Managing major accident hazard risks (people, plant and environment) during organisational change

MANAGING MAJOR ACCIDENT HAZARD RISKS (PEOPLE, PLANT AND ENVIRONMENT) DURING ORGANISATIONAL CHANGE

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FOREWORD

Organisational, technological and process changes often happen for reasons other than to reduce risk. The challenge for those people planning change is to ensure that these changes improve or maintain safety and environmental performance both during and after the change process. Every change, whether organisational or technical, will have implications for risk controls and therefore safety, such as changes in workloads, systems of work, management roles and priorities. The first objectives should be to ensure safety is maintained during and after the transition; then there is an opportunity to challenge current safety performance and set targets for improvement.

Successful change management involves far more than winning the support of people affected by change. Potential impacts on safety performance should be recognised, assessed and proactively managed, and outcomes reviewed and verified.

Achieving significant and sustainable change takes effort; the application of sound human and organisational factors techniques can ensure these efforts are directed at the objectives for the change. These techniques can also provide metrics to assess and monitor the risk and safety benefits, during and after the change.

This publication is aimed at organisations planning on undertaking change. It offers guidance to make these organisations aware of the issues related to organisational change including:

– a discussion of how and why organisational change can adversely impact safety, and
– case studies of organisational change contributing to major accidents.

It also provides guidance and techniques to assess and manage the risks of the change to major accident hazard (MAH) operations, including:

– how to recognise and assess change;
– how to scale the assessment and management of organisational change (MoOC) to the size and significance of changes;
– how to identify risk controls;
– how to determine if the risk associated with change has been reduced to as low as reasonably practicable (ALARP), and
– how to monitor the change for early warning signs of issues that are likely to affect risk.

It also provides references to further guidance that can be used to devise specific risk controls.

This publication provides advice, applicable across different types of energy and related industries and both small and large businesses. Each business should develop its own specific policies and procedures.

The guidance in this document is given in the context of process safety and major accident prevention. It is equally relevant to personal/occupational safety. This publication covers organisational change arising from changes in technology, plant, operations and/or changes in business organisation, staffing and management. Please note, throughout this document the word safety refers both to personal and process safety.

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1 INTRODUCTION TO MANAGEMENT OF ORGANISATIONAL CHANGE

Organisational change is a common and essential aspect of business growth and development. Change may be responsive to business developments. For example, new business operations may be taken on, unprofitable operations may be divested or ceased. New technology and ways of working may be introduced as part of maintaining competitiveness. Businesses may be merged or demerged.

Organisational change can help improve safety performance. Indeed, businesses should be proactively identifying how to change organisational safety arrangements as part of ongoing continuous improvement. For example, the redistribution of roles and responsibilities may help clarify accountability and encourage greater ownership of safety. Moving staff from one business unit to another might help embed expertise within a team that needs additional support. New research might suggest a new and more effective team design with respect to emergency management.

A response to new business requirements may also be used as an opportunity to improve safety management. For example, the merger of two companies may offer the opportunity to share a larger pool of expertise and lessons learnt on safety management.

Whether change is in response to business developments or part of a proactive safety plan, it is advised that all changes are assessed, planned and managed with the goal of reducing risk to ALARP.

The unintended consequences of organisational change can be catastrophic. As illustrated in the case studies in this guide, the costs can be great in terms of damage, business interruption and instances of injury or loss of life. Getting it right can help improve safety performance and thereby facilitate business improvement.

1.1 SCOPE

This publication aims to help organisations successfully manage the major accident risk aspects of organisational change, including:

- how to recognise change;
- what is a suitable form and level of assessment;
- what are the techniques for achieving a safe process of organisational change;
- what are the responsibilities of key people with respect to managing the safety aspect of organisational change;
- when to seek specialist help, and
- what are the indicators of good and poor practice.

This publication is for use by business team managers, human resources, maintenance and operations leads, project managers and planners, as well as safety and regulatory persons.

1.2 WHAT IS ORGANISATIONAL CHANGE?

There are many definitions of organisational change. It is defined here as:

The process of identifying, assessing, planning and implementing a change in an organisation's structure, management processes, strategy or resources. Change may be small or large.

Small organisational change may be merging two roles into one. Large change may be reducing staffing levels by (for example) 20 %, removing a level of management or relocating specialist services to another site.

1.3 SOURCES OF ORGANISATIONAL CHANGE

This publication covers organisational change that comes from changes in technology and operations, as well as discrete changes in business organisation, staffing and management. Whilst MoC procedures may cover technical and operational change, this publication provides guidance on how to recognise and manage the organisational aspects of these changes. A small process change may have a limited impact, such as a need to update procedures and training. A large organisational change, such as moving specialist staff away from a facility, may have a greater organisational impact, thereby limiting the opportunity for local collaboration.

1.4 COMMON PROBLEMS WITH ORGANISATIONAL CHANGE

There are many reasons why the MoC may be ineffective, as illustrated in Figure 1.

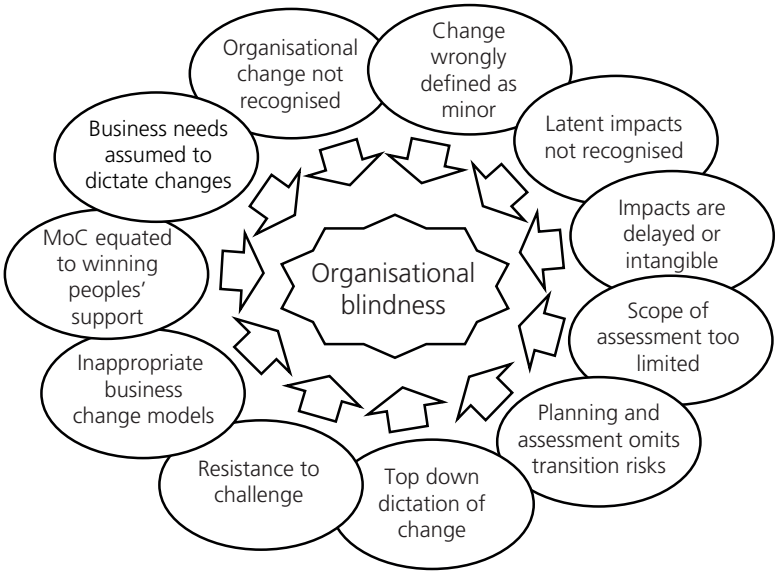

Figure 1: Common problems with organisational change

Some typical reasons are noted as follows:

An organisational, process or technological change is neither recognised nor managed:

– This can be due to the change being labelled as, for example, relocation of a facility, where in fact this involves moving technicians to a remote part of a site and creating a physical (distance) barrier to working with team members.
– Other examples may include a change in operations or processes that requires a change in staff competences, systems of work and organisational structure. For example, changes such as introducing new technology, moving from operations to decommissioning and increasing product throughput may all require (unrecognised) organisational change.

A change is categorised as being of minor importance and assessed by staff without enough authority or perspective to apply effective risk controls:

– For example, the merger of two roles into one may be managed as a job consolidation task, with a team leader authorised only to manage the job consolidation. If the two roles are safety critical and these are the only qualified workforce, the assessment should possibly include determining the need for retaining role 'redundancy' and succession management.

The change has latent adverse impacts that are not recognised:

– For example, a reduction in specialist engineers does not immediately lead to problems in engineering decisions, but gaps in expertise are revealed two years later when a less frequent issue arises. This latent impact is not recognised at the time of change due to assessment focusing on common tasks and/or only looking at routine workload, rather than a more comprehensive assessment of routine and exceptional competence needs, and the organisation not ensuring it has retained sufficient in-house expertise to effectively manage outsourced services.

The scope of assessment is too limited:

– This may be because the scope of assessment is overly limited to workload and does not consider other impacts such as competence gaps, teamwork, communications or team workload. An engineering focused MoC assessment may overlook impacts on staff training and operational support requirements, especially if these only emerge part way through an engineering or operational change.
– The assessment of the safety implications of change may focus on occupational safety without considering or recognising potential impacts on process safety. This may relate to issues such as maintenance schedules being defined as engineering requirements, without recognising their impact on process safety.
– It could also be due to no attempt being made to identify whether any safety critical roles are impacted by change, either due to a lack of understanding of safety by the team leading the change, or a lack of appreciation of major accident risks. Changes are then implemented that adversely impact safety critical roles without due assessment or risk controls.

Another example is where changes are assessed one by one without due regard for the interaction of changes, or of the impact of changes as a whole.

Assessment omits transition risks:

– The assessment is limited to considering the end state and does not consider organisational risks during the period of transition, or has a very narrow focus, for example, staff morale. Other transition risks such as temporary gaps in staffing and periods when staff are being upskilled are not considered.

Top down dictation of change:

– A new target operating model is devised by senior management and applied without consulting staff or considering alternatives, driven by a view that the new model is the 'only option'. This may also be magnified by a conviction that a large amount of time and effort has been devoted to devising plans, creating a feeling that the plans must be right. Commitment to a plan may escalate due to a feeling that a large effort and cost of planning must be justified by implementing the plan.

Resistance to challenge:

– Senior management may fear that listening to challenges about proposed changes may prevent or delay business critical change. This may also be magnified by a conviction that the time and effort devoted to devising plans would be wasted if challenges were to be accepted. Similarly, if a group of people have devised a plan and reached a consensus on it, they may feel a shared sense of commitment to it, causing challenges to appear as threats from people outside of this group. Optimism bias and overconfidence may also cause challenges to be disregarded. Reactance bias may cause planners to believe the opposite of challengers, due to a perceived need to resist attempts to restrict their freedom of choice. Ultimately, managers should recognise that MoC is a complex process in which there is a high potential for unintended consequences. As well as reviewing the logistics of changes, planning regimes should carefully examine changes to ensure risks are not inadvertently increased. This, in turn, requires a sophisticated understanding of how the organisation currently controls its risks.

Inappropriate business change models:

– Businesses operating MAH sites have a legal and moral duty to use suitable and sufficient risk assessment to foresee risks and implement risk controls to reduce risk to ALARP. Potential adverse impacts should be systematically assessed, risk controls applied, and performance proactively monitored.
– The application of what might colloquially be termed a 'change and hope model' or a 'wait and see model', runs counter to good safety practice as well as legal duties. Whilst such models may be accepted with respect to business risks in low hazard sectors, they fall far below expected management standards in MAH sectors.
– Similarly, the application of a standard staffing model across many sites may lead to a failure to recognise or accept that staffing needs may differ between what may at first appear to be similar operations. Staffing needs for similar operations may differ due to, for example, differences in the experience levels of staff, site-specific operational processes, differences in the age and reliability of equipment, or country-specific regulations.

Where MoC is equated to winning the support of people:

– It is assumed that MoC is only about securing staff support of changes, or at least diffusing opposition to change. This mind-set can be exacerbated by a top down approach to change driven by people who have, in isolation, determined those changes. There may be a tension between the temptation to only involve the workforce once it is too late for them to have an impact on the change, and engaging the workforce early in a way that demoralises employees, leading to fear, stress and ultimately resignations.

Assuming business needs dictate change:

– A presumption that specifies organisational changes must be accepted without challenge, due to financial imperatives, can 'blind' an organisation to the potential adverse impacts of proposed changes – closing out risk assessment, preventing consideration of alternatives and challenges from within the organisation.
– This can be exacerbated by a demand for an unrealistically high level of evidence of potential adverse impacts, or evidence that changes are having an adverse impact very soon after implementation. Given that the impact of organisational change may not appear for some time, the demand for evidence can inappropriately cause concerns to be dismissed.

These problems are typically due to:

– change being driven by organisational development specialists without sufficient support from safety specialists;
– insufficient safety management competence amongst decision makers; an example could include management consultants being given a brief to downsize without sufficient appreciation of how the organisation works and how risks are managed due to their limited experience working the the organisation, leading to gaps when MoC results in the downsizing of staff whose roles in the management of day-to-day risks were not formalised or fully realised.

Organisations may fail to recognise these problems, due to the same reasons these problems occur, namely that they do not recognise the issues and the potential consequences. This may be termed 'organisational blindness'. The impacts may also be intangible and delayed. The impact of individual changes may be minor but the cumulative impact of all changes may be more significant, with adverse consequences growing over time as incremental change occurs. A further contributory factor to organisational blindness can be an excessively hierarchical organisational culture and a culture that reacts adversely to challenge and questioning. Rejection of challenges or a culture that dissuades challenge can contribute to a failure of people to raise valid concerns and to the inappropriate dismissal of valid concerns.

This publication outlines a series of methods and steps aimed at achieving a timely, systematic and objective scrutiny of plans, thereby countering 'organisational blindness' and changes driven by an overly narrow set of business requirements.

1.5 POTENTIAL ADVERSE IMPACTS OF ORGANISATIONAL CHANGE

Examples of the adverse impacts of change are summarised in this section.

– Loss of competence.

  Roles are merged without sufficient upskilling of people, contributing to human error amongst operators, engineers and managers.

  Procedures and training are not updated to enable people to correctly operate changed equipment and altered processes.

  Managerial tasks are delegated to supervisors without due regard for upskilling of operators or supervisors.

  Reliance on single experts (singletons) without clear succession planning.

– Loss of local expertise.

  Centralisation of specialists can lead to loss of local expertise, reducing ability to conduct safe operations and respond to abnormal events and emergencies.

  Reduction in staffing levels lead to reliance on a single expert, with no cover in the event of their absence or the unforeseen departure of key staff.

– Loss of organisational memory.

  The loss of experienced staff, without suitable knowledge management, can lead to a loss of memory of risks and reasons for risk controls, contributing to unwitting tolerance of unsafe changes to working practices and risk controls.

– Loss of focus on process safety.

  A new target to improve performance, such as improving occupational safety or environmental performance, may lead to a reduction in focus on process safety, inadvertently leading to less management of process equipment and operational capability.

  Similarly, decentralising responsibility for safety to local management, without oversight and management of accountability, may contribute to local managers overlooking safety responsibilities.

– Degraded process safety management.

  Change driven by a focus on cost reduction and efficiency could lead to a loss of focus on process safety, with degradation of inspection and maintenance of equipment, reduction in safety assessment of processes or technological changes, reduction in resources deployed to managing technological or process changes (such as retraining operators and amending procedures), and management making poor cost-benefit decisions.

  This can lead to organisational drift including the:
  – degradation of key aspects of safety processes, including competences and safety awareness, and
  – failure of oversight processes, both internal and external, to detect and effectively arrest the degradation.

– Excessive workload.

  Staffing levels are reduced to a level where people suffer stress and fatigue, with excessive workloads leading to human error and poor health. This may be due to merging roles, delegating responsibilities without the assessment of workload and capacity, or fewer people doing the same tasks, for example.

Throughput and production levels increase to a level that contributes to human error and omission of safety tasks such as equipment maintenance.

– Over reliance on automation.

  Staff become over reliant on automation, such as relying on automated shut down systems and high-level trips, rather than actively monitoring and controlling operations, with the risk of failing to detect, for example, tank overfilling when automated shutdowns fail. Here, the knock-on effects of 'deskilling' should be fully understood, i.e. it may require additional training/simulator time or procedures to help operators intervene in the event of an automation failure.

– Loss of controlling mind.

  The organisation contracts out activities without retaining sufficient expertise in house to competently specify requirements, oversee performance, or intervene effectively in the event of poor performance.

  The organisation devolves responsibility from a central body to distributed business units, causing loss of corporate oversight of local performance.

– Ambiguous lines of reporting.

  Reorganisation of businesses and roles may, without suitable definition of roles, lead to confusion over lines of reporting and responsibilities, with the risk of key safety decisions and tasks being overlooked or delayed.

– Creating organisational barriers.

  Reorganisation of businesses may create organisational boundaries that hinder the sharing of expertise and support between parts of the business. For example, occassionally systems that worked well before the change do not work well in the reorganised company, e.g. the PTW system may no longer suit the new organisational arrangements.

2 CASE STUDIES OF MAJOR INCIDENTS

The following case studies illustrate how organisational change can contribute to major accidents. The examples show how change can be relatively small and task-specific, such as failing to update training and procedures after installing a new control device, versus major organisational changes. They also indicate how impacts can occur soon after a change, or after a period of time due to latent conditions and how multiple changes, implemented over a period of years, can interact to cause an event.

2.1 CASE STUDY 1: ESSO LONGFORD EXPLOSION 1998

2.1.1 What happened?

The Longford gas explosion was a catastrophic industrial accident that occurred at Esso natural gas plant at Longford near Melbourne, Australia, killing two workers, injuring eight and cutting the gas supply for the state for two weeks.

A failure of a lean oil system caused the temperature of the metal heat exchanger to drop and become intensely cold and therefore brittle. When operators tried to reintroduce the warm oil, the brittle vessels fractured and released large quantities of hydrocarbon vapour, which found an ignition source and exploded.

Andrew Hopkins (*An AcciMap of the Esso Australia gas plant explosion*) identified several factors contributing to the explosion, namely: absence of engineers; focus on lost time injury rates; poor audit; deferred hazard and operability study (HAZOP); management control failure; inadequate regulatory systems; government failure to provide alternative gas supply and market forces leading to cost-cutting strategy.

2.1.2 How was organisational change a factor?

Several changes took place without risk assessments. The first change related to gradual destaffing (1993 to 1998), evident in reduced number of supervisors and associated staff (from 25 to 17) and maintenance staff (67 to 58) on the plant. The destaffing meant that suitable personnel were not available when required.

The second change related to the relocation of all Longford plant engineers to Melbourne as part of the restructuring of the company (also known as centralisation). This change had long-lasting effects on the operational practices of the plant, as operators lacked engineering expertise, and the engineers themselves no longer had access to the detailed knowledge of plant activities as they were no longer collocated.

The Longford Royal Commission Report states that:

> '*Though the existence of a link between this failure and the occurrence of the accident is hard to evaluate, appropriate management of change risk assessment may have exposed important and relevant weaknesses in the level of operator knowledge, in training programmes, in communication systems, in operating procedures and in other aspects of Esso's management system*' (*The Esso Longford Gas Plan Accident*).

Decentralising the responsibility of safety was another factor contributing to the event. Head offices handed over responsibility for safety to operating subsidiaries. Although the head office encouraged Esso Longford to conduct a HAZOP on the plant, it did not exercise any direct control over subsidiary companies. As a result, Esso Longford was able to defer their HAZOP indefinitely.

2.1.3 How might it have been managed differently?

Destaffing, centralisation of engineers and decentralisation of safety all constitute major changes, and therefore could have been treated as such. An MoC risk assessment, identifying potential risks and impact of the change-related activities could have been completed. This might have prompted options such as upskilling plant operators, ensuring accessibility of engineers and maintaining a certain degree of control over safety by imposing stricter requirements for HAZOP.

2.2 CASE STUDY 2: TEXAS CITY REFINERY EXPLOSION 2005

2.2.1 What happened?

The Texas City Oil Refinery explosion occurred when a hydrocarbon vapour cloud was ignited and exploded at the isomer (ISOM) process unit. 15 people lost their lives and 170 were injured. The incident was caused by hydrocarbon vapours meeting an ignition source and combusting. During the start-up of an ISOM unit, the associated raffinate splitter tower was overfilled and overheated. A substantial volume of hydrocarbon liquid and vapour was forced into an adjacent blowdown stack, rapidly exceeding its capacity. Ignition of the vapour cloud caused an explosion that extended to nearby temporary trailers.

Redundant high-level alarms, a faulty tower level indicator, and outdated procedures impaired operators' ability to monitor the level in the splitter tower. An underlying cause was that Texas City Oil Refinery used inadequate methods to assess safety conditions. Focus was given to environmental and personal safety, but less to process safety.

2.2.2 How was organisational change a factor?

The incident inquiry reported that the Texas City refinery's cost-cutting strategies that were maintained despite declining conditions of the equipment and infrastructure, made the refinery vulnerable to incidents. The Chemical Safety and Hazard Investigation board (CSB) stated that:

> '*BP targeted budget cuts of 25 percent in 1999 and another 25 percent in 2005, even though much of the refinery's infrastructure and process equipment were in disrepair*' (*Safety Bulletin*).

The cost-cutting strategies also affected operators' training and led to downsizing. This resulted in insufficient staffing to handle operator workload during high-risk periods.

Many organisational changes occurred after the 1999 merger of AMoCo and BP. In the wake of the merger, responsibility for safety was delegated to business units. As a result, health, safety, environmental and process safety functions were decentralised and split into different parts of the corporation. This restructuring may have been cost-effective; however, it lacked safety reporting and monitoring systems.

The site had numerous process safety committees, which were not aligned with the key site priorities: the committees were devoting time to relatively minor health, safety, and environmental risks, rather than focusing on management of major risks.

Organisational changes led to lack of accountability, poor communication between staff, supervisors and managers, a poor performance management process, and confusion with regard to roles and responsibilities. The CSB stated that:

> *'After the AMoCo merger, Texas City underwent a complex series of leadership and organisational changes that were only informally assessed for their impact on safety and health. BP Texas City did not effectively assess changes involving people, policies, or the organisation that could impact process safety'* (*Investigation report, refinery explosion and fire*).

2.2.3 How might it have been managed differently?

Mergers, reorganisation, staff cutting, budget cuts, policy changes and organisational drift all had an impact on BP Texas' refinery safety systems. Audits found out that changes were not effectively managed. Although BP did conduct MoC analysis, their findings were not implemented effectively. Furthermore, deviations from the procedure were made without reviewing the MoC hazard analyses.

Results from MoC analysis should have been reviewed and the impact of change reassessed. Mitigating strategies and contingency plans should be designed where change may result in an adverse impact on the safety operations. For example, downsizing strategies should consider safety critical roles and their impact upon safe operation of the business. Identifying an effective resourcing strategy and providing training for individuals in safety critical roles is recommended.

Setting a clear accountability and chain of command organisational chart could have brought clarity with regard to the lines of reporting. MoC should aim to drive integration throughout the organisation from the top and reduce the number of interfaces and barriers between different parts of the organisation.

2.3 CASE STUDY 3: HERTFORDSHIRE OIL STORAGE TERMINAL FIRE (BUNCEFIELD) 2005

2.3.1 What happened?

The Buncefield fire was a major conflagration caused by a series of explosions involving 20 storage tanks, on 11 December 2005, at an oil storage facility in Hertfordshire, United Kingdom. The explosion injured 43 people, destroyed homes and businesses and could be heard 125 miles away. The fire burned for several days destroying most of the site and emitting clouds of smoke into the atmosphere.

The storage tank had a level gauge to enable manual monitoring, and an automated high-level switch that would shut off inflow if a certain level was reached. The manual gauge was stuck and the shutoff was inoperative, requiring the operator to fill the tank 'blind'. The tank was overfilled, and fuel leaked from a vent and was then ignited.

The level gauge had stuck 14 times after a service in August 2005, but it is reported this did not concern site management. The shutoff was not fitted with a padlock that was required for it to operate correctly.

The fire was attributed to the overfilled storage tank, and the poorly defined tank filling systems that caused overreliance on automated shut off, increase in throughput, and reduced waiting times between fills. A complacent approach to matters of safety was also cited within investigation reports (*The underlying causes of the explosion and fire at the Buncefield oil storage depot, Hemel Hempstead, Hertfordshire*).

2.3.2 How was organisational change a factor?

The company introduced new operating automated systems which were not checked for functionality and efficiency. There was no formal MoC process – as a result, assessment of the benefits and disadvantages of the change was not conducted. An increase in throughput increased the pressure on staff and management. The poorly defined tank filling system and unreliability of automatic tank gauging (ATG) systems decreased operators' ability to monitor the receipt and storage of fuel.

The impact of process changes and the introduction of new technology increased staff workload and diverted their attention from safety processes. As a result of these changes, the focus was on keeping the process operating with little attention to process safety.

2.3.3 How might it have been managed differently?

If the increase in throughput and automated shutoff had been defined as a change and subjected to MoC assessment, the need to ensure effective management of tank filling operations could have been identified. It is also likely that MoC assessments would have identified the adverse impact these changes might have on the workforce and operational safety, which would lead to design and implementation of risk mitigating strategies.

2.4 CASE STUDY 4: EQUILON ENTERPRISES OIL REFINERY FIRE 1998

2.4.1 What happened?

On 25 November 1998, an explosion and fire erupted on the cooking plant at the Equilon Puget Sound Refinery in Anacortes Washington, USA, killing six workers, who were attempting to restart the delayed cooking unit following a power outage.

A loss of electric power and steam supply prior to the fire had resulted in abnormal process conditions that the operators were not prepared for. A process interruption resulted in a partially filled drum, which operators were attempting to clean up without any written procedures on how to proceed in such circumstances. The temperature reading device indicated a much lower temperature than the temperature expected for a fully filled drum. The absence of procedures and the lack of understanding of the limitations of temperature sensing devices resulted in ineffective decision making. Injecting steam into the drum caused the petroleum vapour to burst into flames.

2.4.2 How was organisational change a factor?

The absence of MoC policies that would deal with abnormal situations was a contributing factor in this incident. In this case, staff were attempting to deal with a situation that was different to thir normal process. As a result, staff had to make decisions in the absence of written procedures for handling partially filled drums, without the support of engineers. The CSB highlights the importance of MoC policies and states that:

> '*the Equilon incident underscores the need to have MoC policies that include abnormal situations, changes to procedures, and deviations from standard operating conditions*' (*Safety Bulletin*).

2.4.3 How might it have been managed differently?

Chemical processing plants should recognise that physical alterations to standard processes (e.g. in this case, stopping production of steam and having only partially filled drums) constitute a change and require systematic methods of management. The impact of these emergent changes should be assessed (through hazard analysis), and processes to mitigate them should be designed. In this case, it would be useful to design operating procedures for process variables for all common tasks and train staff to recognise which deviations are significant to initiate further review.

The Equilon incident could have been avoided if the 'change' was managed by a team experienced in hands-on operations, safety procedures, and engineering calculations. Having a policy document containing written procedures for cooling and emptying partially filled drums might have also decreased the likelihood of the incident.

2.5 CASE STUDY 5: CONDEA VISTA COMPANY DETERGENT ALKYLATE PLANT IN BALTIMORE EXPLOSION AND FIRE 1998

2.5.1 What happened?

On 13 October 1998 an incident involved a reactor vessel's explosion and fire at the CONDEA Vista Company detergent alkylate plant in Baltimore, USA. The incident injured four people and caused extensive damage to the facility.

The Baltimore facility changed its process approximately three months before the incident. The change included replacing the direct addition of aluminium chloride with powdered aluminium to the reactor, where it combined with hydrogen chloride to form the necessary aluminium chloride. Shortly after the introduction of powdered aluminium, sludge-like residue was forming in the reactor. Operators' attempts to clean the reactor included adding water and steam to the reactor, which led to the explosion.

2.5.2 How was organisational change a factor?

The changes to process technology were executed without prior hazard analysis or written procedures for variance in operating procedures and practice. The consequences of absent procedures are described by the CSB report:

> '*. . . the absence of written instructions increased the likelihood of miscommunication between the two shift supervisors, which led to the unsafe application of steam in the reactor vessel*' (*Safety Bulletin*).

2.5.3 How might it have been managed differently?

Adjustment to process technology should be treated as a change. A hazard analysis should be conducted on the proposed procedures to assist in identification of potential safety hazards. This should be followed by design of procedures which would minimise the safety hazards and aid staff in decision-making and identification of the correct solution. Therefore, MoC methodology should be applied to preplanned changes involving technology, processes and equipment, and essential elements of new operational procedures should be communicated in writing. Authorisation of changes would enable the technical manager to review the procedure and detect deficiencies. Staff should be provided with training in new procedures, the effectiveness of which should be periodically reviewed.

3 INTEGRATING MANAGEMENT OF SAFETY INTO ORGANISATIONAL CHANGE

There are many models of organisational change. A typical business model is given in Figure 2. It typically commences with recognising the need to change and then scoping these changes. This is followed by defining changes and then implementing and sustaining change. Where change is driven by business considerations, as opposed to initially being driven by a safety improvement plan, it is advised that management of safety is integrated into each stage.

Some key safety management actions are noted for each stage of change, namely:

– recognising potential impacts on safety early on and ensuring a suitable level of assessment and assurance, including risk assessment within (organisational change) business cases and cost-benefit assessments;
– assessing the impacts on major accidents risks, recognising the latent effects of organisational change on safety and identifying opportunities to improve safety management;
– empowering staff to challenge proposals and offer insights;
– defining risk controls and recognising and managing transition-related risks, and
– defining and using process safety KPIs to monitor the impact of changes.

As part of this it should be recognised that organisational change is more than winning the support of staff. It is also assessing how change may impact major accident risks and proactively managing the safety aspects of change in the short- and long-term.

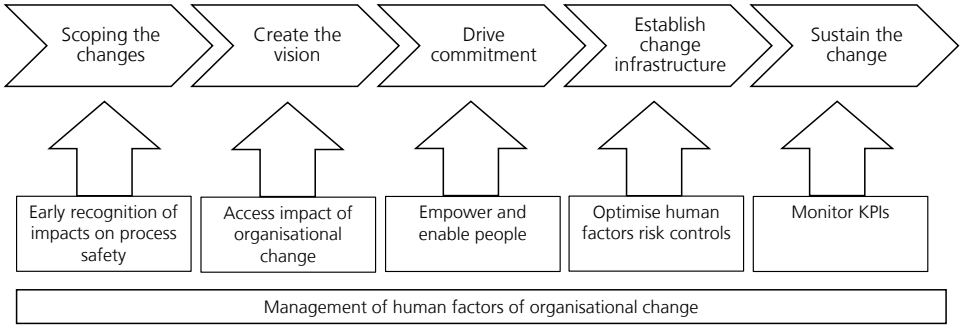

Figure 2: Typical stages of organisational change

4 INTEGRATING ORGANISATIONAL CHANGE INTO MANAGEMENT OF CHANGE

Most energy organisations have an MoC policy and procedure. These are typically applied at a high frequency to engineering and operational changes.

It should be ensured that assessment and management of human and organisational factor (HOF) impacts are integrated into MoC policy and procedure.

The organisation should decide whether to have a single integrated MoC process and MoC committee covering engineering, operations and HOF, or whether to have dedicated approaches assessing engineering/operations and HOF change seperately. If the latter, the organisation should carefully consider the risk of an engineering/operational MoC process overlooking HOF impacts, or only recognising them after adverse outcomes have occurred. If an engineering MoC assessment identifies HOF impacts, this should trigger additional scrutiny of these impacts.

This guide assumes a single integrated approach to the assessment and management of change, irrespective of the origin of these changes and whether change involves engineering, operations, plant, people or the organisation.

4.1 A TYPICAL MANAGEMENT OF ORGANISATIONAL CHANGE PROCESS

Figure 3 presents a typical MoC process that can be mapped onto organisations' own specific policies and processes. The following sections of this publication provide guidance on each of these stages, except the implementation phase. Annex F provides an indication of what good practice comprises.

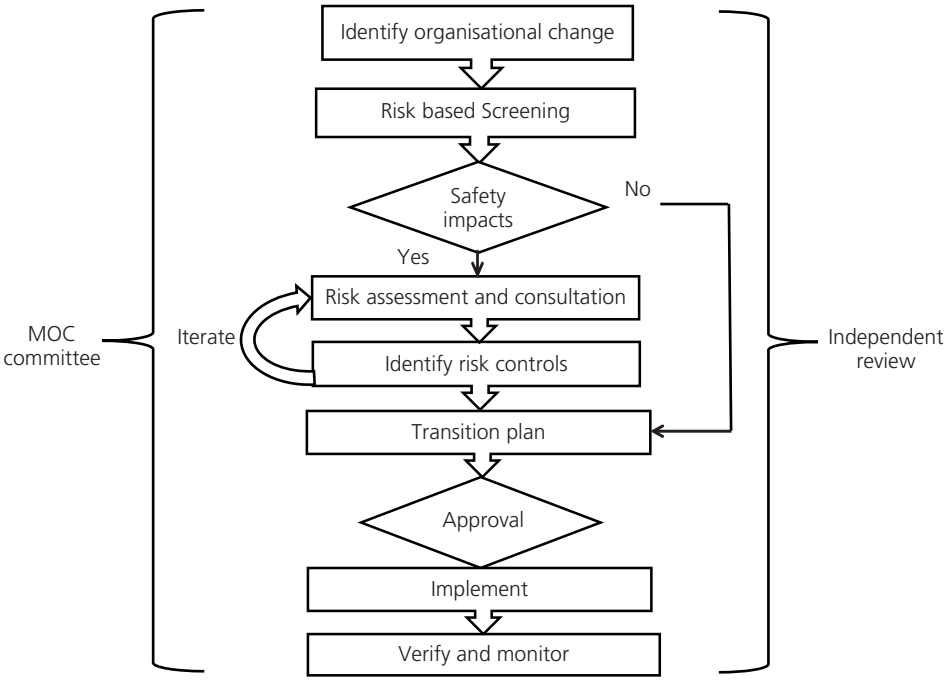

Figure 3: Typical management of change process

5 IDENTIFYING ORGANISATIONAL CHANGE

5.1 RECOGNISING ORGANISATIONAL CHANGE QUICKLY

The early recognition of organisational change allows due diligence to be applied to assessment and planning. Failure to recognise a change may lead to a subsequent omission of change management and, in the event of problems, sudden and unexpected adverse impacts on safety performance, environment, finance, etc. Moreover, the failure to recognise change and failure to manage change may be construed as either negligent or grossly incompetent management performance, leading to a loss of confidence in the organisation by stakeholders, staff, etc.

Engineering, operational and organisational changes should be scrutinised at an early stage, such as during optioneering or during the scoping of changes. If the organisational and HF impacts cannot be clearly discerned at an early stage, then this should be noted and plans made to scrutinise changes once the nature and impacts of change become clearer.

The early recognition of change can be aided by:

– having a policy and commitment that all changes are identified, screened and recognised as changes;
– ensuring managers are competent in respect of understanding organisational change and its management, and
– having a clear view as to what constitutes an organisational change.

This can be supported by use of an organisational change checklist as shown in Table 1. The checklist notes categories of changes and examples. Such checklists may be applied during routine safety management meetings, such as site safety committee meetings, with committee members tasked with noting changes for assessment. Outside of routine meetings, responsible management may apply the checklist to their plans, noting any organisational change and hence, entering them into an MoC procedure.

5.2 TYPES OF ORGANISATIONAL CHANGE: A CHECKLIST

Table 1: Organisational change checklist

Type of change	Examples of organisational change	Yes	No
Merging (or demerging) business units, departments or teams	Merger of two regional business units Sale of one arm of a refinery and chemical productions business Splitting management of a fuel storage site into two units		
Removing levels of management or supervision ('delayering')	Removing (for example) the grade of team supervisor		
New organisational objectives, values, priorities or norms	Greater focus on innovating new products, greater investment in staff retention or focus on reducing operating costs Greater focus on occupational safety		
New employment terms and conditions	Such as moving from permanent to fixed term employment contract, changing working hours/duties and responsibilities/supervisor responsibilities/working locations		
Merging roles	Combining two field operator roles into one, e.g. for two parts of a process		
Changing roles and responsibilities	Addition or removal of responsibilities to/from a role Change in span of managerial control Change in reporting lines Centralising or decentralising roles and responsibilities/functions		
Shift systems or working hours	Such as changing start and end times, reducing or extending working hours, moving from a rapidly rotating to a slowly rotating shift system		
Resourcing – changing staffing or manning levels	Reduction from 5 to 4-person teams of fitters		
Reduction in specialists	Reduction in number of specialist technicians		
Relocating staff	Moving staff to a new building onsite or to a different site Moving staff between departments or teams		
Outsourcing activities	Outsourcing activities previously performed in-house, such as outsourcing maintenance, specialist engineering roles or tanker operations		
Change in outsourcing policy	Change in criteria for selecting subcontractors or suppliers, such as a new requirement for an accredited quality management system		

Table 1: Organisational change checklist (continued)

Type of change	Examples of organisational change	Yes	No
New ways of working	Such as self-managed teams or multi-skilled teams		
New systems of work	Such as new ways of planning maintenance work, new maintenance schedules, change from planned to responsive maintenance Change in shift hand-over process New permit to work system		
New management programmes or system	Such as a new programme or process for determining training needs		
Introduction of new technology	Such as automated control systems, automatic control valves or computerised control systems requiring new procedures, training, staffing arrangements, new roles and/or ways of working etc.		
Altered process design or composition of products	A new product composition, a new type of reactor is added or a change in the piping system, requiring new procedures, training, changed staffing arrangements, new roles and/or ways of working etc. The same stands for a reduction in technology which can, for example, place more emphasis on the operator to respond to alarms rather than have automatic shutdown		
Change in production level or production/operation times	A higher rate or volume of production, requiring new procedures, training, changed staffing arrangements, new roles and/or ways of working etc.		

6 RISK BASED SCREENING

6.1 DETERMINING THE LEVEL OF ASSESSMENT AND ACCOUNTABILITY

The scale and safety criticality of change can vary from insignificant to major. The extent and form of assessment, verification and management accountability should be aligned with the significance of the change. This commonly involves applying screening and 'scaling' criteria to the proposed change. Typical criteria may include:

– the safety criticality of roles and activities impacted by changes;
– the number of roles/operations affected, and
– whether the change requires regulatory approval or impacts the licence to operate.

When assessing changes, an organisation should aim to recognise the overall impact of a group of changes, as well the impact of each individual change. Whilst each individual change may be minor, the changes as a whole may be more significant. Therefore, a judgement should be required as to whether a set of changes may interact or have a cumulative impact. These changes may be separate in terms of when they are being implemented, who they affect and/or the type of change. It is useful to define the changes being screened and, if need be, revise an earlier assessment if it subsequently becomes apparent that a set of changes has occurred.

6.1.1 Screening safety impacts

An example set of screening criteria is noted in Table 2. The table also notes the level of assessment and management accountability.

In the case of major and significant changes, these may require a formal assessment, approval and verification process, with 'hold points' where formal approval to proceed is determined. This may include a detailed documented assessment, independent review and possibly external regulatory approval. Approval may be contingent on development of detailed project plans, interim and final verification of changes.

Minor changes may have lesser control, such as a checklist-based assessment and self-approval by the management responsible for the changes. Change with insignificant risk may be self-approved with no further assessment. Care should be taken to ensure that the aggregate risk associated with a group of small changes is not underestimated. Where a series of small changes are made in the same period of time or impacting the same group of people, consideration should be given to assessing these as a single set of changes.

The level of scrutiny of the impact of changes on HOF, should be equal to the level of scrutiny for engineering and operational changes. The level of scrutiny should be proportionate to the magnitude and potential consequences of change, rather than whether the impacts relate to engineering, operations, organisational or HF.

An ideal is for all changes to be checked by a safety committee, to verify their categorisation. The organisation might maintain a register of organisational changes, logging their categorisation. A safety committee could be responsible for maintaining the register.

Table 2: Risk based screening of changes: safety impacts

Category	Examples	Level of assessment and accountability
Major	Outsourcing a safety critical function Large scale reduction in staffing levels (e.g. 10 %) Any change that affects licence to operate Removing a layer of supervisors or managers	Detailed and formal documented assessment, for example by a site or company safety committee Peer review Formal staff consultation May require assessment and approval by external regulator Approval by director(s)
Significant	Transferring responsibilities, e.g. between roles or between departments Merging two safety critical roles Making one of two safety critical posts redundant Relocating specialist staff to a new site away from an operating site	Detailed and formal documented assessment, for example, by a site or company safety committee Peer review Approval by director(s)
Minor	Change in operating procedures and training due to amended process or new technology	Assessment by checklist Self-approved by local management
Insignificant	Merging two roles that have no significant safety responsibilities or impacts	None Self-approved by manager responsible for change without further assessment or verification

6.1.2 Who should be accountable for assessment?

The management level responsible for approving changes should be proportionate to the risk. As noted in Table 2:

- Site level or corporate safety functions (committees and/or boards) should take responsibility for major changes with external/independent audit and review, with approval by the company board/head safety committee.
- Significant changes may be assessed and managed by site management with approval by directors.
- Minor and insignificant changes may be proposed by a local department or unit management, such as by an operations manager, but should be assessed by a safety committee or other independent person.

7 RISK ASSESSMENT

7.1 ORGANISATIONAL CHANGE RISK ASSESSMENT TEMPLATE

A typical risk assessment template is given in Annex C. A common approach to MoC risk assessment includes:

– describe the changes;
– determine a proportionate level of assessment, informed by the risk-based screening in Table 2;
– identify and describe potential impacts (positive and negative) and the causes of these impacts;
– rate the risk associated with changes;
– determine risk controls;
– reassess the post-risk controls;
– define indicators, audit and review actions for monitoring impacts of changes and verifying implementation of risk controls, and
– independent review and validation of the risk assessment and risk controls.

As noted above, assessment should cover latent and transition risks. These are elaborated in 7.2 – 7.3.

7.2 ASSESSING LATENT IMPACTS ON PROCESS SAFETY

A key issue with organisational change is that the impact of some changes may not be immediate. For example, the relocation of specialist technicians away from a site may not adversely affect day-to-day operations during normal operating conditions. However, in the event of abnormal operations, such as during a process upset, the relocation of specialist technicians may reduce their ability to diagnose faults and advise on safe control of abnormal operations. As abnormal operations may be infrequent and may not occur until sometime after the change, this impact will not be immediately apparent but will be a latent risk.

Latent risks have been defined as:

> '*conditions or threats that result from 'decisions made' or by positions taken by organisations as a whole, where the damaging consequence may lay dormant for some time and only become evident when local triggering factors overcome the organisation's defence*' (*Human error: models and management*).

Local triggers may be, for example, abnormal operations, faulty equipment, a peak workload, a change in process design or a process upset. As these triggers may not occur for a while, the unsafe condition is not immediately revealed.

If the MoC requires immediate or short-term evidence of adverse impacts and risks, this may inhibit recognition and acceptance of latent risks. Similarly, if MoC assessment requires a high level of evidence of an adverse impact, such as observation of unsafe operations, this may equally inhibit recognition and acceptance of latent risks, as the unsafe condition will not be observable until local triggers occur.

MoC risk assessment should foresee all risks, including latent risks, and assess risks based on their potential impact as well as their likelihood. This can be achieved by identifying and assessing all potential impacts in the same manner, namely, to identify risks and assess their potential impacts on process safety.

7.3 ASSESSING TRANSITION RISKS

The assessment of transition risks can feed into the specification of:

– what actions need to be implemented to enable changes to be safely started and concluded;
– review and decision points (i.e. have essential enabling actions been achieved so as to allow next stage of change to start), and
– criteria regarding the standard of performance/indicators that needs to be demonstrated to allow changes to be continued and/or moved to the next stage

Transition risks may include, for example:

– merging two posts into one before upskilling the individual;
– operating a changed process design before providing new operating procedures and training, and
– removing a layer of supervision before upskilling people to work with less supervision.

Assessment can entail assessing the need for risk controls, such as training, to be implemented before a change is concluded.

However, ensuring risk controls have been implemented prior to organisational change may not always be necessary. This may be due to controls being naturally established throughout the implementation of organisational change i.e. the development of new skills.

Assessing the need for risk controls therefore requires a judgement of:

– the safety criticality of the risk controls;
– potential consequences of adverse impacts, and
– the ease or difficulty and speed with which new skills and arrangements can be developed.

These points can feed into a transition plan.

7.4 ADDITIONAL ASSESSMENT

If changes are determined to have some potentially major safety critical impacts, further assessment using more specialist methods may be useful. Some existing techniques exist that support further assessment of the following points as given in Annex D:

– workload (changes in job roles, manning levels and task design);
– fatigue (changes in task loads, working hours and shift systems);
– job analysis, and
– competence gap analysis (changes in roles and responsibilities and staffing levels) and training needs analysis.

These additional forms of analysis may be useful where changes impact one or more safety critical roles, the impact is judged to be potentially significant and it is difficult to assess the impact and adequacy of risk controls by simple judgement.

7.5 REVIEW AND REVISE SAFETY CASES AND ASSESSMENTS

If a safety case, where a major accident prevention policy (MAPP), safety critical task analysis, HAZOP or quantified risk assessment has been completed for the affected facility, there may be a need to review the assumptions and claims made in these before considering any changes that could compromise those assumptions. Existing case studies should be re-examined by those individuals with corporate knowledge of the content. This may include applying modern standards to a safety case or assessment that was completed, for example, 10 years ago. Local national regulatory requirements to review and revise safety cases and risk assessments should be checked and, as required, fulfilled. This might include a requirement for a human reliability assessment (*A guide to practical human reliability assessment*). Where applicable, safety case and safety assessment specialists should be consulted to determine the need to review and revise assessments.

8 CONSULTING YOUR WORKFORCE

8.1 EMPOWERING AND LISTENING TO STAFF

EI *Human factors briefing note no. 3: Organisational change* provides guidance on maintaining morale during change. However, engaging people in change is far more than winning the support of staff and maintaining morale. In the context of organisational change, staff engagement may:

– identify risks and impacts overlooked in planning of changes;
– provide additional insights and knowledge to enable a better understanding of risks and impacts, and
– offer suggestions on how best to maintain or improve safety performance.

A top down approach to change may generate barriers to engagement and empowerment, especially if it is assumed that the changes are essential for commercial survival or business performance. A top down approach implies imposed decisions as the change derives from the top of the organisation. This approach typically focuses on making changes fast and focuses on what might be perceived to be critical business issues. Decision-making may be centralised at the higher organisational levels and exclude lower level employees in the process, despite them being directly affected by the change. As a result, risks may go unnoticed and people are obliged to adapt to changes that they may have concerns over.

It should be acknowledged that change may lead to legitimate concerns and may be rightly challenged by staff. Staff may identify risks overlooked by the change managers. Adopting a consultative approach, listening to employees and acknowledging their views, and amending change plans, can help identify and prevent significant risks and increase workforce ability to adapt to the new changes.

The MoC process should recognise and respond to the feedback from staff and use the feedback and insights to improve safety and performance. A flexible approach to change should be adopted, where leaders and employees are willing to discuss solutions and adjust change plans when required. Time should be allowed for consultation, deliberation and amendment of plans.

Different approaches to staff engagement can be adopted depending on whether the change is of minor or major importance. Minor changes might include amendments to operating procedures and changes to equipment, such as a new automated shutoff valve or increased throughput or new pipework system. These might be dealt with locally by a standing safety committee and operational managers, with involvement of an employee representative. Consultation on minor changes may cover, for example, whether the procedures can be understood, appear valid and are practicable.

Major changes such as mergers of businesses, downsizing and decentralisation of safety critical roles may require a more complex approach. In the case of major changes, these are likely to require formal consultations with safety representatives, safety critical roles and other affected employees. This may take the form of a planned programme of employee consultation sessions, with time scheduled to brief employees on potential changes, run consultation sessions, collate feedback and consider and respond to feedback prior to concluding change proposals.

Conversely, it should be acknowledged that engagement of staff during change also has the potential to negatively impact staff morale and job satisfaction. This paticularly applies to those key employees who are likely to be directly affected by the change and could ultimately lead to staff demoralisation, stress and resignation.

9 IDENTIFYING RISK CONTROLS

Risk controls should align with the type of change and reduce risk to ALARP. The identification of risk controls is achieved by subject matter specialists, supported with good practice guidance and systematic assessments of the risks. Table E.1 indicates the types of risk controls that may be considered per type of change and references relevant EI guidance.

These options can also be a means of improving safety as part of the change. As each change is considered, opportunities for improving safety can be determined.

For example:

– task simplification may be applicable if the change entails reducing the number of staff performing the same tasks;
– upskilling staff may be required if a supervisor's role is removed;
– new systems of work or new technology may require instruction, and
– outsourcing safety critical roles may require retention on in-house capability as an 'intelligent customer'.

9.1 CONTROLLING RISK FROM MULTIPLE CHANGES

Whilst Table E.1 considers changes in isolation, a risk management plan may also need to consider changes as a whole. For example, the totality of changes may have a cumulative impact for which risk controls are needed, such as a transition plan. It should also be noted that an accumulation of change may, in combination, degrade safety performance in a gradual manner that is difficult to detect. Risk controls should ideally counter the impact. Examples of these impacts may include overall increase in workload from multiple changes, or from the interaction of a refocus onto cost reduction or process safety, or with the introduction of new technology, as well as individual changes.

9.2 ALARP AND MOC

As with all aspects of safety, it should be demonstrated that risk is reduced to ALARP. In the context of MoC, ALARP includes:

– Ensuring that all changes have been recognised, assessed and suitable risk controls determined, as per the assessment guidance in this publication.
– Ensuring that risk controls are valid and realistic. This may be achieved by independent audit and review of MoC assessments and plans, with a higher level of review for major changes.
– Ensuring that good or best practice has been applied in the MoC, such as in defining suitable and sufficient retraining of staff, possibly with best practice used as a benchmark for major changes and good practice for other changes.

The achievement of best and good practice entails applying relevant benchmarks and guidance to the proposed changes. As noted, Table E.1 indicates the types of risk controls that may be considered per type of change. Guidance on good and best practice may be drawn from existing references including the cited EI's *Human and organisational factors briefing notes*. This covers a wide range of topics, such as pressures and stress, workload and staffing levels, training and competence, and many others.

9.3 TRANSITION PLAN

Transition risk management entails ensuring that there is a suitable sequence of implementation and that those risk controls required to enable safe change have been identified and sequenced correctly. Typical examples include:

– updating procedures and operator instructions for new equipment and amended processes, before starting operation of new or amended equipment/processes;
– upskilling employees before removing a supervisory role, and
– testing the adequacy of staffing levels to carry out emergency procedures before reducing staffing levels.

Furthermore, it should be considered whether changes need to be sequenced to avoid over load and disruption during the implementation process. This may require consideration of the total change workload and impacts, and development of a suitable change timescale, with supporting resources and checks.

The change transition programme should:

– allow due time to implement and verify the effectiveness of essential risk controls on which the safety of changes depend;
– identify 'hold points' and 'decision points' where the effectiveness of risk controls are verified before progressing further with changes;
– have defined criteria and indicators to judge if risk controls are suitable and sufficient and enable plans to proceed, and
– resources needed to support change.

This may be achieved by producing a transition plan with a formal critical path sequence of risk controls.

9.4 APPROVAL

As noted in 6.1.2, the level of accountability for reviewing and approving changes should be matched to the significance of changes. Upon completion of the appropriate level of assessment, plans and assessments should be formally approved. This approval process should be managed by an MoC committee, with independent review providing assurance that due process has been achieved.

10 VERIFYING AND MONITORING

10.1 VERIFYING IMPLEMENTATION OF RISK CONTROLS

As highlighted by the discussion of transition risks, it may be important to verify that risk controls are effective and are implemented when required. The form of verification should match the form of risk control. This is likely to be a combination of auditing and performance assessment. For example:

Upskilling or retraining may be verified by:

– auditing if specified training has occurred, and
– checking competence assessment against defined competence standards.

If new equipment or technology is introduced:

– checking staff have been trained;
– checking competence assessment against defined competence standards, and
– do staff report confidence in operation of the new equipment?

If staffing levels are being reduced:

– were (reduced) workforce able to perform safety critical tasks and emergency response during exercises and task simulations?

If roles have been merged

– have new job descriptions been written, explained and agreed?
– do staff report concerns with the new roles?

The scope and depth of verification should match the scale and safety criticality of changes. The timing of verification should align with the critical path in a transition plan.

10.2 MONITORING INDICATORS

As noted before, the impact of organisational change may not be immediately or readily apparent. Safety performance may be degraded slowly. The impact of changes on safety performance can be monitored by observation of relevant indicators. These indicators should align with the risks and their potential impacts. For example:

Changes in staffing levels and/or workloads may be monitored by review of:

– overtime worked;
– unfilled safety critical posts;
– number of singletons;
– safety culture assessment results;
– stress survey results, and
– staff turnover.

Changes in technology may be monitored by review of:

– incident rates associated with human error, and
– reported rate of non-compliance with standard operating procedures.

The impact of merging roles may be monitored by:

– staff engagement and/or stress surveys, and
– staff absence and turnover rates.

Table E.1 provides examples of indicators aligned with risks.

11 MANAGING ORGANISATIONAL CHANGE

11.1 ORGANISING FOR MOC

Organisations responsible for operations with the potential for MAH should have a suitable set of policies, procedures and managerial arrangements to formally manage organisational change. This typically includes:

An MoC policy and procedure, noting:

- purpose of the policy to identify, assess and control change and ensure effective, safe and reliable operation;
- scope of changes covered by the policy;
- roles and responsibilities for MoC, including:
  - MoC process owner/MoC coordinator;
  - heads/managers of functions (human resource, operations, maintenance etc);
  - staff representatives;
  - proposers of change;
  - assessors, and
  - approvers of change.
- MoC oversight or steering committee, and
- relationship between MoC committee and other safety committees.

Documented MoC process, including:

- identified change;
- criteria for categorising the level of change control;
- a documented organisational change risk assessment form and process;
- guidance on criteria for acceptance of changes and risk controls;
- plan changes and risk controls;
- implement risk controls, communications and transition plan;
- definition of hold points and decision points for continuing with change, and
- audit, review and verify risk controls.

This is typically supported by a set of MoC forms, registers and formal approval documentation. An option is to have a register of changes with unique identification to support systematic management and control.

11.2 MOC COMMITTEE

An MoC committee may be created, as a permanent group, that operates at a scheduled frequency. This committee may comprise, for example, a business unit director/manager, an MoC coordinator, an independent assessor, and possibly staff and safety representatives. Ideally, a set of terms of reference would be developed for the committee, covering role and powers. This typically includes monitoring changes, oversight of due process and verification of risk controls, ensuring MoC competence of responsible persons, lessons learnt from MoC and continued development of the MoC process.

11.2.1 MoC competence

Directors and high-level managers should be competent in at least recognising that any organisational change may impact safety.

Engineers involved in MoC should be able to recognise the HOF implications of engineering and operational changes, as well as from discrete organisational change.

11.2.2 Consulting human factors specialists

HF specialists may be called in when:

– additional specialist assessment is required (as per Annex D);
– if there is uncertainty with respect to safety critical risk controls, and/or
– if it is unclear whether risk has been reduced to ALARP.

HF specialists may also be drawn in if there is a possibility of HOF impacts of changes being overlooked or underestimated; however, naturally this can be challenging to foresee.

HF specialists may also be required in the event that specialist analysis, such as human error analysis or human reliability assessment, is applied to the assessment of changes.

ANNEX A
REFERENCES AND FURTHER READING

A.1 REFERENCES

American Chemistry Council (www.americanchemistry.com)

Management of safety and health during organisational change

Chemical Safety and Hazard Investigation Board (CSB) (www.csb.gov)

Investigation report: Refinery explosion and fire

Safety bulletin

Energy Institute (EI) (publishing.energyinst.org)

Guidance on effective workforce involvement in health and safety

Human factors briefing note no. 3: Organisational change

Human factors briefing note no. 4: Maintenance

Human factors briefing note no. 5: Fatigue

Human factors briefing note no. 6: Safety critical procedures

Human factors briefing note no. 7: Training and competence

Human factors briefing note no. 8: Ergonomics

Human factors briefing note no. 10: Communications

Human factors briefing note no. 11: Task analysis

Human factors briefing note no. 18: Leadership

Human factors briefing note no. 19: Pressure and stress

Human factors briefing note no. 21: Supervision

Human factors briefing note no. 23: Workload and staffing levels

Eurocontrol (www.ext.eurocontrol.int)

Subjective workload assessment technique

Health and Safety Executive (HSE) (www.hse.gov.uk)

Human factors briefing note no.11. Organisational change

The underlying causes of the explosion and fire at the Buncefield oil storage depot, Hemel Hempstead, Hertfordshire

Chemical information sheet number CHIS7: Organisational change and major accident hazards

Fatigue risk index

Contract research report 348: Assessing the safety of staffing arrangements for process operations in the chemical and allied industries

Inspection of competence management: Systems at COMAH establishments

Longford Royal Commission (www.parliament.vic.gov.au)

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Function and content of the nuclear baseline

Miscellaneous

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ANNEX B
ABBREVIATIONS, ACRONYMS AND GLOSSARY

B.1 ABBREVIATIONS AND ACRONYMS

ALARP	as low as reasonably practicable
ATG	automatic tank gauging
COMAH	control of major accident hazards
CSB	Chemical Safety and Hazard Investigation Board
EI	Energy Institute
HAZOP	hazard and operability study
HF	human factors
HOF	human and organisational factors
HOFCOM	Human and Organisational Factors Committee
HSE	Health and Safety Executive
ISOM	isomer
KPI	key performance indicator
KSA	knowledge skills and attitudes
MAH	major accident hazard
MAPP	major accident prevention policy
MoC	management of change
MoOC	management of organisational change
SWAT	subjective workload assessment technique
TNA	training needs analysis

B.2 GLOSSARY

ALARP	A principle that commits organisations to demonstrate that the cost involved in reducing risk further would be grossly disproportionate to the benefit gained.
ATG system	An electronic device, whose basic function is to monitor the fuel level in the tank over a period of time to see if the tank is leaking, as well as monitoring other information.
Decision point	Latest moment at which a predetermined course of action is (or must be) initiated.

HAZOP	Structured and systematic examination of a complex planned or existing process or operation to identify and evaluate problems that may represent risks to personnel or equipment.
Hold point	A critical step in the project progress that requires an inspection, approval, or permit, prior to moving further steps according to the procedure or specification.
Human and organisational factors	The environmental, organisational and job factors, along with human and individual characteristics, that influence behaviour at work in a way that can affect health and safety.
Intelligent customer	The capability of the organisation to have a clear understanding and knowledge of the product or service being supplied.
Key performance indicator	Type of performance measurement evaluating the success of an organisation.
Major accident hazard	A potential source of danger which could cause a major accident.
Management of organisational change	Framework for managing the effect of new business processes, changes in organisational structure or cultural changes within an enterprise.
Organisational change	The process in which an organisation changes its structure, strategies, operational methods, technologies, or organisational culture, resulting in change within the organisation, and the effects of these changes on the organisation.
Organisational memory	The accumulated body of data, information, and knowledge created in the course of an individual organisation's existence.
Risk control	A method by which firms evaluate potential losses and act to reduce or eliminate such threats.
Subjective workload assessment technique	Multidimensional scaling method designed to assess time load, mental effort load and stress load.
Transition risk management	The process of implementing a suitable set of ordered risk controls in the event of a risk.

ANNEX C
RISK ASSESSMENT OF ORGANISATIONAL CHANGES

MoC risk assessment can adopt a similar approach to HAZOP but with guidewords and impacts tailored to organisational change. Two hypothetical examples are given in Table C.2. This may be developed as a form detailing the name of the change, a statement of location of change, who completed the assessment, who proposed the changes, signed approval, date and a summary of the justification for the agreed actions.

C.1 PREPARING FOR AN ASSESSMENT

Preparation should include:

– determining the safety criticality of changes (such as major, moderate, minor or insignificant);
– determining the level of management responsibility for the assessment and approval of changes and risk controls;
– identifying an appropriate array of subject matter specialists to perform the assessment, and
– agreeing the level and form of peer review and validation of the assessment.

People involved in the assessment may include:

– persons with knowledge of the proposed changes and systems;
– specialists (safety, engineering, HF, etc.);
– directors/operations managers/supervisors responsible for the affected operations, and
– staff representatives.

C.2 RISK ASSESSMENT TABLE

As with HAZOP, the assessment of risks entails subject matter specialists systematically considering each change and, drawing on guidewords, identifying and assessing potential impacts. This can be aided as follows:

– the type of change and impact may draw on the guide words in Table C.3, all of which may apply;
– the types of risk controls and mitigations may be drawn from Table E.1 in this guide, and
– indicators may be drawn from the guidance in 10.2.

An option is to also use a qualitative risk matrix to assess likelihood and consequence, such as the one in Table C.1.

The risk level may be informed by reference to existing site risk assessments, such as HAZOP and quantitative risk assessments, and to major accident prevention plans and emergency plans. These may inform the judgement of the consequence level and safety criticality of potential impacts.

Table C.1: Typical qualitative risk matrix

Likelihood	Very high	C	B	B	A	A
	High	C	C	B	B	A
	Moderate	D	C	C	B	B
	Low	E	D	C	C	B
	Very low	E	E	D	C	C
		Very minor	Minor	Moderate	Major	Catastrophic
		Consequence				

Risk level	A	B	C	D	E
	Very high risk	High risk	Moderate risk	Low risk	Very low risk

Table C.2: Examples of a typical MoC organisational risk assessment

Change	Description of change	Potential impact	Description of impact	Cause of impact	Likelihood	Consequence	Risk assessment	Risk controls/ mitigation	Post mitigation risk	Indicators and monitoring
Relocating of staff	Specialist technicians relocated to another site	Gaps in competence of people	Increase in operator error during operations and during response to abnormal operations and emergencies	Reduction in extent of on the job coaching if operators, reduction in ability to provide diagnostic and control advice during abnormal operations	High	Catastrophic	A	Upskill operators and team leaders. Develop formal coaching scheme Install remote display of site instrumentation for remote view by technicians Transition plan (upskill operators and install remote view before relocating technicians)	C	% of operators upskilled Assessment results for operators Audited ability of technicians to view and diagnose faults remotely

Table C.2: Examples of a typical MoC organisational risk assessment (continued)

Change	Description of change	Potential impact	Description of impact	Cause of impact	Likelihood	Consequence	Risk assessment	Risk controls/ mitigation	Post mitigation risk	Indicators and monitoring
Merger of roles	Merge supervision of two units into one job	Gaps in competence of people Fatigue Excessive workload	Lack engineering knowledge of both units Workload may cause fatigue and stress leading to error and omission of tasks. Unable to direct safe operations, diagnose and respond correctly to faults	Excessive workload and lack of knowledge of new unit	High	Catastrophic	A	Require technical training prior to role merger Detailed workload analysis and task simplification (eliminate unnecessary reporting tasks)	C	Audited ability of supervisor to diagnose faults on both units Self-reported stress and fatigue Absence

Table C.3: Risk assessment guidewords

Type of change	Potential organisational impact
Organisational structure: – Merging (or demerging) business units, departments or teams – Removing levels of management or supervision – Change in reporting lines Roles: – Merging roles – Changing roles and responsibilities – Additional tasks for a role Priorities: – New organisational objectives, values, priorities or norms Staffing: – Resourcing – changing staffing or manning levels – Long-term absence of key staff – Reduction in specialists – Relocating staff Outsourcing: – Outsourcing activities previously done in-house – Change in outsourcing policy Ways of working: – New ways of working – New systems of work – Shift systems or working hours – New employment terms and conditions Management programmes: – New management programmes or systems, – New culture programme, – New training needs analysis system etc. Plant, technology, process or operational: – Introduction of new technology – Altered process design or composition of products – Change in production level or production/ operation times	Gaps in competence of people/team competence Loss of safety leadership Cultural erosion Gaps/out-of-date procedures and training Loss of local expertise Reliance on a single expert(s) Excessive workload Fatigue Loss of morale Loss of self-confidence (stress) Creation of organisational barriers Ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed, etc.) Reduction in communication (between people, departments or teams) Loss of organisational memory Loss of oversight of safety performance Degradation of process safety management Loss of focus on process safety Overreliance on automation Lack of confidence in new technology or systems of work (risk of improvised ways of working, disregarded systems, violation of new ways of working)

ANNEX D
ADDITIONAL FORMS OF ANALYSIS

D.1 TASK SPECIFIC WORKLOADS AND STAFFING NEEDS

A number of task analysis techniques are available to assess whether organisational changes significantly change workloads of people performing safety critical tasks. EI *Human factors briefing note no. 11: Task analysis* introduces three widely used methods of task analysis.

D.1.1 Timeline analysis (A guide to task analysis: The task analysis working group)

This method entails:

– mapping graphically tasks out along a timeline;
– noting simultaneous tasks and who performs each task;
– noting the physical location of each sub-task;
– rating task difficulty (at each point in time), and
– judging if the tasks can be performed within the allotted time by the allotted number of people.

This may be applicable to tasks such as emergency response, control of process upsets and other time critical tasks. It may note, for example, that two simultaneous tasks occur in difference locations, or that a task workload requires two or more persons to complete it in the available time.

It may also be applicable to spotting peak loads of work for operational or maintenance tasks.

The time periods models may be in the order of minutes for time critical emergency response tasks, or hours for normal operational tasks.

D.1.2 Subjective workload assessment technique (A guide to task analysis: The task analysis working group)

This may be applicable to operational tasks that require time-bound judgement and decision making, such as emergency response decision making and performance of complex safety critical operations. Subjective workload assessment technique (SWAT) involves rating a task as low, medium, and high for each of time load, mental effort load, and psychological stress load. The three ratings are combined to produce a rating of mental workload.

D.1.3 Task trials/exercises

This may be particularly applicable to emergency response tasks. This entails designing and running a simulated task or emergency exercise with the proposed staffing and organisational arrangements, before implementing them. Typically, this entails:

– identifying one or more emergency scenarios that place a demand on the affected roles, ideally drawn from emergency plans;
– devising an exercise that simulates the tasks;

– defining performance criteria, such as correct fault diagnosis, correct selection of emergency response actions, completing tasks within a specific time (e.g. within the period needed to safely shut down a system);
– running the exercise and observing task performance, and
– reviewing performance and reflecting on implications for proposed changes.

D.2 FATIGUE

The UK HSE provide a Fatigue Risk Index (*Fatigue risk index*). This is applicable to assessing changes in:

– shift systems;
– task demands, and
– working hours.

The tool is available as a free online tool.

D.3 STAFFING LEVELS

D.3.1 Staffing level assessment

The UK HSE provides a tool for assessing operator staffing levels on chemical and allied plants. This is applicable to manning levels in process operations (*Contract research report 348: Assessing the safety of staffing arrangements for process operations in the chemical and allied industries*).

D.3.2 Organisational baseline

The UK nuclear industry develop and apply organisational baselines (*Function and content of the nuclear baseline*). These comprise a systematic listing of all safety implicated roles required for safe operations. This may be produced as a tabulated listing of roles, typically by unit, and possibly also as a hierarchical organisational diagram. A statement is made regarding the nature of the safety critical roles, minimum competences, the level of importance of the role and workload. The baseline is used as a check on whether any safety critical roles are impacted by change.

D.4 JOB DESIGN CHECKLIST

The types of questions that may be posed with respect to the design of new jobs or merged roles are given as follows:

– are there safety critical tasks where a second person is needed to double check actions?
– are there tasks, e.g. liaising with laboratory staff, that may take staff away from safety critical duties?
– are there periods of intense activity, such as shift hand-over?

- are other staff available to help during periods of intense activity?
- is there a risk of information overload at peak workloads?
- are there periods of inactivity which could cause boredom and lack of attention?
- would the range of duties provide job satisfaction?
- if the usual employee is absent, would other employees have the skill to do their job?
- would the employee have enough 'hands on' operation tasks to maintain their knowledge of the process?
- are the new roles and responsibilities clearly defined?
- might the new level of staffing cause excessive shifts if one or more employee was absent, such as due to illness?
- have new roles and responsibilities been clearly defined?
- has the level of decision-making authority and accountability been clearly defined?

Job design can be supported by job analysis. This is an analysis of:

- the tasks that make up a job;
- the task conditions, and
- competences i.e. knowledge, skills, attitudes (KSA) and the physical capability.

Job analysis is used to determine methods for performing a job, achieving job satisfaction, identifying training needs and performance measures and supporting selection.

D.5 COMPETENCE GAP ANALYSIS

In the context of major accident hazards, competence is defined as:

> *The continuing ability of individuals and teams to perform reliably the MAH elements of their roles, responsibilities and tasks, and for this to be demonstrable.*

An additional level of analysis may be performed when changes involve, for example:

- merging two jobs into one;
- reallocating roles and responsibilities between people, and
- reducing the number of people in a team.

This may be particularly important for safety critical roles such as control room operators/ supervisors, technicians, engineers and safety specialists.

The purpose of competence gap analysis is to:

- understand the cumulative impact of changes on the organisation's ability to perform safely and effectively;
- provide objective data and guidance on how to address the needs of the organisation, and
- identify technical and non-technical KSAs gaps.

Gap analysis typically consists of three broad steps, usually supported by a tabulated statement of KSAs per role, as noted here:

1. Identify KSAs per new role. Step 1 entails determining KSAs required for each new role. This constitutes training needs analysis (TNA).

   These may cover, for example:
   - KSAs, such as knowledge of the process and potential faults;
   - procedural KSAs, such as knowledge of operating and management procedures, and
   - non-technical KSAs such as safety leadership, supervisory and communication skills.

   An option is to note:
   - which KSAs are safety critical;
   - which KSAs are cited within safety reports or major accident prevention plans, and
   - how many people possess these KSAs (potential singletons).

   The skill set for each job role makes up a competency map of the required KSAs, which can be used to check the impact of organisational changes.

2. Determine KSAs held by proposed role holders.

   Step 2 entails determining the KSAs held by people proposed for the new roles, either on a person-by-person basis or by assuming a typical role holder.

3. Identify gaps in KSAs.

   Step 3 compares the KSAs by people proposed for new roles with the KSAs required of the new roles, noting any gaps. An option is to:
   - rate these gaps in terms of minor, moderate or major;
   - note if competence gaps can be filled within available time by training, coaching or other personal development, and
   - note requirements for transitioning from current to future roles, such as stating what training and competence must be demonstrated before changing roles.

ANNEX E
RISK CONTROLS TABLE

Table E.1 provides examples of risk controls, verification checks and indicators aligned with types of changes and risks, as well as references for further guidance on these risk controls.

Table E.1: Human factors risk controls and safety improvements

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Merging (or demerging) business units, departments or teams	Competence gap Workload Stress and fatigue Creation of organisational barriers	Defined competence requirements, knowledge and skill redundancy, succession planning and the impact on career progression Defined responsibilities and reporting chain of command Provision of training in new role prior to implementation Review task and job design to establish safety-critical tasks and task dependencies Review links, dependencies and communications with other areas and how these may be affected Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams Task simplification e.g. eliminate unnecessary reporting tasks	Business/ department or team consolidation task Evaluate job design and tasks Competence gap analysis Training audits Employee consultation Monitor workload and stress Conduct and review MoC hazard analysis	*Human factors briefing note no. 3: Organisational change* *Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 18: Leadership* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 21: Supervision* *Human factors briefing note no. 23: Workload and staffing levels*
Removing levels of management or supervision	Competence gap Workload Stress and fatigue Ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed)	Provision of training in new role prior to implementation Defined competence requirements, knowledge and skill redundancy, succession planning and the impact on career progression Defined responsibilities and reporting chain of command	Business/ department or team consolidation task Evaluate job design and tasks Competence gap analysis	*Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 18: Leadership* *Human factors briefing note no. 19: Pressure and stress*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Removing levels of management or supervision (continued)	Loss of oversight of safety performance Degradation of process safety management Increased span of control	Review links, dependencies and communications with other areas and how these may be affected Define responsibility for safety Consultations with safety representatives to review the impact of change and hazards associated with change	Training audits Monitor workload and stress Employee consultation Conduct and review MoC hazard analysis	*Human factors briefing note no. 21: Supervision* *Human factors briefing note no. 23: Workload and staffing levels*
New organisational objectives, values, priorities or norms	Loss of focus on process safety Decline in process safety management	Detailed definition of the change Understanding the wider impact of the change on other business areas, processes, procedures and ways of working Define competence, safety management and other requirements Review policies, procedures and ways of working that may be specific to the business units, departments or teams	Competence gap analysis Workload assessments and fatigue risk assessments where task demands and working hours change Establish baseline to assess change impact Employee consultation	*Human factors briefing note no. 5: Fatigue* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
New employment terms and conditions	Loss of morale Loss of self-confidence (stress) Fatigue Gaps in competence of people/ team Ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed etc.)	Changes should be made with agreement (either individual, collective or inferred, depending on the change made) Defined competence requirements, knowledge and skill redundancy, succession and the impact on career progression Defined responsibilities and reporting chain of command Provision of training in new role prior to implementation Review task and job design to establish safety-critical tasks and task dependencies	Evaluate job design and tasks Competence gap analysis Monitor workload and stress Employee consultation Workload assessments and fatigue risk assessments where task demands and working hours change	*Human factors briefing note no. 5: Fatigue* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 23: Workload and staffing levels*
Merging roles	Loss of oversight on process safety Loss of safety leadership Excessive workload Gaps in competence of people/ team	Defined competence requirements, knowledge and skill redundancy, succession and the impact on career progression Defined responsibilities and reporting chain of command Provision of upskilling and training in new role prior to implementation Review task and job design to establish safety-critical tasks and task dependencies	Business/ department or team consolidation task Evaluate job design and tasks Competence gap analysis	*Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 19: Pressure and stress*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Merging roles (continued)	Reliance on a single expert Loss of local expertise, ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed etc.)	Define responsibility for safety Consultations with safety representatives to review the impact of change and hazards associated with change	Training audits Employee consultation Monitor workload and stress Conduct and review MoC hazard analysis	*Human factors briefing note no. 23: Workload and staffing levels*
Changing roles and responsibilities	Ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed etc.) Gaps/out-of-date procedures and training Gaps in competence of people/ team Loss of organisational memory Personal physical fitness does not match new role New role does not suite individual needs, such as working hours or role aspirations	Defined competence requirements (including a review of implicit and experience-based KSAs), knowledge and skill redundancy, succession and the impact on career progression Defined responsibilities and reporting chain of command Provision of upskilling and training in new role prior to implementation Review task and job design to establish safety-critical tasks and task dependencies Define and clarify accountability and ownership of safety Consultations with safety representatives to review the impact of change and hazards associated with change	Business/ department or team consolidation task Evaluate job design and tasks Competence gap analysis Training audits Employee consultation Monitor workload and stress Conduct and review MOC hazard analysis	*Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 18: Leadership* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 21: Supervision* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Changing roles and responsibilities (continued)		Review links, dependencies and communications with other areas and how these may be affected Task simplification e.g. eliminate unnecessary reporting tasks Assess the impact of changes on the wider system such as people, policies, or the organisation that could impact process safety Consult individuals on potential new roles and take account of individual needs as far as reasonably practicable		
Shift systems or working hours	Fatigue Workload Loss of morale Gaps/out-of-date procedures and training Reduction in communication (between people, departments or teams)	Defined competence requirements Defined staffing levels and redundancy/ cover availability Review task and job design to establish safety-critical tasks and task dependencies Review policy and procedure, for example, to establish effective handover routines and avoid critical task steps occurring during or close to shift handover Establish task and workload is within reasonable limits Manage shift patterns and working hours in a way that minimises fatigue and overwork (for example, overtime)	Competence gap analysis Training audits Workload assessments and fatigue risk assessments where task demands and working hours change Establish baseline to assess change impact Employee consultation	*Human factors briefing note no. 5: Fatigue* *Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Resourcing – changing staffing or manning levels	Workload Stress Fatigue Loss of expertise Ambiguous roles and responsibilities (tasks not performed, decisions not made) Gaps in competence of people/ team	Task simplification (e.g. eliminate unnecessary reporting tasks) Task automation, including a review of changes to the role of the operator and tasks associated with monitoring, maintaining and recovery of the automated system Defined competence requirements, including a review of implicit and experience-based KSAs, knowledge and skill redundancy, succession and the impact on career progression	Evaluate job design and tasks Competence gap analysis Monitor workload and stress Workload assessments and fatigue risk assessments where task demands and working hours change	*Human factors briefing note no. 5: Fatigue* *Human factors briefing note no. 18: Leadership* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 21: Supervision* *Human factors briefing note no. 23: Workload and staffing levels*
Reduction in specialists	Loss of expertise Reliance on a single expert Workload	Role redundancy through secondary specialist or multiskilling Defined competence requirements (including a review of implicit and experience-based KSAs), knowledge and skill redundancy, succession planning and the impact on career progression Capability management to track and evidence competence levels Defined staffing levels and redundancy/ cover availability Review task and job design to establish safety-critical tasks and task dependencies Establish task and workload is within reasonable limits	Evaluate job design and tasks Competence gap analysis Verification of succession plan Workload assessment where task demands and working hours change Monitor workload and stress	*Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Relocating staff	Reduction in communication (between people, departments or teams) Creation of organisational barriers Loss of oversight of safety performance Degrading of process safety management Decrease in emergency response capability	Review links, dependencies and communications with other areas and how these may be affected Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams Define responsibilities and reporting chain of command Review task and job design to establish safety-critical tasks and task dependencies Task simplification e.g. eliminate unnecessary reporting tasks Assess the impact of changes on the wider system such as people, policies, or the organisation that could impact process safety Consultations with safety representatives to review the impact of change and hazards associated with change	Evaluate job design and tasks Competence gap analysis Monitor workload and stress Assess barriers and enablers to communication and task completion	*Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Outsourcing activities	Outsourcing a safety-critical function Loss of intelligent customer ability Poor contractor safety performance Loss of contractor Loss of local expertise Gaps in competence of people/ team Reliance on single expert(s) Creation of organisational barriers Ambiguous roles and responsibilities resulting in tasks not being performed, decisions not being made, decisions being delayed etc. Reduction in communication (between people, departments or teams)	Define competence, safety management and other requirements. Ensure suitable and sufficient assessment of contractors' safety capabilities Retain adequate resources to be able to closely supervise Monitor the expertise of people employed, and the quality and safety of their work Remain an intelligent customer – retain adequate technical competence to judge whether, and ensure that, work done is of the required quality and safety Have contingency plans to maintain low risks and not increase risks should the contractor lose the capacity or willingness to deliver to requirements Retaining responsibility for outsourced functions Retaining the capability (for example, adequate competence to be able to resume direct control over an outsourced activity) Retaining responsibility for management functions	Evaluate job design and tasks Competence gap analysis Review outsourcing management procedures Review reporting procedures and communication chains Workload assessment where task demands and working hours change	*Human factors briefing note no. 21: Supervision* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Change in outsourcing policy	Loss of contractors Difficulty contracting in new skill Gaps in competence of people/ team Reliance on single expert Creation of organisational barriers Ambiguous roles and responsibilities resulting in tasks not being performed, decisions not being made, decisions being delayed etc.	Establish competence and KSAs to manage and maintain outsourcing arrangements and contracts Ensure suitable and sufficient assessment of contractors' capabilities and performance, for example, through individuals monitoring and managing arrangements Define an approach to outsourcing that includes contingency plans and exit strategies Review the resource, competency experience and skill redundancy	Review outsourcing management procedures Evaluate job design and tasks Competence gap analysis Review reporting procedures and communication chains	*Human factors briefing note no. 6: Safety-critical procedures* *Human factors briefing note no. 21: Supervision* *Human factors briefing note no. 23: Workload and staffing levels*
New ways of working	Creation of organisational barriers Gaps/out-of-date procedures and training Lack of confidence in new technology or systems of work (risk of improvised ways of working, disregarded systems, violation of new ways of working) Ambiguous roles and responsibilities leading to tasks not being performed, decisions not being made, decisions being delayed etc. Degradation of process safety management	Provision of training in new ways of working prior to implementation Provision of updated policy and procedure prior to implementation Review links, dependencies and communications with other areas and how these may be affected Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams Review task and job design to establish safety-critical tasks and task dependencies Task simplification e.g. eliminate unnecessary reporting tasks	Business/ department or team consolidation task Evaluate job design and tasks Competence gap analysis Training audits Employee consultation Monitor workload and stress Conduct and review MOC hazard analysis	*Human factors briefing note no. 6: Safety-critical procedures* *Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 8: Ergonomics* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
New systems of work	Degradation of process safety management Loss of focus on process safety Creation of organisational barriers Gaps/out-of-date procedures and training Lack of confidence in new technology or systems of work e.g. risk of improvised ways of working, disregarded systems, violation of new ways of working Ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed etc.)	Provision of training in new ways of working prior to implementation Provision of updated policy and procedure prior to implementation Review links, dependencies and communications with other areas and how these may be affected Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams Review task and job design to establish safety-critical tasks and task dependencies Task simplification e.g. eliminate unnecessary reporting tasks Defined responsibilities and reporting chain of command Define responsibility for safety	Review reporting procedures and communication chains Evaluate job design and tasks Competence gap analysis Training audits Employee consultation Monitor workload and stress Conduct and review MoC hazard analysis	*Human factors briefing note no. 4: Maintenance* *Human factors briefing note no. 6: Safety-critical procedures* *Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 8: Ergonomics* *Human factors briefing note no. 10: Communications* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
New management programmes or system	Degradation of process safety management Loss of focus on process safety Creation of organisational barriers Gaps/out-of-date procedures and training Lack of confidence in new technology or systems of work (risk of improvised ways of working, disregarded systems, violation of new ways of working) Ambiguous roles and responsibilities leading to tasks not performed, decisions not made, decisions delayed etc.	Provision of updated policy and procedure prior to implementation Review links, dependencies and communications with other areas and how these may be affected Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams that may be affected Define responsibility for safety Consultations with safety representatives to review the impact of change and hazards associated with change	Review reporting procedures and communication chains Competence gap analysis Training audits Employee consultation Monitor workload and stress Conduct and review MoC hazard analysis	*Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 8: Ergonomics* *Human factors briefing note no. 10: Communications* *Human factors briefing note no. 19: Pressure and stress* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Introduction of new technology	Loss of focus on process safety Lack of confidence in new technology or systems of work leading to a risk of improvised ways of working, disregarded systems, and violation of new ways of working Overreliance on automation Gaps in competence of people/ team Gaps/out-of-date procedures and training Ambiguous roles and responsibilities leading to tasks not being performed, decisions not being made, decisions delayed etc. Degradation of process safety management and culture	Defined competence requirements, knowledge and skill redundancy, succession planning and the impact on career progression Review of changes to the role of the operator and tasks associated with monitoring, maintaining and recovery of the automated system Review task and job design to establish safety-critical tasks and task dependencies Establish task and workload is within reasonable limits Review implications for safety processes including any changes in safety-critical tasks and the role of the user Task simplification e.g. eliminate tasks where possible	Workload assessments and fatigue risk assessments where task demands are high and working hours change Evaluate job design and tasks Competence gap analysis Training audits Review reporting procedures and communication chains Conduct and review MoC hazard analysis	*Human factors briefing note no. 4: Maintenance* *Human factors briefing note no. 5: Fatigue* *Human factors briefing note no. 6: Safety-critical procedures* *Human factors briefing note no. 7: Training and competence* *Human factors briefing note no. 8: Ergonomics* *Human factors briefing note no. 10: Communications* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Altered process design or composition of products	Loss of focus on process safety Lack of confidence in new technology or systems of work leading to a risk of improvised ways of working, disregarded systems, and violation of new ways of working Overreliance on automation Gaps in competence of people/ team Gaps/out-of-date procedures and training Ambiguous roles and responsibilities (tasks not performed, decisions not made, decisions delayed etc.) Degradation of process safety management	Provision of training in new ways of working prior to implementation Provision of updated policy and procedure prior to implementation Review links, dependencies and communications with other areas and how these may be affected Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams Review task and job design to establish safety-critical tasks and task dependencies Task simplification e.g. eliminate unnecessary reporting tasks Defined responsibilities and reporting chain of command Define responsibility for safety processes	Review reporting procedures and communication chains Workload assessments and fatigue risk assessments, where task demands and working hours change Evaluate job design and tasks Competence gap analysis Training audits Review reporting procedures and communication chains Conduct and review MoC hazard analysis	*Human factors briefing note no. 4: Maintenance* *Human factors briefing note no. 6: Safety-critical procedures* *Human factors briefing note no. 8: Ergonomics* *Human factors briefing note no. 10: Communications* *Human factors briefing note no. 23: Workload and staffing levels*

Table E.1: Human factors risk controls and safety improvements (continued)

Type of change	Typical organisational impacts	Typical risk control/safety improvements	Typical checks and indicators	EI guidance
Change in production level or production/ operation times	Loss of focus on process safety Loss of oversight of safety performance Gaps/out-of-date procedures or training	Task simplification e.g. eliminate unnecessary reporting tasks Task automation, including a review of changes to the role of the operator and tasks associated with monitoring, maintaining and recovery of the automated system Review task and job design to establish safety-critical tasks and task dependencies Establish task and workload is within reasonable limits Defined competence requirements including a review of implicit and experience-based KSAs, knowledge and skill redundancy, succession and the impact on career progression Understand the wider impact of the change on other business areas, processes, procedures and ways of working Review implicit policies, procedures and ways of working that may be specific to the business units, departments or teams	Workload assessments and fatigue risk assessments, where task demands and working hours change Evaluate job design and tasks Competence gap analysis Training audits Conduct and review MoC hazard analysis	*Human factors briefing note no. 4: Maintenance* *Human factors briefing note no. 5: Fatigue* *Human factors briefing note no. 6: Safety-critical Procedures* *Human factors briefing note no. 8: Ergonomics* *Human factors briefing note no. 23: Workload and staffing levels*

ANNEX F
SELF ASSESSMENT CHECKLIST

Table F.1 provides examples of good MoC practice to help identify organisational factors requiring closer examination. One option is to review the questions shown in Table F.1 and investigate those that are answered as 'no'.

Table F.1: What does good practice look like?

	Yes	No
1) Management understand what constitutes an organisational change and the need to apply MoC process		
2) Management are aware of MoC assessment errors Such as failing to recognise a change, categorising it as minor, under-scoping the assessment, ignoring latent effects, etc.		
3) Management are aware of decision-making risks Such as ignoring warning signs, refusal to change course – invested too much to stop, concerns being dismissed, concerns seen as a challenge to company policy, new working practices imposed with assumption they are right, requiring hard proof that the risks are real, 'change and hope' and 'one size fits all' models etc.		
4) Management display effective behaviours Such as actively listening, accept challenges, willingness to change plans, cooperative, communicating, do not see concerns as threats, beware assumptions that it will work, accept that some risks are intangible and latent, be proactive in avoiding risks, change is used as an opportunity to improve safety performance etc.		
5) Management are aware of potential adverse impacts Such as competence gaps, loss of local expertise, excessive workload, degradation of process safety management etc.		
6) Safety-critical capabilities i.e. staff and functions have been identified for use as a baseline		
7) There is an effective organisational change risk assessment process Such as change recognition guidance, risk-based screening, risk assessment of immediate, latent and transition risks and risk controls etc.		
8) There are effective MoC arrangements		
i. Organisational change management policy and procedure		
ii. Scope, definition of organisational change, roles and responsibilities, documented process and checklists, approval process		

Table F.1: What does good practice look like? (continued)

	Yes	No
iii. Organisational change management teams/committee (with employee involvement)		
iv. Independent reviewers		
v. Authorisation of assessments and changes		
vi. Transition management i.e. hold points, critical paths, sequencing, resourcing, dependencies		
vii. Transition communication plans		
viii. Verification of implementation of change plans and risk controls		
ix. Monitoring of performance indicators of tangible and intangible risks		
x. Management are competent in MoC		

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