational changes.

Given that it is such a simple thing to do, it is surprising that most companies never do it.

4 PRIORITISING TASKS

The Task Risk Management method I am proposing works on the Pareto principle, which states that roughly 80% of effects come from 20% of causes. In this case, as a rule of thumb we can assume that 80% of issues will be associated with 20% of our tasks. Therefore, prioritising allows us to focus our efforts where we are likely to get the greatest benefit. The tasks we are most interested in the ones that:

1. Involve some interaction with our most significant hazard; and
2. Are prone to human error.

We can simply ask people to identify the most critical. This is fine, but in my experience this approach results in a large proportion being identified as critical. After all, a task would not be performed if it was not critical, would it? Whilst true, it seems likely that some tasks are more critical than others.

Another problem with asking people to 'cherry pick' critical tasks is that it does not demonstrate a systematic approach and it is difficult to justify the outcome (i.e. why one task is considered critical and another is not).

4.1 A Simple Scoring Method

In 1999 I worked on a project with the Health and Safety Executive (HSE) that resulted in the publication of OTO 1999 092 - Human Factors Assessment of Safety Critical Tasks¹. This proposed a screening tool to determine task criticality using five diagnostic questions. An evaluation of the method² stated that the "the Screening Tool presented in OTO 1999 092, is a particularly powerful tool for systematically linking tasks to the Major Accident Events."

I have had the opportunity in recent years to revisit the scoring method. I have found that with a little bit of customisation it is a very effective for prioritising tasks. It is quick and easy to use and provides a ranking of task criticality that stands up to scrutiny. It is particularly powerful because it helps people understand the risks associated with tasks in relation to human factors and major hazards.

4.1.1 SCORING CRITERIA

I have found that scoring each task against the following five aspects is sufficient:

- Hazardousness;
- Introduction of energy;
- Change of system configuration;
- Error vulnerability;
- Impact on safety devices.

Each task is given a score of between 0 and 3 for each aspect. The scores are added together to give a total for the task. The ones with the highest score are considered to be the most critical.

4.1.2 PRIORITISATION

I find that the following generally works well for determining task priority based on criticality scores:

¹ Available at <http://www.hse.gov.uk/research/otopdf/1999/oto99092.pdf>

² Available at <http://www.hse.gov.uk/research/rrpdf/rr033.pdf>

Total Score	Criticality/priority
9 – 15	High
5 – 8	Medium
0 – 4	Low

These are fairly arbitrary and the most important thing is that some differentiation is achieved to allow sensible prioritisation. Given that most sites/facilities will have a mixture of hazardous and non-hazardous systems, the proportion of task criticalities should be in the region of:

- 10 – 30% high;
- 20 – 40% medium;
- 50 – 70% low.

If you find that your task criticality is significantly different, you may want to review the guidelines you have used to assign scores. It is important to remember that the main aim is to prioritise where specific analysis is going to be carried out. If a lot more than 30% of your tasks are high criticality it will make it difficult to prioritise effectively.

4.1.3 SCORING GUIDELINES

I have found that tailored guidelines assist with the scoring tasks. The latest version is shown in Table 2 in Annex A. Initially I had two tables, one for operations and the other for maintenance tasks, but I found there was often some overlap and so I developed a single table. For each aspect the guidelines above the dashed lines are notionally more related to operations, and those below with maintenance, but either can be used when assigning the score as deemed appropriate.

The following table gives an expanded example for operations tasks where the question for the hazardousness aspect is “how hazardous is the system that the task interacts with?”

Score	Guide (operations – hazardousness)	Example
0	Non-hazardous	Low pressure/temperature air or water
1	Small amount of low hazard	Low pressure gas or steam, low voltage electricity, drums of chemical or flammable material, high pressure air, hot water. Potential for harm to people or environment in close proximity
2	Large amount of low hazard or small amount of high hazard	Medium pressure gas or steam, small volume of high pressure gas, high voltage electricity, small tank of chemical or flammable material Potential for harm over larger area
3	Large amount of high hazard	High pressure gas or steam, large storage tanks of chemical or flammable material, quantities of very toxic or explosive material Potential for widespread impacts

4.1.4 ASSIGNING SCORES

Scoring the tasks should be carried out as a group exercise involving people who know how the tasks are performed. The aim is for a ‘rough and ready’ assessment rather than a detailed analysis. Whilst there is often some debate around the scores for the first couple of

tasks, the remainder can usually be completed fairly quickly. In my experience it is possible to identify and score over a 100 tasks in a day.

4.2 Hypothetical System

The full scores for the tasks associated with our hypothetical system are shown in Annex A – Table 1. The following illustrates the process of assigning scores.

4.2.1 OPERATIONS TASKS

We are assuming that the material stored and pumped in our hypothetical system is moderately hazardous. It could be something like diesel, which can burn and is harmful to the environment, but is not highly flammable or particularly toxic.

For the hazardousness aspect, the nature of the material and the large quantity would mean any tasks involving an interaction with the storage tank would score 2. Other tasks interacting with parts of the system where there is a lower quantity of material (e.g. filters and pumps) would score 1.

It is important to consider each aspect individually. For example, people are sometimes surprised that a very simple task can score high on hazardousness. What they need to understand is that the complexity is covered by the other aspects. A simple task will have a relatively low overall score, even if it scores high on hazardousness.

The table below show the rationale for scoring the delivery from tank task for our hypothetical system.

Task - Receive delivery from road tanker		
Aspect	Score	Rationale
Hazardousness	2	Moderately hazardous material. Tanker and storage tank considered to be a large quantity.
Introduction of energy	2	Vehicle engine is a potential source of ignition. Guidelines say internal combustion engines score a minimum of 2 by default.
Change of system configuration	2	As well as some valve movements, the task involves the use of a hose. Guidelines say temporary connections score a minimum of 2 by default.
Error vulnerability	3	The default score is 1, with 0 only applied to tasks that are fully automated (e.g. operator only has to press a button to start the task). In this case, the lack of high level protection (i.e. trip) that would stop the flow from the tanker means the operator has to remain vigilant to avoid overfilling the storage tank.
Impact on safety devices	0	The task will not interfere with any of the safety devices.
Total	9	High criticality task (score greater than 8)

To some people, a high score for receiving a tanker delivery is a surprise. This may be because it is something they do fairly frequently. But the reality is that the quantities of material involved are relatively large, which means the consequences of a problem can be significant. Also, receiving a tanker delivery is one of the very few situations where you allow a third party to enter your site and connect to your plant introducing both a potential ignition source and temporary connection.

Equally, it can be noted that reducing the score by one would have taken this task into medium criticality. If there had been a reliable form of overfill protection the error vulnerability score could have been reduced. This is a good example of where scoring tasks

in this way can prompt you to ask why a task is so critical and what can be done to reduce risk.

The table below shows the rationale for scoring the filter changeover task.

Task - Changeover duty/standby pump		
Aspect	Score	Rationale
Hazardousness	1	Moderately hazardous material, but relatively small quantity.
Introduction of energy	1	A pump will be started. This will involve electrical switching and energy in the form of flow through the pump.
Change of system configuration	1	Small number of valves changed
Error vulnerability	1	Manual task, not fully automated, with no specific concerns regarding error. Default score of 1 as per guidelines
Impact on safety devices	0	None
Total	4	Low criticality task (score less than 5)

It is unlikely that anyone would expect a pump changeover to be high criticality, but some may be surprised that it comes out so low. The key message here is that the whole idea of scoring the tasks is to create differentiation. The fact this only scores 4 does not mean there is no risk, it just highlights that when it comes carrying out task analysis, this is likely to be at bottom of our priorities. In practical terms, starting and stopping pumps is very much part of basic operation and so carrying out a task analysis is unlikely to tell us much we don't already know.

4.2.2 START-UP AND SHUTDOWN TASKS

Start-up and shutdown tasks can usually be scored in exactly the same way as the routine operational tasks. The table below shows the rationale for scoring one of the shutdown tasks identified for our hypothetical system

Task – Shutdown system and prepare for maintenance		
Aspect	Score	Rationale
Hazardousness	2	Will involve interaction with tank
Introduction of energy	1	Although stopping pump will remove energy, the system will require flushing and purging, which will introduce energy to different parts of the system
Change of system configuration	3	A number of valves will be changed and temporary connections used for flushing and purging
Error vulnerability	3	Errors made in the preparation may lead to hazards being released during maintenance (e.g. when equipment is opened up)
Impact on safety devices	3	To pump out the contents of the tank, the low level trip will be overridden
Total	12	High criticality task (score more than 8)

An important factor for this task is that the most significant consequences of error are likely to occur after the task is complete, when the maintenance is being carried out. A key message here is that many maintenance tasks will have relatively low criticality if the plant and equipment are prepared properly so that hazards are removed effectively.

One of the areas this task scores highly is impact on safety devices. In this case the issue is that an override on the low level trip allows the contents of the tank to be reduced to a minimum. Some may argue that the tank level should only be reduced by pumping to the trip level, with the remaining liquid being removed in some other way. This would reduce the shutdown task score, but also introduce an additional task that would have risks. This is another example of the types of debates that can be prompted by scoring tasks in this way. There is no intention of stopping high criticality tasks from being performed, but just pointing out that they need to be well understood so that the risks can be managed.

4.2.3 ROUTINE MONITORING AND CONTROL

Monitoring and controlling all hazardous systems will be critical. Therefore, identifying and scoring individual tasks of this type is rarely required. Also, it is usually the case that these types of tasks cover a number of systems, and so it does not make sense to identify routine monitoring and control tasks on the lists for each system.

4.2.4 RESPONSE TO EVENTS

Whilst a number of possible events have been identified, the actual responses are likely to be covered by the routine operations, start-up and shutdown tasks. For example, if a high differential pressure is experienced across the filters, the response will be to changeover duty standby filters, which has already been considered above. Where this is the case it is appropriate to keep the response tasks on the list because it can be useful when considering the need for procedures, training and competence. But rather than scoring them it is usually sufficient to simply reference the relevant routine operation, start-up or shutdown task.

Emergency response tasks will typically be critical by default. Again, applying a score to each is not usually required but they should be included in the task lists.

4.2.5 MAINTENANCE TASKS

Maintenance tasks are scored the same way as operations tasks. However, maintenance tasks have a number of features that mean they need to be viewed a bit different.

A key point to note is that many of the maintenance tasks performed on our hypothetical system will be quite generic. For example, the pump maintenance task is likely to take place in a very similar fashion on other systems. The scoring can be used to compare the criticality of the task when carried out on different systems. The one with the highest score will be our priority for detailed analysis.

Another point to note is that the total score for our hypothetical system is influenced by the hazardousness because it is assumed that several of the tasks will be performed whilst the system is live. Therefore, an effective way of reducing criticality will be to perform the tasks when the system is shutdown. There can then be a trade-off between maintenance task criticality and impact on production.

4.2.6 OVERVIEW OF TASK SCORES

For our hypothetical system five tasks are ranked high criticality, five medium and six low. For a system handling moderately hazardous material this is a fairly representative split. If the material was more hazardous we would expect a greater proportion of high criticality tasks and for it is was less hazardous we would expect a greater proportion of low criticality tasks.

4.3 Other Methods of Identifying Critical Tasks

The simple scoring system proposed above is only 'rough and ready' but I find it works well in practice. I know there are other methods being used that appear to be more sophisticated, but they also take longer to apply and I find it hard to believe there is much

benefit in having a more accurate score when it is only being used for prioritisation. Another approach is to start with the major accidents that could potentially occur at a site/facility and to consider which tasks could contribute to these. These include tasks that can initiate the event, are designed to prevent the scenario or maintain a related control measure. This may be seen as a more efficient approach because less time is spent on identifying and scoring tasks that turn out to have low criticality. However, there are concerns that tasks may be overlooked, and it is not so easy to show why one task was considered a higher priority than another.

It has been proposed that 'normal' process safety methods can be used to identify critical tasks, including:

- Hazard Identification (HAZID);
- Hazard and Operability (HAZOP);
- Process Hazard Review (PHR);
- Bow Tie analysis;
- Safety Integrity Level (SIL) assessments;
- Fault and event trees.

My view is that these methods rarely provide enough insight into tasks to allow the prioritisation we need. This is because they do not result in a comprehensive list of tasks, and so are often little better than simple 'cherry picking.' Also, they are focussed on hazard and consequence, and make little account for the human factors that indicate the vulnerability to human error.

I am not saying these assessments have no value when carrying out Task Risk Management. They can provide a useful structure when listing tasks (e.g. the way the system broken down into units). It is important to make sure all relevant tasks identified in the other studies are included in our task lists. But I have never found them to be very useful for demonstrating a systematic method of identifying and prioritising tasks.

5 TASK ANALYSIS

The purpose of task analysis is to document the way tasks are performed and to assess the potential for error or human failure using a systematic method. We should use it for our most critical tasks to make sure we get the greatest benefit from the effort we put in.

5.1 Objectives

Our aim is to understand how tasks are carried out, the human factors risks and methods of risk control. We achieve this by:

- Using a structured method of describing how a task is performed;
- Carrying out a human error analysis;
- Evaluating risk controls and identifying improvement actions;
- Evaluating Performance Influencing Factors.

Analysing a task can sometimes be like 'opening a can of worms.' Typical issues to emerge include the fact that different individuals or teams perform the same task in a different way. Also, it is often discovered that no one is following best practice, either because of equipment problems, picking up bad habits or lack of understanding of the risks. This is why Task Risk Management is far more than simple task analysis. Given that you will be analysing the highest criticality tasks, it is clear that action has to be taken to rectify problems when you find them.

5.2 Describing how tasks are performed

It is easy to assume that information about how tasks are performed is readily available from procedures, but in practice this is rarely the case because many procedures are poorly written and/or do not reflect how tasks are carried out in practice.

5.2.1 HIERARCHICAL TASK ANALYSIS (HTA)

Although it has its limitations, I find that HTA is effective and practical for most of the critical tasks we are interested in. It is a tried and tested technique that I have used a great deal, and I would always recommend it to anyone wishing to understand and document how a task is performed.

HTA is a method of developing a structured and systematic description of a task. Whilst the result is similar to a standard procedure, the process followed means it is a far more precise and accurate account of what the task entails. Also, the way a HTA is developed means the level of detail in different parts of the task can be tailored according to risk.

5.2.2 PRACTICAL ASPECTS OF HTA

It is best to perform HTA in a workshop attended by the people who perform the task being analysed. Others such as Supervisors and people with more technical knowledge can be involved, but it is important that they do not dominate the process, as this can result in a simple review of existing procedures or technically correct but impractical methods being analysed.

A good facilitator has a key role in making sure HTA is applied correctly and that the objectives of the analysis are achieved. Their role is to gather the information needed about the task and so they should be independent and remain objective.

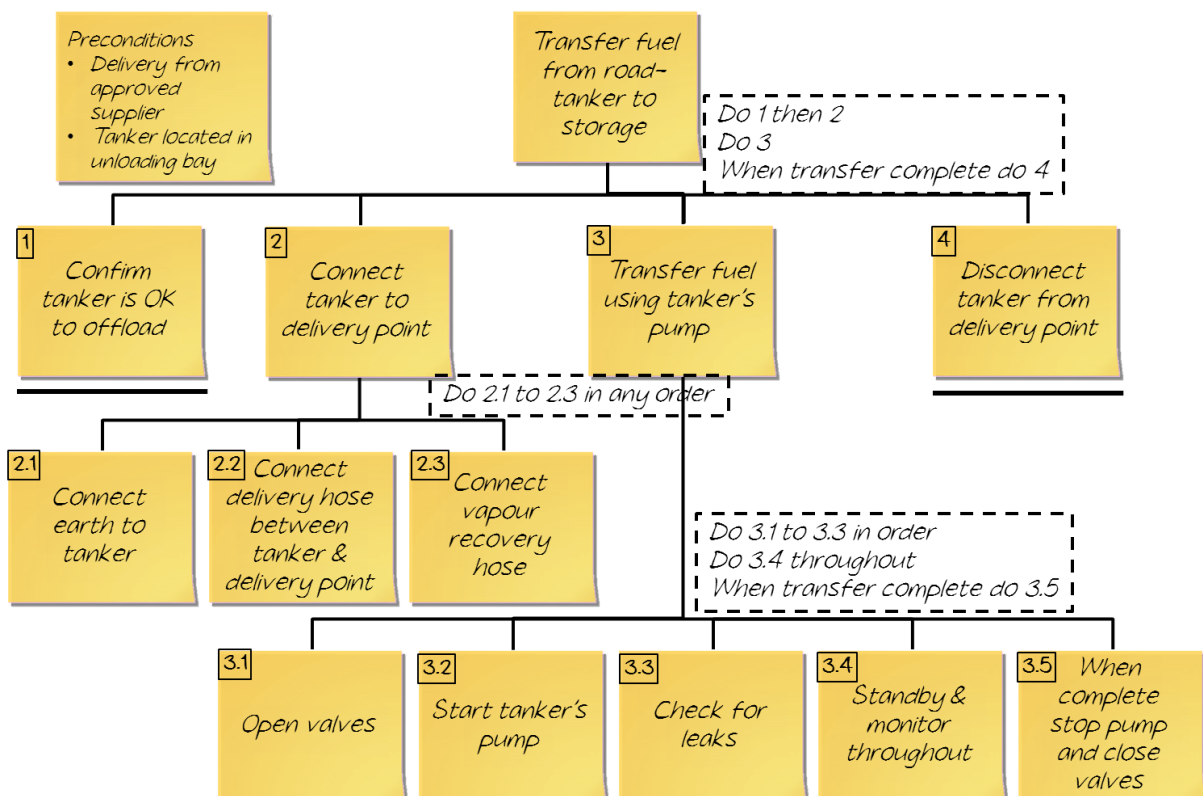
Post-it notes and flip charts can be used to develop and capture the task analysis as it develops. Alternatively, proprietary software is available that can be particularly useful when a data projector is used.

Given that HTA is a well-established technique I will not describe it in too much detail. In fact it is far easier to grasp the method when doing it for real. I have put together a video animation that gives a practical demonstration. It is available at <http://www.abrisk.co.uk/key-topics/hierarchical-task-analysis> (note: the video is hosted on YouTube. Some companies may block access)

The most important thing to remember is that prioritising the tasks means that you are only going to be analysing a relatively modest number. I believe it is far better to analyse a few tasks really well rather than a lot of tasks poorly. From my experience, going through the following stages for each task will help you achieve a good quality analysis:

- Agree the task title – this may sound obvious but it is important to agree a clear title that is unambiguous and defines a clear goal;
- Agree a set of ‘preconditions’ – these are the assumptions you make regarding the starting point for the task. It is important that everyone understands the scenario that is being assessed;
- Identify the main ‘sub-tasks’ – avoid going into detail. There should normally be no more than 10 sub-tasks, although this is not always practical;
- Examine each sub-task and identify which need to be broken down into more detail. Some will not need to be broken down, either because they are self-explanatory, not critical or refer to another task that can be analysed separately;
- Examine each of the detailed steps and determine if any of them need to be broken down into further detail;
- Review the sub-tasks and detailed steps to determine whether there is anything unusual or complex about the order they are performed – this can be documented in a separate box on the analysis, which is called the plan.

The image below shows a completed example. .



5.2.3 OTHER METHODS OF DESCRIBING TASKS

HTA does have some limitations for some types of task. For example, responses to events usually involve relatively little action and it is diagnosis and decision making that is of most interest. A flow chart or event tree may be more useful in identifying the most critical aspects of the task.

Continuous monitoring and control tasks do not lend themselves to pure HTA because they tend to involve a set of discrete steps rather than hierarchies of activities. For these it is often sufficient to simply list the key monitoring and control steps; although using post-it notes or HTA software in a workshop is still a good way of doing this.

5.3 Human Error Analysis

Having described how a task is performed it is then possible to evaluate the potential for errors or other human failures (e.g. violations). Once again a structured approach is required

5.3.1 TASK HAZOP

There may appear to be a number of different techniques available for carrying out human error analysis. They include Predictive Human Error Analysis (PHEA) and Task HAZOP. In reality they are essentially the same technique. A tried and tested method that assists with the systematic identification and assessment of human errors.

A reasonable account of the method is described in HSE guidance document 'Core topic 3: Identifying human failures'³

The method involves applying a set of prompt words to each step in the task. These cover the types of error that may occur. The people analysing the task consider all the potential errors for each step and identify those that are credible. They then record the potential consequences.

5.3.2 TASK HAZOP PROMPT WORDS

The main basis for the prompt words is that a task step may be:

- Omitted (not carried out);
- Incomplete;
- Performed on the wrong object;
- Mistimed (too early or late);
- Carried out at the wrong speed (too fast or slow);
- Carried out for the wrong duration (too long or too short);
- Performed in the wrong direction.

Certain types of step may have their own potential errors. For example actions may be misaligned or use the wrong degree of force (too much or little). When transmitting information it may be incorrect, unclear or ambiguous. When receiving information the wrong data may be selected or it may be misinterpreted.

³ Available at <http://www.hse.gov.uk/humanfactors/topics/core3.pdf>

A table of task HAZOP prompt words is shown in Annex A – Table 3.

This is another method that is easier to grasp when performing it in practice, than it is to understand a written description. A video animation is available at <http://www.abrisk.co.uk/key-topics/human-error-analysis> (note: the video is hosted on YouTube. Some companies may block access).

5.3.3 WHAT IS A CREDIBLE ERROR?

There is a balance to be struck when carrying out human error analysis. Going through every potential error for every step may ensure all possibilities are considered, but is laborious and time consuming. It is a case of diminishing returns on the effort put in and people quickly start to lose interest.

On the other hand, people can be a bit too quick to dismiss some potential errors as not being credible. A good example is a system protected by interlocks or trips. They are inclined to say the error cannot happen because of the protection in the system. If it can be proven that the protection is totally reliable and cannot be overridden or bypassed in any way, that may be acceptable. This is rarely the case. The best way of handling this is to record the potential error and then to make reference to the protection (interlock or trip) when considering risk control measures (see below).

5.3.4 IDENTIFYING POTENTIAL CONSEQUENCES

I feel it is beneficial to record all types of potential consequence when carrying out the task HAZOP, even if the worst possible case is of relatively little concern. This is because it demonstrates that the whole task has been reviewed and every possible error considered. However, the focus should be on major accident hazards, and it is important to cross-reference with the major accident scenarios identified during the initial prioritisation of systems to evaluate. A simple way of making sure these stand-out from the assessment is to include some form of code and different font. I tend to use the letters 'MAH' in bold.

5.3.5 TASK HAZOP EXAMPLE

Using the tanker delivery task from the HTA example above. Step 2.1 is “Connect earth to tanker.” The first thing we do is consider what type of step it is. In this case it is an action.

We then review the possible errors and identify the most credible. They are ‘omitted’, ‘incomplete’, ‘performed on the wrong object’, ‘carried out too late’ and ‘misaligned’.

As well as recording the error types, I find it useful to describe the error in words. In this case, we find that actually that the different error types all result in the same failure, which is ‘failure to achieve an earth before starting the transfer.’

We then consider the consequence of those errors. In this case it is ‘potential for static discharge to act as a source of ignition’. We record the Task HAZOP findings in a table, as shown below. The MAH code and bold font is used to make errors with potential to cause a major accident stand-out.

Task/Step	Error type and description	Potential consequence
2.1 Connect earth to tanker	Action omitted, incomplete, performed on wrong object, too late or misaligned – Failure to achieve earth before starting the transfer	Potential for static discharge to act as a source of ignition MAH – May result in pool fire (Scenario X in Safety Report)

HSE suggest including another column, which is headed “potential to recover.” I have always struggled to find a real benefit in this addition, and so rarely use it. If there are good

methods of recovery, I find that they can be recorded easily when reviewing the task risks (see below).

Annex A – Table 4 shows a more complete Task HAZOP.

5.3.6 CARRYING OUT A TASK HAZOP

Task HAZOP is another method that is best carried out by a group and it requires the same skill set as carrying out an HTA. In particular people with knowledge of the task and a facilitator familiar with the method.

It is possible to complete the Task HAZOP for each step as it is added to the HTA. However, I find it best to complete the HTA first. You can then carry out the Task HAZOP immediately or return to it at some later date. Both options have their advantages. Doing it immediately means that the task is fresh in the minds of the people performing the analysis. However, carrying it out some time later means that the Task HAZOP acts as an objective review of the HTA. From a practicality point of view it is probably best to complete it immediately as there is less chance of it being forgotten about.

5.4 Performance Influencing Factors (PIF)

PIFs are characteristics of the job, individual and the organisation that affect the way people perform. The quality of those characteristics will affect the likelihood that a task will be performed correctly or incorrectly. It is important to consider them when analysing tasks as they can provide some of the best opportunities to reduce risks. I have found it is best to do this in two parts; first identifying which PIFs are relevant to a task, and then evaluating the quality of the PIFs when observing or walking through the task.

5.4.1 IDENTIFYING RELEVANT PIFS

Checklists are a useful prompt when identifying PIFs that are likely to be relevant to the task being analysed. An example checklist from HSE is shown in Annexe A - Table 5.

It is tedious and of little value to go through every PIF for every task step. A hierarchical approach can be used very effectively starting by identifying the PIFs that apply to the whole task and then to the main sub-tasks. A quick run through of the detailed steps can follow to consider whether any relevant PIFs have been overlooked during the high level review.

This step of identifying relevant PIFs can be carried out during or immediately after the human error analysis (task HAZOP). At this stage the main requirement is to record which PIFs need to be evaluated and to make any relevant notes of specific issues to follow-up.

5.4.2 PIF EVALUATION

The next stage is to evaluate the quality of the PIFs that have been identified as relevant. This is done when observing or walking-through the task. The main objective is to identify any characteristics related to the job, individual or organisation that are having a negative impact on human performance and any opportunities to improve performance by improving the quality of the PIFs.

The PIF evaluation is an excellent opportunity to review the whole task analysis, ensuring all details have been recorded correctly and hence the risks have been understood properly. An example of a completed PIF evaluation is shown in Annexe A – Table 6.

5.5 Reviewing Task Risks

Having identified potential errors and their consequences, the final part of the analysis is a consideration of how well the risks are managed and whether more should be done. A lot of this will be completed during the Task HAZOP and PIF evaluation.

5.5.1 ASSESSING EXISTING RISK CONTROLS

It is tempting when recording information about existing risk controls to include statements like “procedure available” and “task performed by competent people.” Whilst it may be true that these factors are part of the way the task risks are managed, I would say they are a given and hence there is no value in recording this, after all I can’t imagine it ever being accepted to not have some form of procedure for a critical task (remembering we only analyse the most critical) or for it to be performed by incompetent people. Equally, if there is a piece of documentation (e.g. permit, checklist) or specific competency that helps with a key part of the task, that can be recorded.

The main points we are looking for in completing this part of the analysis are the features of the system that reduce the vulnerability to the potential errors. These include:

- Alarms and trips that warn or protect against deviations caused by errors;
- Locks and interlocks that prevent the wrong valve or control being used in error;
- Design features that reduce potential consequences of an error (e.g. flow rate limited by small diameter pipework);
- Safety valves that will prevent a high pressure leading to a catastrophic failure;
- Bunds and other catchments that prevent spilt material spreading;
- The fact that errors may be immediately apparent and can be rectified before a serious consequence occurs;
- The likelihood that someone else will check or notice an error has occurred.

HSE in their guidance suggest dividing information about existing risk controls into ‘measures to prevent the failure from occurring’ and ‘measures to reduce the consequences or improve recovery potential.’ I find this division an unnecessary complication and stick to one column headed ‘existing risk control measures.’

5.5.2 IMPROVING CONTROL OF RISK

I have called this process Task Risk Management because I believe it is far more than simply analysing tasks. The most value gained will be from identifying improvements, particularly in the way risks are managed. The level of scrutiny and the fact that we concentrate on the most critical tasks means that it is inevitable that improvements are likely to be found; and this is backed up by experience of using the process.

I find it best to document potential improvements whilst reviewing the existing risk control measures. I do this by adding a column headed ‘potential improvements.’ Examples of what may be recorded include

- Modifications to plant;
- Changing alarm and trip points;
- Improved signs and labels;
- Improved lighting;
- Use different Personal Protective Equipment (PPE);
- Provide training;
- Maintain items that are not working as they should.

6 USING THE OUTPUT

I believe each of the stages of Task Risk Management described above are beneficial in their own right. For example:

- Developing a list of tasks is simple, but is very useful for reviewing procedures, training and competence, and as a baseline for managing change;
- Prioritising tasks using the scoring system can change perceptions of criticality. Also, going through the scores can lead you to challenge certain arrangements, particularly if it identifies that a task requires constant vigilance or involves defeating safety systems;
- Assessing a task using HTA can highlight discrepancies between written procedures and actual practice; different practices between individuals and teams; and conflicts between technical good practice and reality;
- Task HAZOP can open your eyes to the potential for things to go wrong and the PIF evaluation gives you an indication of likelihood;
- Reviewing current risk controls will invariably result in suggestions for improvement.

However, I believe there is a final stage of analysis that can lead to more fundamental and long term improvements for managing risks. If you are writing some form of report to document your Task Risk Management exercise for a system, this is probably where you will complete this. If you are not writing a report it will have to be a thought process you go through when implementing the findings from the exercise.

6.1 Implementing Long Term Risk Management

When going through the detailed analysis of each task you will have considered risk control measures and opportunities for improvement. Having completed the analysis for a number of tasks you can then consider the bigger picture. The aim is to ensure you have arrangements in place to manage task risks effectively. To achieve this you need to:

1. Eliminate the opportunity for error where possible;
2. Reduce the possible consequence of error;
3. Reduce the likelihood of error;
4. Improve the mitigation after an error has occurred.

Ultimately you need to be able to demonstrate that the risks are As Low As Reasonably Practicable (ALARP). This involves identifying ways that risks can be reduced. It is then necessary to determine whether those options are going to be implemented or explaining why they will not be implemented.

Rather than reviewing every individual task, it makes more sense at this stages to think of them as a whole. That way the ALARP assessment and subsequent recommendations can apply to all tasks, not those that have been identified as being high criticality.

6.1.1 ACTIONS TO ELIMINATE THE OPPORTUNITY FOR ERROR

Eliminating the opportunity for error will always be the most effective control, provided the action taken to eliminate an error does not create a greater risk elsewhere. The options to consider include whether the task or certain error prone steps actually need to be performed. Automating tasks can eliminate some potential errors, although it can lead to other, unforeseen vulnerability.

6.1.2 ACTIONS TO REDUCE THE CONSEQUENCES OF AN ERROR OR FAILURE

Where an error cannot be eliminated the next consideration is how the consequences of error can be reduced. Hazard reduction or substitution would be the most effective. Use of alarms and trips can assist, although only if implemented through a well designed and maintained system.

6.1.3 ACTION TO REDUCE THE LIKELIHOOD OF AN ERROR OR FAILURE

Having determined that an error may occur, but with tolerable consequences the next consideration is how the likelihood can be reduced. This is generally achieved by implementing engineering and soft controls.

6.1.4 ACTIONS TO IMPROVE MITIGATION

The final consideration is how errors can be mitigated. This generally includes systems that activate following a loss of containment including catchments (e.g. bunds, closed drains), detection (e.g. fire and gas detection), emergency procedures and arrangements; and Personal Protective Equipment (PPE).

6.2 Reducing risks through good engineering

We should always be looking for engineered solutions because, unlike softer controls, they are always present and predictable. The design stages of a project are the best time to implement engineering solutions. Once a system has been built it is far more difficult to make changes and they may result in higher and possibly unexpected risk.

The objective reducing risk through good engineering is to design systems that are easy to use without error. This has to include all modes of operation (e.g. normal operations, start-up/shutdown, and emergency) and maintenance. At the most basic level this is concerned with making sure people can access valves, gauges, instruments, sample points etc; taking into consideration what they need to do with these items, including use of tools and equipment.

I believe the principles of Task Risk Management allow us to go beyond the basic engineering considerations. It is difficult to provide generic examples of what to look out for but the following examples from projects I have been involved in may give you some ideas:

- Two identical compressors arranged as a mirror image – increases the likelihood of action or check on wrong object errors;
- Four compressors arranged in line, associated coolers arranged in pairs, one in front of the other – another example of increased likelihood wrong object error;
- Instrument air compressors located far from control room – response to trip task requires quick access to attempt restart, and so they should be nearer the control room;
- Drains vessel sized to take contents of system – some tasks may require system to be drained two or more times in quick succession, so vessel needs to be larger;
- 'Batch pigging' involving two spheres being launched in quick succession, with chemical slug in between - project had specified manual pig launching, requiring draining, venting and purging each time. Operator may be inclined to omit or shorten the duration of key steps. Automated pig launching would be much better;
- Chemical delivery facilities designed to accept different chemicals, some of which would be incompatible – unique connections specified to eliminate error potential. Reality is that tankers often arrive with adaptors, so the benefit of unique connections is greatly reduced.

I find that most design reviews tend to focus on physical arrangements of plant and equipment. Taking a task view leads you to asking different questions and challenging whether the design will allow people to do the tasks they need to in a safe and efficient manner.

6.3 Administrative controls

Whilst every effort should be made to engineer out risks, some will inevitably remain. Also, with an existing system, engineering solutions are not always practical. There will always be a place for soft controls including procedures, training and competence systems.

6.3.1 PROCEDURES

Companies have used procedures for many years, with part of their role being to manage risks. Unfortunately it is fair to say that most companies have problems with their procedures, particularly regarding use and compliance. I believe the root of these problems is failing to identify where procedures are really needed and what they need to contain. This results in too many procedures, with too much text that do not provide the users with what they need.

A lot has been written about how to write procedures, which I will not get into here. But what they usually fail to cover is what tasks require procedures. I find that the Task Risk Management process I have described here can help greatly. For example:

- The task lists make it easy to conduct a procedure ‘gap analysis’;
- The prioritisation identifies the most critical tasks, which are the ones that really need procedures;
- HTA is an excellent way of developing the content for a procedure;
- Task HAZOP identifies the parts of a task that are most vulnerable to error, allowing warnings and cautions to be included in the procedure.

As a general rule, I would propose the following approach to determining procedure needs based on task criticality:

- High criticality – full, step by step procedure required with tick boxes against every step; and sign-off at key stages in the task including completion;
- Medium criticality – detailed procedures provided for reference, but not necessarily used every time the task is performed by an experienced person (although they should perform the task the same way as written in the procedure);
- Low criticality – tasks do not require specific procedures. May be covered by generic instructions or guidelines where deemed necessary.

I find it useful to include a summary key information from the prioritisation scores and Task HAZOP on the front page of the procedure, as this explains how the task criticality has been determined and hence why the procedure has been written.

One thing to be wary of is the idea that all procedure should look the same. This seems to be something that came about when quality standards were introduced. The problem is that different tasks lend themselves to different forms of procedure, and tasks that are relatively simple and/or performed frequently may only require a simplified job aid. The actual format should be chosen according to the nature of the task and the needs of the user. In reality, a handful of different styles is usually enough to cover all types of task.

6.3.2 TRAINING AND COMPETENCE

As with procedures, I find the Task Risk Management process can help with improving training and competence. For example:

- The task lists make it easy to conduct a training and competence systems 'gap analysis';
- The task lists can be used to structure training and competence systems, especially for the lower criticality tasks where specific procedures may not be provided;
- The prioritisation of tasks can be used to determine the degree of rigour required for training and competence assessment;
- The review of risk control measures can identify specific competencies required to carry out the task.

For the higher criticality tasks the HTA, Task HAZOP and procedures form an excellent basis for training and assessment. My recommendation is that copies of these procedures are signed and retained as a record of the training and assessment carried out.

For the lower criticality tasks the task lists can be particularly useful. This is because these tasks are often learnt 'on the job' and most companies do not have very good systems in place to manage this. By rearranging the task lists to reflect the order that tasks are learnt in practice, it is easy to develop a very useful training and assessment plan.

6.3.3 FREQUENTLY PERFORM HIGH CRITICALITY TASKS

One issue that has emerged, especially for older sites, is where tasks ranked as high criticality by the scoring system are performed frequently. The guideline above says that the people performing the task should follow a full procedure every time. But I agree when clients say this is unrealistic for tasks that are performed very frequently, and can actually introduce risks if people blindly follow a procedure without thinking about what they are doing.

Ideally high criticality tasks should not be performed very frequently because the risks should have been controlled through good engineering, automation etc. But this is difficult to implement once a system has been built. In these cases I think the only solution is to ensure there are very robust competence management systems in place that can confirm and demonstrate that good practices are followed every time the task is carried out.

6.4 Review

The final stage of any management system is continuous review. This should include proactive and reactive interventions. In this case the aim is to keep the output from the process up to date, and look for opportunities to improve the overall systems.

One thing I would emphasise is that the result of review is invariably to identify apparent gaps that need to be filled with more task analyses, procedures etc. This is one of the reasons why companies have such problems with their systems continually growing. Sticking with the principles of Task Risk Management can help avoid these 'knee jerk reactions.'

6.4.1 TASK FEEDBACK

The best way of making sure any system is working as intended is to use it. If you have implemented Task Risk Management as described above you will have generated procedures, training and competence systems. If these are used as intended, information will be continuously available about how well these systems are working.

6.4.2 SCHEDULED REVIEW AND AUDIT

As with all systems, it cannot be assumed that the output from Task Risk Management will be correct forever. Therefore, review and audit is important; and should look at the whole system (i.e. task lists, prioritisation, task analysis) as well as the individual tasks.

Deciding what degree of review and audit can help you decide how many tasks you analyse in the first place. At some point you will find that the effort put into analysing lower criticality tasks would be more beneficial if it was directed to reviewing the higher criticality tasks that have already been analysed.

6.4.3 LEARNING FROM INCIDENTS

It is fairly obvious that any incidents or accidents that occur should result in a review of relevant procedures, training and competence systems. However, I believe that having implemented Task Risk Management will allow you to investigate the cause of events more effectively when they happen in the future. For example, answering the following questions will help you identify systemic and root causes:

- Was a task being carried out that was not on the task list for the system?
- Had the task scored low in prioritisation, yet been involved in a significant incident?
- Was the task being performed in the same way as described in its HTA?
- Had the errors that occurred in the incident been identified in the Task HAZOP?
- Were the existing risk control measures identified in the assessment correct and effective?
- Had recommendations for improved risk control measures been implemented?

I believe this reactive element shows why Task Risk Management is far more than simple task analysis.

ANNEX A – REFERENCE TABLES

Table 1 – Task List and Prioritisation

Task	Hazard-ousness	Introduced energy	Change config	Error vulnerability	Impact on device	Criticality Ranking
Routine Operations						
Receive delivery from road tanker	2	2	2	3	0	9 = High
Manually dip tank	2	0	1	1	0	4 = Low
Changeover duty/standby filter	1	0	1	1	0	3 = Low
Changeover duty/standby pump	1	1	1	1	0	4 = Low
Start-up & shutdown						
Shutdown system and prepare for maintenance	2	1	3	3	3	12 = High
Return system to service after maintenance	2	2	3	3	0	10 = High
Shutdown for operational reasons	2	0	1	1	0	4 = Low
Restart after operational shutdown	2	1	1	1	0	5 = Medium
Restart after a trip	2	1	1	2	0	6 = Medium
Respond to events						
Storage tank low level	Shutdown system					
Storage tank high level	Stop tanker loading or close valve in return line					
Filter high differential pressure	Changeover duty/standby filter					
Pump low flow	Changeover duty/standby pump					
Pump high discharge pressure	Shutdown system					
Respond to spill	Emergency - Critical task by default.					
Maintenance tasks						
Replace filter element	3	0	1	1	0	5 = Medium
Remove, repair and replace pump	3	0	2	1	0	6 = Medium
Remove, calibrate and replace safety valve	3	0	2	1	2	8 = High
Remove, repair and replace manual valve	1	0	2	1	0	4 = Low
Remove, repair and replace activated valve	1	0	2	1	0	4 = Low
Calibrate level instrument	3	1	1	1	3	9 = High
Calibrate pressure instrument	3	1	1	1	0	6 = Medium
Test trip function	3	1	1	2	2	9 = High

Table 2 – Task Scoring Guidelines (Operations and Maintenance)

Operations	None	Low	Medium	High
	(score 0)	(score 1)	(score 2)	(score 3)
How hazardous is the system involved?	Non-hazardous system (operations)	Small amount of low hazard / condition	Large amount of low hazard or small amount of high hazard	High amount of high hazard / condition
	Non-hazardous system (maintenance)	Task carried out after hazardous system has been proven hazard free	Actions taken to remove hazard, but some may remain	Work carried out whilst adjacent/related systems remain live
To what extent does the task involve the introduction of energy or an ignition source?	No ignition / energy sources	Low pressure or temperature rise	Medium pressure or temperature rise. Combustion engine.	High pressure or temperature rise
	No possibility of a flammable atmosphere	Electrical switching. Electrical equipment used.	Potential for sparks or hot surfaces	Flames
To what extent does the task involves changes to the operating configuration?	No change required	Simple valve changes (few valve moves)	Complex or multiple valve changes. Use of temporary connections	Complex and multiple valve changes. Use of temporary bypass line.
		Connect/dis-connect points designed for routine use (e.g. quick coupling, plug and socket)	Make/break small number of bolted joints	Complex assembly/disassembly. Multiple components.
What is the potential for error in performing the task?	Fully automated task	The potential for error cannot be rule out although there is no specific concern	There is a recognised possibility for error	There is a significant possibility of error Task requires constant vigilance.
	Very simple and errors would have no consequence	A 'normal' task	Complex task	Errors are likely to be unrecoverable No automated protection.
To what extent could the task affect performance of a safety system?	No systems overridden or defeated	Task involves a deviation from an original procedure or design.	Warning devices may be made inoperable (e.g. alarms, gauges, meters)	Trip systems overridden. Safety valves isolated.
	No safety system affected by task	May affect system calibration. Safety system may not operate as normal.	One of several layers of protection may be made inoperable	Multiple layers of protection may be made inoperable. Potential for common cause failure

Table 3 – Task HAZOP guidewords

Actions errors	Checking errors	Information retrieval errors
Omitted	Omitted	Omitted (Info not obtained)
Incomplete	Incomplete	Incomplete
Right action on wrong object	Right check on wrong object	Wrong information obtained
Wrong action on right object	Wrong check on right object	Incorrectly interpreted
Too fast/too slow	Too early/too late	Information communication errors
Misaligned	Selection errors	Omitted
Mistimed, too early/too late	Omitted	Incomplete
Too long/too short	Wrong selection made	Wrong information communicated
In wrong direction	Planning errors	Information unclear/ambiguous
Too little/too much	Omitted	Violations
	Incorrect	Deliberate actions

Table 4 – Task HAZOP Example

Task/Step	Error type and description	Potential consequence	Existing risk control measures	Suggested improvements
2.1 Connect earth to tanker	Action omitted, incomplete, performed on wrong object, too late or misaligned Failure to achieve earth before starting the transfer	Potential for static discharge to act as a source of ignition MAH – May result in pool fire (Scenario X in Safety Report)	Standard practice for all tanker operations Earth connection readily available	Consider installing interlocked earth connection
3.3 Check for leaks	Check omitted or delayed Do not check for leaks after starting transfer	Delay in detecting a leak. Larger spill to deal with. Possible escalation	Operator and driver standby throughout transfer. Area curbed to contain any spill	Improve lighting in area, Consider installing leak detection.
4. Disconnect tanker from delivery point	Action omitted or incomplete Not properly disconnected	Damage to hoses, plant or tanker	Driver responsibility Error unlikely	None
	Action too early Disconnect hose whilst transferring	Release of material being transferred	Noise will alert operator to face transfer is ongoing	None
	Action on wrong object Disconnect hose being used for another transfer	Release of material being transferred	Noise will alert operator to face transfer is ongoing	None

Table 5 – PIF checklist⁴

<p>Job factors</p> <ul style="list-style-type: none">J1 - Clarity of signs, signals, instructions and other informationJ2 - System/equipment interface (labelling, alarms)J3 - Difficulty/complexity of taskJ4 - Routine or unusualJ5 - Procedures inadequate or inappropriateJ6 - Preparation for task (e.g. permits, risk assessments, checking)J7 - Time available/required - Divided attentionJ8 - Tools appropriate for taskJ9 - Communication, with colleagues, supervision, contractor, otherJ10 - Working environment (noise, heat, space, lighting, ventilation)J11 – Access to worksite or equipment (including use of tools)
<p>Person factors</p> <ul style="list-style-type: none">P1 - Physical capability and conditionP2 - Fatigue (acute from temporary situation, or chronic)P3 - Stress/moraleP4 - Work overload/underloadP5 - Competence to deal with circumstancesP6 - Motivation vs. other priorities
<p>Organisation factors</p> <ul style="list-style-type: none">O1 - Work pressures e.g. production vs. safetyO2 - Level and nature of supervision / leadershipO3 - CommunicationO4 - Manning levelsO5 - Clarity of roles and responsibilitiesO6 - Peer pressureO7 - Consequences of failure to follow rules/proceduresO8 - Organisational learning (learning from experiences)O9 - Organisational or safety culture, e.g. everyone breaks the rules

PIF J11 is additional to the original list from HSE

⁴ Reference – www.hse.gov.uk/humanfactors/topics/pifs.pdf

Table 6 – PIF Evaluation Example

No.	PIF	Key points	Site Assessment	Action
	Job factors			
J1	Clarity of signs, signals, instructions and other information	Valve and pipework labelling needs to be good to avoid errors Tanker connection point must clearly show product name	Valves labelled with tag number and description Signage at tanker connection point is in poor condition	Install new sign at tanker connection point showing product name
J2	System/equipment interface (labelling, alarms)	Need to be able to monitor tank level during tanker operation	Local level gauge is not easy to see from tanker connection point. Operators relying on display in control room, using radio to communicate.	Re-position local level gauge on storage tank so that it is easy to view from tanker connection point.
J3	Difficulty/complexity of task	This is a relatively straightforward task. This PIF is not expected to be particularly relevant for this task.	No issues raised	None