Human and organisational factors in end of service life and decommissioning

HUMAN AND ORGANISATIONAL FACTORS IN END OF SERVICE LIFE AND DECOMMISSIONING

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FOREWORD

Health, safety, wellbeing and performance of those working on sites, both on and offshore, undergoing decommissioning can be adversely affected by changes in the nature of the tasks performed and the conditions under which they are performed.

Guidance on managing human and organisational factors in decommissioning, published in 2010, originated within the nuclear industry. It was kindly donated to the Energy Institute by Magnox Sites and retained its essentially nuclear plant decommissioning focus. The 2010 guidance will remain available from the Energy Institute's website for reference; however, this new version broadens the scope of the original to include material of more specific interest to other industrial sectors, in particular onshore process industry and offshore oil and gas.

Decommissioning refers to the stage in a facility's lifecycle where activities are carried out to stop production, make the facility safe and, typically, to dismantle/demolish the facility and return the site to a greenfield or brownfield state. Clearly, there are variations in this. Sometimes a facility is only partially decommissioned, or it could be 'mothballed' (where operations are temporarily suspended with a view to restarting at some future date). The human and organisational factors (HOF) issues are largely the same in each case.

The risks presented by decommissioning arise from the hazards present – toxic, flammable and radioactive materials to be handled, stored energy in systems designed to contain them in normal operations and heavy items to be moved. Some of the hazards are not obvious. The presence of these specific hazards is coupled with the often fast pace of decommissioning, the need to assemble and integrate large teams of staff and contractors in a working environment in which motivation and morale may be low, plus many other factors that need to be managed. This presents a series of HOF issues that should be managed. Failure to manage HOF issues can lead to project delays, extra costs, as well as incidents (potentially leading to injury or fatality).

These issues, and how they can be managed, are the subject matter of this publication. However, this publication does not provide details on how to decommission major hazard facilities.

The EI welcomes feedback on its publications. Feedback or suggested revisions should be submitted to:

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1 INTRODUCTION

1.1 WHAT IS DECOMISSIONING?

'Decommissioning typically includes dismantling of the facility (or part thereof) but […] a facility could for example be decommissioned without dismantling and the existing structures subsequently put to another use (after decontamination). The use of the term decommissioning implies that no further use of the facility (or part thereof) for its existing purpose is foreseen. Decommissioning actions are taken at the end of the operating lifetime of a facility to retire it from service with due regard for the health and safety of workers and members of the public and the protection of the environment. The [administrative and technical actions taken] will need to be such as to ensure the long-term protection of the public and the environment […]' (*IAEA safety glossary: Terminology used in nuclear safety and radiation protection*)

There are several reasons why the decision may be taken to decommission a facility, for example:

- Its activities are no longer economically viable i.e.:
  - The asset has reached the end of its design life and expenditure to extend operational life by technology improvements is no longer economically viable, or, production costs outweigh the income from the price of the product.
- The site owners/operators or managers decide to no longer conduct those activities.
- The site owners/operators or managers decide to locate those activities elsewhere.
- The facility has become irreparably damaged through unexpected events such as a fire, flood, vandalism or structural collapse.
- Regulatory compliance – regulators cannot support continued operation of the facility.

Ideally (and often as a regulatory requirement) facilities should be designed in a way to allow for decommissioning and disposal.

> '*New nuclear power stations should be designed and operated so that they can be safely decommissioned, with decommissioning being carried out as soon as is reasonably practicable after final shutdown.*' Office for Nuclear Regulation (ONR) website, New nuclear reactors: Generic design assessment guidance to requesting parties

> '*Regulation 5. (1) The duty holder shall ensure that the designs to which an installation is to be or in the event is constructed are such that, so far as is reasonably practicable –*
> *[…]*
> *(d) it may be decommissioned and dismantled safely*'

> Source: The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996

1.2 CHALLENGES

The risks presented by decommissioning arise from the hazards present – toxic, flammable and radioactive materials to be handled, stored energy in systems designed to contain them in normal operations and heavy items to be moved. Some of the hazards are not obvious.

The presence of these specific hazards is coupled with the often fast pace of decommissioning, the need to assemble and integrate large teams of staff and contractors in a working environment in which motivation and morale may be low, plus many other factors that need to be managed.

> '*…some business and property owners abandon industrial facilities without cleaning or securing the materials that were stored, used, or treated at their sites. These circumstances can lead to tragic results.*
>
> *In 1987, vandals entered an abandoned site in Ohio and attempted to remove the copper cores from several transformers. As a result, PCB* oil was released to a nearby creek. The release resulted in a clean-up that lasted three years and cost the public $8 million dollars.*'
>
> *Polychlorinated Biphenyl – a toxic and polluting compound.
>
> Source: Michigan Water Environment Association (MWEA), *Decommissioning industrial facilities: practical considerations from an IPP perspective*

1.2.1 EXAMPLE OF A SAFETY ALERT

A contractor placed a ladder on a concrete slab covering a drainage channel, then climbed the ladder. The slab collapsed into a deep void below; the ladder dropped into the drain but the contractor fell clear of the hole suffering only jarring and bruising. The slabs covering the void were found to be, in some cases, badly deteriorated with age (confidential source).

Decommissioning a facility therefore poses new challenges compared with routine operations. Many of these are of a technical nature (beyond the scope of this publication), but there are also many human and organisational factors (HOF) challenges.

It should be noted that competent authorities such as the Health and Safety Executive (HSE), the Environment Agency and Department for Business Energy and Industrial Strategy (BEIS) recognise the importance of HOF and increasingly, regulatory site inspections, audits and incident investigations include it in their scope. The primary purpose of HOF guidance such as the current document, of course, is not only to help meet regulatory demands: the material available also provides useful signposts towards requirements and highlights the value of HOF as a means of improving the way that manual tasks are performed, and thereby reducing human failures that could have untoward consequences such as lost production, incidents and accidents.

Few of the HOF issues are unique to decommissioning. Many of the topics covered in this publication are equally of concern during normal operations, shutdowns and turnarounds, etc. and, indeed, one of the ironies of decommissioning is that new facilities are often needed, along with new tools and equipment and new skills required to carry out the decommissioning activities.

Some aspects, however, are distinctly different; for example, the workforce at the site will be acutely aware that they may not have a job, or the same job, or be living in the same place at the end of the process. This is clearly a HOF issue that brings with it a number of key challenges, e.g.:

– How to manage down-manning of redundant personnel.
– How to retain the most suitable personnel – those with the skills, experience, knowledge or potential that will be most useful within the decommissioning programme and beyond.
– How to build and maintain the motivation of staff and contractors.
– How to train or retrain staff to ensure they have the appropriate skills for decommissioning activities.

> '*You're not in the power generation business anymore; you're in the waste disposal business.*'
>
> Source: Quote from a nuclear power plant manager

It is likely that some HOF aspects will be included within the workscope of other specialities such as human resources (staffing and skills assessment; outplacement and counselling) or procurement (acquisition of new tools and equipment), but specialist HOF support will be likely to be needed to apply some of the more specialised methods and to interpret data and guidance material correctly.

> '*An important part of human resource management is the staffing forecast. All positions should have end dates. We openly communicated the end dates of jobs, which should be known and updated on a quarterly basis. Everyone should know where he/she stands. This reduces uncertainty and anxiety, and helps foster trust in senior management. It makes good sense for both the company and its workers.*'
>
> Source: Confidential interview

When coupled with the technical challenges of decommissioning, as well as changes in business structure, management of HOF likely becomes more important during decommissioning, rather than less. For example:

– There are likely to be serious motivational and team working issues during decommissioning and HOF specialists have the expertise and experience to address these. This can make a major improvement to productivity.
– Decommissioning can be high-risk due to the speed and magnitude of change, therefore extra attention should be paid to both the technical factors and HOF to ensure safe decommissioning.
– Specialist HOF involvement can help identify and avoid showstoppers, for example, the proposed use of unsuitable equipment or methods where there is a clear breach of standards or established good practice.

The HOF challenges can be summarised as two key problems:

1. The first is that some aspects of decommissioning can affect the health, safety, wellbeing and performance of those working in the facility. For example, it would be clear to the existing workforce that they too are likely to be 'decommissioned' once the facility has been taken out of service. This can lead to stress and anxiety and a poor morale coupled with poor motivation at work.
2. The second problem is that those working on the facility can affect their own and

others' health, safety and wellbeing and, possibly, the environment through their activities. For example, the tasks to be performed in decommissioning are likely to be quite different from those conducted in normal operations and are often carried out under time pressure – since the site is no longer productive – and these factors can lead to human error.

3. This publication attempts to describe the specific problems presented by decommissioning though, ultimately, the tools and knowledge applied will be fairly generic.

1.3 SCOPE

The purpose of this publication is to explore the HOF issues that are relevant to ensuring safe and effective decommissioning. It describes a generic decommissioning life cycle, as well as the potential HOF problems that can arise during decommissioning and guidance on how they can be addressed.

The guidance is applicable to all major accident hazard industries and to many others since the HOF requirements are largely the same across all sectors. Note, however, that different terminology is used within the different industries; for example site owner/operator (to mean the site organisation that owns and operates the site) vs. operator (meaning the personnel working on the installation).

The guidance in this publication is aimed both at the specialist HOF practitioner and anyone who wishes to know more about the subject. It will allow practitioners to determine whether they have adequately considered all HOF aspects of decommissioning, and help other readers to test their understanding of the issues and determine whether specialist help is needed.

This publication includes material gathered from interviews with industry practitioners – both core personnel and contractors with experience of decommissioning, and from workshops convened to exchange learning experiences of decommissioning. Experiences are presented as short transcribed quotes throughout in italics, as well as one longer case study presented in Annex C that illustrates some of the key challenges covered in this publication (all quotes are sourced from confidential interviews, unless otherwise stated).

Note that this publication does not specifically consider 'mothballing', where there has been no firm decision to decommission a facility and there remains the possibility that it will be recommissioned at a later date. There is limited information available on such projects and little evidence that this has been done successfully in that 'mothballed' facilities remain, effectively, permanently shut down. The issue is similar to that arising in offshore installations that become 'normally unattended or unmanned' (NUI), where the equipment required for ongoing care of the facility and the fabric of modules and structures is found to have deteriorated between maintenance visits to the extent that reinstating the installation is impracticable. This may begin to change in the thermal generation sector; in 2017, the EI published guidance for the preservation and recommissioning of power stations (EI, *Guidance on the preservation and recommissioning of existing combined cycle gas turbine (CCGT) plant*); however, this document does not cover HOF.

> *'The platform became a NUI with maintenance visits every three months. On one occasion, when we got there, we found that the gratings had corroded badly and were unsafe. Not only that, the crane was not working so we couldn't lift in gratings from elsewhere. Manhandling these with ropes and brute strength is clearly not safe.'*
>
> Source: Confidential interview

1.4 PUBLICATION STRUCTURE

This publication is structured to allow users to more easily and rapidly gain an understanding of HOF issues during decommissioning by providing:

- an overview of HOF for non-specialists;
- an overview of end of service life operations and decommissioning lifecycle and the HOF issues that can arise, and
- a set of HOF checklists.

A key element of the guidance is the set of readily-accessible self-assessment checklists provided in Section 4. The checklists provide an overview of the key HOF topics that are likely to arise within the decommissioning phases of a facility's life. The answers given will enable the HOF-experienced practitioner to judge whether there are any gaps in their planned programme. They will also enable those with little or no HOF experience to scope out a programme of work and establish whether specialist support is needed.

Readers of the guidance can choose different entry points to the checklists depending on the extent of their prior knowledge of HOF. A large amount of general and detailed HOF guidance is already available – for example, from the EI and HSE – and the intention is not to repeat the content of such guidance within this publication. If the reader requires more detail than is provided in this publication then further reading material is referenced.

2 OVERVIEW OF HUMAN AND ORGANISATIONAL FACTORS

This section explains what is meant by HOF, and is intended for non-specialists.

As a basic description, HOF is about designing tasks and ensuring that everything required to ensure optimum task and human performance – such as tools and equipment, supervision, training, procedures/job aids, and the right work environment (both physically, such as lighting, and non-physically, such as company culture) – is provided. Key to this is a suite of coordinated management systems and processes that support the delivery of the above, for example a user-centred process for the procurement of tools and equipment, and a competence management system for selection, training and assessment of personnel required to perform tasks.

Tables 1–3 summarise the key HOF issues to be considered in any project split between:

– Task design – what is the operator required to do?
– Task support – what facilities, equipment and administrative controls are needed to optimise task performance?
– Organisation and management systems and practices – what formal processes are needed to ensure task success?

The tables describe, briefly, the HOF issues, the purpose of considering that issue and the methods and tools that can generally be applied to achieve this. Note that there is not a one-to-one relationship between the HOF issues raised and the methods described. For example, various methods of 'task analysis' are useful for many different applications such as procedure and training development, for analysis of communications and for identifying possible errors.

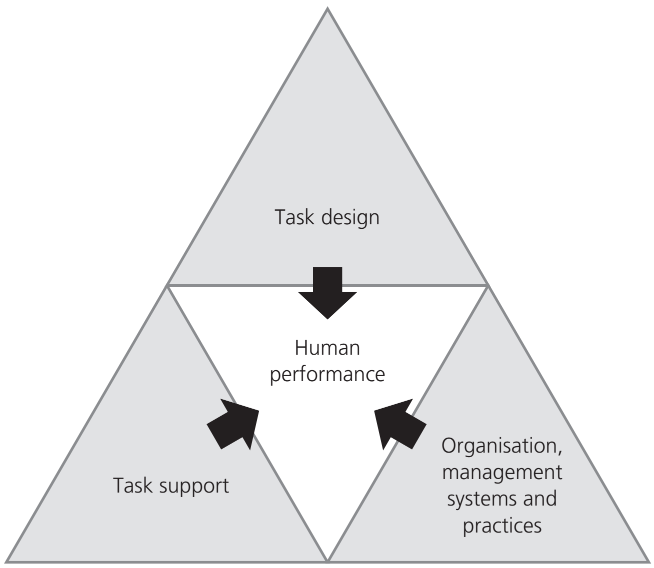


Figure 1: HOF issues

Table 1: Task design

<table>
<tr><th>Human Factors</th><th>Purpose</th></tr>
<tr><td>Determine the appropriate task content and characteristics:
what the operator is required to do;
required physical or mental effort, and
difficulty of the task or any sub-tasks
Covered in: 4.2;4.13;4.14; 4.15; 4.19; 4.27; 4.31</td><td>To ensure a meaningful, motivating, achievable task is assigned to the individual
To ensure that all physical and other risks potentially arising from the tasks are assessed and managed</td></tr>
<tr><th colspan="2">Methods/tools/techniques</th></tr>
<tr><td colspan="2">Allocation of function analysis (see 4.13)
Assignment of tasks/functions to the system or the human based on assessment of their respective strengths and weaknesses

Task analysis (see 4.14)
Different methods of formally examining tasks to support, for example, workload assessment, procedure design, training and error identification

Workload assessment (see 4.15)
To optimise the physical and mental demands of the tasks assigned

Fatigue risk management (see 4.31)
To ensure that tasks do not induce excessive fatigue

Competence management (see 4.4; 4.5; 4.6; 4.7; 4.8)
Selection, training and assessment of personnel and contractors

Human reliability analysis (see 4.22)
To identify errors/violations; identify defences against error and error recovery mechanisms

Workforce involvement (see 4.3)
To ensure that task performers have input to the task design</td></tr>
</table>

Table 2: Task support

Human factors	**Purpose**
Workplace/workspace layout. (See 4.16) Design of tools, equipment and human-machine interfaces. (See 4.17;4.18;4.19;4.20) Procedures: design, provision, training to use them, update or withdrawal of procedures (See 4.14; 4.21) Organisational change management. (See 4.2; 4.3; 4.5; 4.10; 4.11; 4.12)	To create a workplace that optimises task performance, e.g. is adequate in size, shape and location, is comfortable, safe and pleasant to work in To ensure that all human equipment interfaces are appropriate, safe and easy to use To provide and maintain fit for purpose instructions, written materials (similar principles apply to signs and labelling)
Methods/tools/techniques	
Anthropometric analysis (see 4.16; 4.19) Apply data on operator body size and strength	
Work environment assessment (see 4.16) Ensure optimal lighting, temperature, noise levels	
Design standards, guidance and good practices (see 4.17; 4.18; 4.20) Applying formal national and international standards	
Task analysis (also procedure design/technical authorship guidelines) (see 4.14; 4.21) To ensure procedures are based on sound principles	
Usability testing (see 4.3; 4.18; 4.20) Practical evaluation of equipment, tools and workplace using actual or simulated tools, equipment and facilities	
Outplacement/redundancy counselling (see 4.3; 4.4; 4.5) When staff losses are unavoidable	
Retraining (see 4.3; 4.5; 4.6; 4.7) To make best use of existing resources/capitalise on core staff strengths	
Management development (see 4.8) As management roles change or other personnel are identified for promotion	
Human factors engineering (see 4.17; 4.18) Assessment of physical aspects of the workplace, tools and equipment	
Methods/tools/techniques	
Manual handling assessment (see 4.19) To assess physical risks and how to eliminate or avoid them	
Fitness for duty checking (see 4.31) To ensure that operators are well, alert and unimpaired for the planned work	
Stress risk assessment (see 4.30) To assess stress and provide help where needed	
Human reliability analysis/safety critical task analysis (see 4.14; 4.22) To identify error and violation potential in (mainly) safety critical tasks	

Table 3: Organisation and management systems and practices

<table>
<tr><th>Human Factors Issue</th><th>Purpose</th></tr>
<tr><td>Human factors integration (see 4.1)
Safety culture (see 4.11;4.13)
Organisational learning (see 4.9; 4.28)
Change management (see 4.10)
Maintaining motivation and morale (see 4.2; 4.3)</td><td>To learn from past events and strategies to feed into task design and support
To ensure that changes in the organisation, in tasks, methods, procedures or any other element affecting human performance are appropriately controlled</td></tr>
<tr><td colspan="2">Methods/tools/techniques</td></tr>
<tr><td colspan="2">Human factors integration planning (see 4.1)
To develop a strategy for involving HOF throughout a project; to capture issues arising and ensure they are resolved; to scope out the necessary interventions and identify tools and techniques to be applied
Safety culture promotion and assessment (see 4.3; 4.11)
Management and workforce joint activities to ensure that safety is demonstrably a primary consideration in the workplace
Operating experience/knowledge capture and retention (see 4.9; 4.23)
To learn from experience or to rebuild a knowledge base that has deteriorated or been lost entirely</td></tr>
<tr><td colspan="2">Methods/tools/techniques</td></tr>
<tr><td colspan="2">Human performance tools (see 4.3; 4.24; 4.26; 4.27; 4.29)
To instil good practices: questioning attitude, situational awareness development/assessment
Incident and accident investigation (various tools) (see 4.9; 4.23; 4.28)
To efficiently and thoroughly identify the root causes of incidents, accidents and other events (e.g. from observation) and to prevent occurrence of specific and similar incidents
Safe communications (see 4.29)
To ensure that information is transmitted – either by word of mouth or in writing accurately and effectively
Indicators (see 4.9; 4.23)
Establish, monitor and act upon leading and lagging indicators and any signs of slowly developing faults; can be applied to equipment and facilities and people (signs of personnel problems)</td></tr>
</table>

3 CONSIDERING HOF DURING THE DECOMMISSIONING LIFECYCLE

3.1 GENERIC LIFECYCLE

While technical details will vary for how different industry sites are decommissioned (for example a nuclear site vs. an offshore facility), they broadly follow a similar decommissioning lifecycle. This is understandable as all facilities typically hold large inventories of hazardous and/or potentially polluting materials which must be removed and made safe before the structures can be finally cleaned and removed. For example, fuel cooling ponds are unique to the nuclear industry, but they are similar to other industry vessels in that they require emptying/draining, cleaning and disposal. Dismantling all types of facility and clearing the site completely requires the use of heavy machinery and novel techniques, although these are normally deployed by specialist contractors.

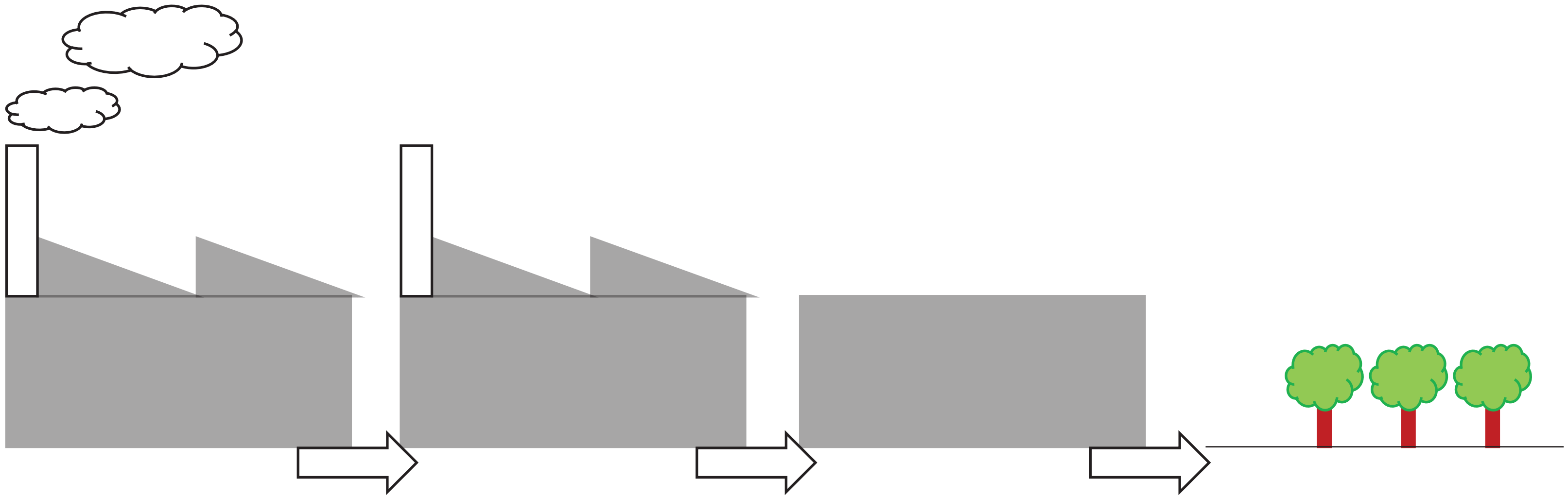
At a high level, the decommissioning life cycles comprise four stages (Figure 2).

It is difficult to generalise completely and there will be some overlap between phases; for example, the decision to cease operations is an aspect of the planning for decommissioning phase, but most detailed planning will actually take place after that decision is made.

Although it is clear that some HOF issues should be considered early on in the programme of decommissioning – such as staffing arrangements and resourcing in terms of retaining key personnel – there are other aspects (including of staffing and resourcing, such as the integration of contract personnel) that should be revisited periodically throughout decommissioning. The HOF self-assessment checklists in section 4 are ordered broadly according to when in the decommissioning programme they are likely to be most applicable, but many issues will be applicable in most phases (see Figure 2).

Before reading the remainder of this section, the following cautions should be noted:

– Within any given sector – even those that are closely regulated and have the benefit of regulator guidance and direction – it is unlikely that the phases of decommissioning will be the same in different organisations. What is presented in 3.2 is an example only.
– There is no clear one-to-one relationship between phases of decommissioning and HOF issues that should be considered; broad guidance only can be given on what should be done at each stage; indeed, it is fair to state that most HOF issues should be considered to some extent within almost all stages.
– Many of the issues described in this guidance are generic HOF issues applicable to any project or lifecycle stage of a facility, but the guidance, in particular the checklists shown in section 4, describe (to the extent possible) the specific problems that can arise within decommissioning.
– Many of the issues faced during decommissioning are also true of shutdowns and turnarounds/outages, especially concerning the management of large numbers of contractors. Whilst there are some obvious differences (the dismantling of plant rather than its maintenance and commissioning), it is recommended that the reader reads EI Transient contractor and supplier risk management and assurance during shutdowns, outages and turnarounds, which covers a large number of HOF and technical issues that are not covered elsewhere (including in this publication); for example, the use of tools and power tools, conflicts over resources, supervision, permits to work, etc. Many of these topics covered are equally valuable for decommissioning.



1. Planning for decommissioning – considering and choosing options (a continuous process throughout decommissioning).

a. Decommissioning activities are determined and scheduled

2. End of service life operations (EOSLO) – (gradually) ending site operational activities.

a. The decision is taken to cease production

b. Operations cease/plant is shutdown.

c. The plant retains hazardous inventory – flammables, toxic or radioactive materials.

3. Decommissioning/demolition – physical dismantling and disposal of structures and plant.

a. Hazardous materials are removed and the process plant purged and cleaned.

b. The facility is dismantled and disposed of.

4. Site clearance and remediation – returning the site as much as possible to its original condition.

Figure 2: Decommissioning lifecycle

3.2 LIFECYCLE PHASES

3.2.1 Planning for decommissioning

As described in 1.1, the decision to decommission a facility is made for various reasons. It may be clear to everyone working at the facility that it is reaching the end of its useful life even before any formal announcement is made. Indications of this include:

- visible signs of facility ageing such as the deterioration in its fabric – the facility may have already had several life extensions;
- reduced investment accompanied by downsizing and lack of resources, and
- dwindling reserves that can be economically exploited with the existing facility's technology.

In these cases, it should be possible to plan the process in an orderly and logical way. Planning will precede the decision to cease production since the fate of the facility will be known well in advance.

In the case of a more sudden or enforced reason for ceasing production, the facility owner is likely to have to consider options on a much shorter timescale than in the planned case, for example if production must stop immediately due to a catastrophic incident. It is beyond the scope of this guidance to consider all situations that could lead to the decision to decommission and the variations in the approach to decommissioning that could ensue. The lifecycle in this publication is on planned decommissioning but note that in all cases the activities required and the HOF issues related to them will be much the same in the planned case as are presented here.

Planning in one form or another continues throughout decommissioning and is not treated as a separate stage but is referred to throughout.

3.2.2 End of service life operations

Depending on the size of the facility, this phase could start 10 years or more prior to cessation of production (CoP). During this phase, the plant is still operating, albeit (depending on the sector and the market conditions) its mode of operation may differ to that originally intended so as to extract maximum return on investment.

As time progresses and the likelihood of CoP comes within a five-year window, the facility owner will focus on more specific issues related to decommissioning. At this point it should be recognised that employees will be particularly concerned about what this means to them and their future employment.

Operating staff, including long-term contractors, will want to know whether they will lose their jobs or what other alternatives are available to them. It should be recognised that unless a structured and accurate means of conveying information is implemented then speculation will take over, whereby employees will discuss and conclude worst case scenarios, i.e. redundancy. The effects of this are potential demotivation resulting in inefficient working and lack of attention, which can easily lead to risks to the plant and personnel in the form of incidents and accidents. In addition, key personnel required to facilitate decommissioning may opt to leave the company and seek employment elsewhere.

Within the later stages of this phase, the facility owner should focus on transitioning the facility from production to decommissioning, i.e. identifying the services, processes and skills that will be required during decommissioning.

There may be internal conflicts during this phase as the existing production management team may be focused purely on maximising production, which could compromise decommissioning and safety by reducing or taking out of service certain systems required for decommissioning. To avoid such potential conflict, it is often useful to appoint a 'late life manager' responsible for managing the interface between production and decommissioning in this early phase.

HOF implications should be clearly considered when planning decommissioning, especially since proposed changes to operational processes may result in new hazards being introduced. For example:

- The implications of reduced maintenance, both short-term and long-term, may result in unexpected failures of plant and equipment integrity. For example, in the case of an offshore platform placed in unmanned mode for extended period, the potential consequences are:
  - failure in secondary steelwork (grating, handrails, access ways, cladding, supports, etc.);
  - failure or loss of efficiency in equipment and systems required for decommissioning (cranes, pumps and life support services), and
  - deterioration in the fabric of buildings; loss of signs/signposting and labelling.
- Systems being taken out of service: there should be robust procedures for ensuring these are safely isolated. The consequences can include mistakenly working on live electrical equipment.

As the plan for decommissioning develops, this is the most effective point to begin thinking about the content of a human factors integration (HFI) plan. Integrated planning is essential during this phase, as multiple operations may well be carried out by both operations personnel and those conducting decommissioning activities.

It is essential that regular communication with staff is carried out and, where appropriate, plans are made to manage changes in staff and contractor requirements.

Key HOF issues during this phase include:

- Staff motivation and retention (including developing measures to retain key personnel). Keeping staff informed with regular updates can help, as can promoting and acknowledging feedback from employees and contract staff.
- Management of change from production to decommissioning, with emphasis on organisational changes (such as staffing numbers), bearing in mind there may be resistance to change from key personnel.
- Data gathering and corporate knowledge capture (so that knowledge does not get lost once personnel leave).
- Assessing competencies and any associated training needs for the upcoming decommissioning activities.
- Maintaining a good safety culture, being especially mindful of the effects on culture of motivation and potential early loss of key personnel, some of whom may have been instrumental in maintaining the existing culture.
- Considering required upgrades to equipment and facilities for decommissioning and the fitness-for-purpose of those for personnel using them.

3.2.2.1 Cessation of production

The transition phase from a producing facility to cessation of production involves detailed consideration of potential safety issues associated with shutting the facility down, and appropriate steps taken to eliminate or mitigate risk. The following are typical examples of the types of things that may need to be done:

- detailed integrated planning and regular reviews with involved parties and stakeholders;
- training programmes to meet new activities;
- identification and verification of key competency and skill requirements;
- management of safety critical elements;
- detailed procedure development for critical activities and verification process;
- Hazard Identification studies (HAZIDs) and hazard and operability studies (HAZOPs), as appropriate – ideally with HOF involvement, and
- maintenance and inspection regime throughout.

3.2.3 Decommission, dismantle, demolish, dispose

3.2.3.1 Engineering down and cleaning

A key objective for this phase is to remove hazardous materials from the various process and storage systems. This is typically achieved by cleaning and isolation, utilising existing operations personnel and specialist cleaning contractors.

The extent of cleaning may vary from facility to facility, but as a minimum it can be expected that systems containing hazardous materials will be purged, flushed, decontaminated and freed of the bulk of those materials. It should be noted that some residual solids, liquids and gases may remain in the system, including materials that have accumulated in the vessels and pipework such as pyrophoric scale; in the nuclear industry, metals may have become activated (radioactive). Residual materials will be handled as appropriate to the industry and according to legal requirements and good practices.

Depending on the facility owner's strategy for removal of the facility it is possible that the facility, or parts of it, will be left for several years before final dismantling and demolition. In the case of offshore facilities, the facility may become a normally unattended installation (NUI) or minimum manned installation (MMI) (also referred to as cold suspension, cold stack, mothballed or in 'lighthouse' mode). In the nuclear industry waste materials will be held in an interim storage facility for many years to decay into a less radiologically active form.

HOF will be important during many of the main activities during this phase, including:

- shutdown of live systems;
- isolations;
- purging and flushing of process and storage systems;
- specialist cleaning;
- initial installation of temporary systems, and
- waste disposal from cleaning.

This is because each of these activities will require the undertaking of a series of tasks or new ways of working. These tasks are likely to be novel and may be done on site for the first (and possibly only) time, meaning it is important to get them right the first time. Alternatively, the activities may require a new way of working over an extended period of time (e.g. minimal staffing) or use of specialist contractors. In any event the implications are the same: a novel task should be designed in a way that sets the operator up to succeed; good task support (working environment, procedures, etc.) should be provided to help the operator succeed, and an organisation and management system should be in place that ensures these things happen.

Other HOF issues that should be considered include:

- changes in workforce mix (e.g. increased use of contractors);
- integration of specialist contractors;
- down-manning or minimal manning;
- scheduling of visits, and
- remote monitoring.

These issues stem from changes to personnel – including the temporary use of contractors in some areas (such as for specialist tasks) and the reduction in staff in other areas (such as in the control room). There will be training considerations (e.g. site inductions), as well as considerations over whether contractors should use the site owner's/operator's permit to work (etc.) system.

It is possible that this phase may be carried out in parallel with other phases. This would require integrated planning to consider the implications of this. This is a well-known practice offshore, called simultaneous operations (SIMOPS).

Site owners/operators should consider the structure of the operating organisation once the facility is considered to be (largely) free of the main hazards and the requirements for operations and maintenance personnel are reduced i.e. the facility could be deemed a decommissioning site rather than a production facility.

During the transition phase from production to decommissioning, detailed consideration should be given to the potential safety and environmental issues, and appropriate steps taken to eliminate or mitigate them. The following are typical examples of the types of activities likely needed:

- detailed integrated planning and regular reviews with involved parties;
- training programmes to meet new activities;
- identification and verification of key competency and skill requirements;
- management of safety critical elements as they are decommissioned;
- revisions to the safety case;
- detailed procedure development for critical activities and a verification process;
- HAZIDs and HAZOPs as appropriate – ideally with HOF involvement;
- implications of long-term down-staffing with increasingly infrequent visits and possibly remote monitoring (equipment or fabric failure);
- maintenance and inspection regime throughout to be determined, and
- considerations of future decommissioning requirements if the facility is to be placed in NUI/MMI.

3.2.3.2 Preparatory work

This phase will include the work necessary to prepare the facility for the removal of major structures and may be carried out post clean-out or after a period of time in an NUI/MMI state. This work may well be carried out by the company's existing construction contractor or by a specialist decommission services contractor (DSC).

For an offshore installation, preparatory work may be carried out by a heavy lift contractor as the most practical option if the platform has been left in an unattended phase for a period of time and recommissioning life support services is no longer a practical consideration.

The scope of work during this phase will be dependent on the removal option which may entail the removal of entire modules and items of plant – for example, in the offshore sector, removing the entire topsides[1] and transporting it to shore by heavy lift barge for onshore dismantling.

Preparatory activities include:

- Separation of large items by cutting and disconnection of structural, piping, cables, heating, ventilation, and air conditioning (HVAC), instrumentation and cladding.
- Installation of local stiffening.
- Installation of lifting aids (padeyes, bumpers and guides).
- Installation of temporary utilities and safety systems.
- Installation of load bearing base to support mobile dismantling or lifting equipment.
- Cutting items into small sections for loading into skips or separate crane lift.
- Material handling and separation of scrap materials.

Similar to 3.2.3.1, these tasks are likely to be novel and may be done on site for the first (and possibly only) time, meaning it is important to get them right the first time. Alternatively, the activities may require a new way of working over an extended period of time (e.g. minimal staffing) or use of specialist contractors. The main activities possibly requiring HOF analysis or intervention during this phase include the following:

- Mobilising new personnel who are unfamiliar with the facility.
- Depending on size of the facility and scope, the work could be only for a short duration – hence the need for rapid deployment of training and procedures and possibly closer supervision.
- Managing the safety risks when systems/components containing stored energy (in whatever form that takes, e.g. pressure, tension in pipework, weight) are cut.
- Managing the potential risks associated with the increased number of lifting and material handling operations.
- Changes in crew mix due to site accommodation or other restrictions.

The site owner/operator should consider whether it would be appropriate to create a training programme to train staff in the required activities and health and safety considerations.

Significant work should be carried out during the planning phase to identify potential HOF, safety and environmental issues at an early stage such that steps can be taken to eliminate or mitigate. The following are typical examples of detailed activities in the planning phase:

1 Those parts of an entire offshore installation which are not part of the substructure. It includes modular support frames and decks where their removal would not endanger the structural stability of the substructure.

- Detailed integrated planning and regular reviews with involved parties – especially contractors.
- Training programmes to meet new activities.
- Identification and verification of key competency and skill requirements.
- Means of communicating with multi-language crew.
- Detailed procedure development for critical activities and verification process.
- HAZID and HAZOP as appropriate.
- Implications of long term in NUI/MMI (equipment or fabric failure).
- Maintenance and inspection regime throughout.
- Considerations of future decommissioning requirements if the facility is to be placed in NUI/MMI.
- Access to facility for surveys and eventually for preparatory work after extended NUI/MMI phase.
- Potential spills or whiplash as pipework is separated.
- Changing access to the facility and structures/workspaces within the facility as items are removed (which may entail setting down on site temporarily).

3.2.3.3 Disposal

This phase is primarily an activity carried out away from the main site and relates to the facility selected for receiving, dismantling and recycling[2] (or reusing) the components removed from the site. Disposal of 'waste' is highly regulated; consequently, selected facilities require to demonstrate that they meet specific acceptance criteria for both waste disposal and environmental considerations.

Contractors involved are from a well-established dismantling and demolition industry, albeit the oil and gas industry imposes stricter control and reporting requirements than is typical for onshore disposal activities. Disposal of nuclear wastes is also highly regulated.

Onshore dismantling is largely a mechanical operation rather than labour intensive, with cutting mainly carried out by hydraulic shears mounted on mobile units.

Depending on the location of the disposal site, certain local restrictions may apply to transportation of modules, etc., and specific approvals may be required before offloading, especially if hazardous materials are contained within the modules.

Typical activities are:

- Offloading modules.
- Waste management and accounting.
- Further cleaning and removal, handling and disposal of hazardous waste (asbestos, PCB, mercury, low specific activity (LSA)/naturally occurring radioactive material (NORM)).
- Removal and disposal of marine growth – where appropriate.
- Dismantling of components and separating materials.
- Reuse where appropriate and with site owner's/operator's agreement.

2 In the context of decommissioning, this is the process of conditioning the components and materials of a facility during dismantling e.g. resale of equipment; recovery of metals forwarded to smelters.

HOF considerations are primarily occupational safety related and no different than the existing onshore demolition industry and hence out of scope of this guidance document. However, some indication of likely HOF considerations required are presented here amongst the various activities:

- Identification of potential hazards with receiving and offloading.
- Ensuring site security to prevent accidents from interested bystanders.
- Ensuring a detailed inventory identifying hazardous materials is available, such document to estimate quantities and location.
- Dropped loads or unplanned collapse during dismantling.
- Detailed planning and regular reviews with staff.
- Training programmes to meet new activities and use of dismantling/cutting equipment.
- Identification and verification of key competency and skill requirements.
- Means of communicating with contractors (bearing in mind language barriers if using specialist contractors from other countries).
- Detailed procedure development for critical activities and verification process.
- HAZIDs and HAZOPs as appropriate.
- Potential spills as pipework is separated.
- Controlled safe access to demolition area.

3.2.4 Site clearance

3.2.4.1 Site remediation

This phase is primarily to return the site to a greenfield or brownfield state. As with demolition and standard land clearance activities, hazards will be primarily occupational – slips, trips and falls arising from the site clearance, waste and scrap disposal and landscaping. The HOF issues are outside the scope of this publication.

3.2.4.2 Close-out

This final phase of decommissioning has two components:

- regulatory and company requirements, and
- ongoing liability obligations for items decommissioned in situ.

The initial requirements relate to satisfying the regulators that the work as agreed has been carried out and primarily consists of a close-out report with appropriate evidence. Company requirements will also necessitate a close-out report complete with 'lessons learnt' etc.

The following is indicative of the content of the close-out report:

- introduction, scope of report, project background;
- scope of work;
- deviations from scope;
- post-decommissioning activities;
- decommissioning programme outcome;
- project management (safety and environment statistics);
- project costs, and
- appendices (certificates, as-builts, waste disposal, sampling).

The second requirement relates to periodic monitoring and regular survey of any components decommissioned *in situ*[3].

At this late phase of the project minimal personnel will be involved and they may be only on a part-time basis. A key consideration will be knowledge retention, as the company should consider how to ensure that experienced project personnel are retained through to close-out.

3 In the offshore sector, decommissioning *in situ* refers to leaving infrastructure in place and carrying out appropriate work to ensure that there is minimal risk to other sea users or the marine environment. This could apply to any installed facilities on the seabed, such as pipelines, manifolds, pipeline crossings and the footings of larger jackets.

4 HOF GUIDANCE NOTES

This section provides 31 HOF guidance notes. Each note provides a self-assessment checklist to enable the organisation to recognise whether the HOF issue has been managed during decommissioning. Unless otherwise specified, an answer of 'no' to any of the questions means that this topic may be an issue in need of further consideration.

The intent of the guidance is to indicate the specific HOF issues that typically require attention within a decommissioning environment. Figure 3 maps the HOF issues (and the accompanying guidance notes) against the decommissioning phases they will be most relevant to. There is considerable overlap in terms of the HOF issues that are relevant to each phase of decommissioning, and some issues (such as HFI) should be considered up-front but will have an impact on later phases. For example, it will be necessary to consider the selection of suitable personnel/contract staff throughout most phases (and, of course, selection of personnel is not an issue exclusive to decommissioning). It is also worth bearing in mind that HOF is a highly integrated subject and, as such, when considering any one element, for example task content, it is essential to consider other related aspects, such as the competence of the person assigned to the task, the tools they are to use and procedures required.

It should be noted that even if the 'disposal' phase is undertaken by a specialist contractor, the site owner/operator will still have a duty of care obligation for waste and may still have a site presence. Although the HOF issues have been mapped to this phase, the owner/operator may not have as much direct involvement in management of HOF issues.

Each guidance note refers to a list of more detailed guidance that provides further information on the topic. Some references are in the form of website addresses. Since these are prone to change as items are moved or no longer supported, the website home page address is given: the reference material can then be found by searching from the home page.

Key websites to consider for human factors information of relevance to the topic areas in this report are given in Annex A. Search terms are provided but a general search for 'human factors' will produce results.

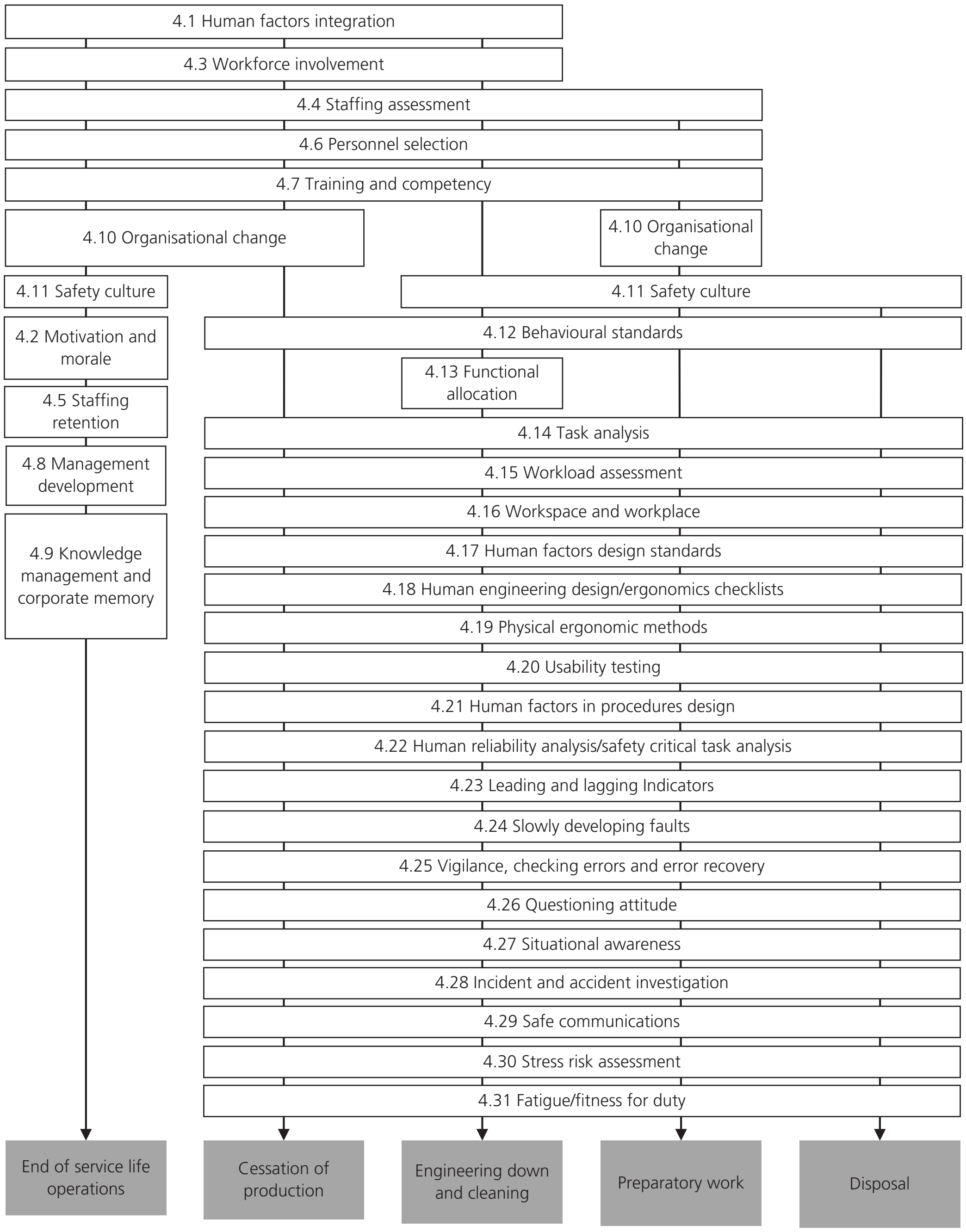


Figure 3: HOF issues mapped against decommissioning phases

4.1 HUMAN FACTORS INTEGRATION (HFI)

4.1.1 Overview

HOF should be integrated into decommissioning work plans from the earliest stages. A human factors integration plan (HFIP) should be developed that shows HOF activities to be carried out at each stage. It will usually also include reference to the approaches and methods to be used and describe how issues will be raised, communicated and resolved. The HFIP should be managed by someone with the necessary competence. The plan should describe the HOF work required and how it will be resourced and delivered.

4.1.2 Issues/problem areas

HOF is not always regarded as an essential discipline in many projects. If HOF is not integrated into the overall work plan, important considerations may be missed and any HOF work that is done is likely to be piecemeal and uncoordinated. If HOF is seen as an 'add on' to the end of a phase of work, remedial actions will invariably be more costly than if the work is assimilated appropriately into the project.

4.1.3 Possible solutions

A HFIP should be developed at the earliest stages of the project. A HOF specialist should be appointed to develop this and manage its application throughout the project. Consider and formally assess whether existing personnel have any of the necessary expertise in HOF; use these personnel to develop the HFIP.

4.1.4 Checklist

Table 4: Human factors integration checklist

Questions		Y	N
1	Is there a clear understanding within the project of what HOF tasks must be considered within each phase of the decommissioning work (for example: task analysis, human reliability studies, design assessment, developing/ assessing procedures, assessing the working environment, identifying training needs) and the HOF methods to be used?		
2	If yes to 1, is there a formal HFIP capturing the requirements based on good practice for such a plan?		
3	Are you confident that HOF requirements will be met with the planning and resourcing available?		
4	Are all project managers aware of the plans for HOF?		
5	Is there a formal process for registering and resolving HOF issues that arise e.g. an 'issues register'?		
6	Is there a clearly identified point of contact/champion responsible for ensuring HOF tasks are carried out?		

4.1.5 Further reading

- EI, Human factors briefing note no. 16: Human factors integration
- HSE, RR001, Human factors integration in the onshore and offshore industries
- International Association of Oil and Gas Producers (IOGP 454), Human factors engineering in projects
- ONR, Safety assessment principles for nuclear facilities
- ONR, Technical assessment guide: Human factors integration

4.2 MOTIVATION AND MORALE

4.2.1 Overview

It is difficult to maintain morale and motivation in any short-lived project where there are many uncertainties and where the end result will be a change of job or unemployment.

4.2.2 Issues/problem areas

Lack of motivation and morale can lead to inefficient performance and, in the worst cases, stress or other psychological problems. It can also lead to antisocial behaviour and vandalism on site.

4.2.3 Possible solutions

It is important to provide a supportive and sympathetic environment and to identify and implement ways of maintaining a positive outlook during decommissioning.

4.2.4 Checklist

Table 5: Motivation and morale checklist

Questions		Y	N
1	Have you taken positive steps to build trust and loyalty within the workforce?		
2	Is the organisation positively encouraging discussion and genuinely listening to and acting upon concerns expressed?		
3	Are you monitoring signs of problems such as: unusual levels of absenteeism; social withdrawal; lack of interest?		
4	Are you conducting regular surveys (with, if necessary, the opportunity for anonymous responses) to gauge opinions/levels of job satisfaction and to make any required changes)?		
5	Do you have strategies for dealing with any of the motivational issues described in question 3?		
6	Have you made some of the less motivating tasks as satisfying as possible? (involving the operators in designing the task content and method; rotating the more routine and tedious tasks around the team)		
7	Have you considered the future of each individual: within the company; outside the company; helping with training and development of transferable skills, etc.?		

4.2.5 Further reading

- EI, Human factors briefing note no. 18: Leadership
- EI, Human factors briefing note no. 21: Supervision
- Management study guide website: http://www.managementstudyguide.com/what_is_motivation.htm

4.3 WORKFORCE INVOLVEMENT

4.3.1 Overview

Employees (including contract staff) may feel detached from important decisions concerning the work they do as well as the equipment and procedures they are required to use.

4.3.2 Issues/problem areas

A poor culture can result from lack of 'ownership' and engagement by the workforce believing that key decisions are simply imposed on them. Those working at the 'sharp end', however, typically have the best insight about what will work and be accepted, and what will not; contractors with experience of other sites can also bring a different perspective on these aspects of working. Involvement can be overdone: it is important to ensure that 'involvement' does not become 'delegation' to the workforce; involvement should be a cooperative team-based process.

4.3.3 Possible solutions

As a minimum, consult with the workforce and provide good communications on decisions that need to be made. Ideally, involve the workforce from an early stage before firm decisions are made on matters that affect them. Implement and give credit for suggestions made by the workforce.

4.3.4 Checklist

Table 6: Workforce involvement checklist

	Questions	**Y**	**N**
1	Have you considered (or taken benefit from) workforce involvement in the following:		
	Organising tasks/developing job descriptions?		
	Risk assessments?		
	Incident investigations?		
	Workplace (safety or other) audits?		
	Behavioural safety initiatives?		
	Equipment selection and trialling?		
	Developing or upgrading procedures?		
	Developing training/competence enhancement?		
	Other?		
2	Have you provided the necessary resourcing (including time off the job) for workforce involvement?		

Table 6: Workforce involvement checklist

	Questions	**Y**	**N**
3	Do you know how to maintain involvement and how to avoid 'drift'/ complacency/lack of interest?		

4.3.5 Further reading

– EI, Effective workforce involvement in health and safety: a guide
– EI, Workforce involvement poster pack
– HSE, INDG232, Consulting employees on health and safety: a guide to the law
– HSE, Involving employees in health and safety
HSE, WPS/00/03, *Employee involvement in health and safety: Some examples of good practice*
– The Health and Safety (Consultation with Employees) Regulations 1996
– The Safety Representatives and Safety Committees Regulations 1977

4.4 STAFFING ASSESEMENT

4.4.1 Overview

Early staffing assessment through the key decommissioning phases is crucial, especially during the transition from operations to decommissioning, i.e. shutdown, cleaning etc.

4.4.2 Issues/problem areas

Failing to capitalise on the knowledge, skill, plant experience and adaptability of existing staff. This might require the use of additional contractors in key roles and increase the resource requirements for training and supervision.

4.4.3 Possible solutions

Careful planning of the entire decommissioning lifecycle (this cuts across a number of other areas covered in this guidance such as competency analysis and workload assessment).

4.4.4 Checklist

Table 7: Staffing assessment checklist

Questions		Y	N
1	Have you identified the potential risks involved in conducting key decommissioning tasks?		
2	Have you identified suitable resourcing of each key task:		
	Number of personnel required?		
	Key skills and competencies?		
	The organisational structure needed including – managers, supervisors, core staff and contractors?		
	Training needs?		
	Communication methods and content?		
3	Is there a strategy for severance/relocation/counselling of personnel who are to leave the organisation immediately or in the longer term?		

4.4.5 Further reading

- Byers, J.C., Bittner, A.C. Jr., and Hill, S.G. (1989). Traditional and raw task load index (TLX) correlations: Are paired comparisons necessary?, found in Advances in industrial ergonomics and Safety I, pp 481–485
- EI, Human factors briefing note no 23: Workload and staffing levels
- EI, Safe staffing arrangements – user guide for CRR348/2001 methodology: Practical application of Entec/HSE process operations staffing assessment methodology and its extension to automated plant and/or equipment
- HSE, CRR 348/2001, Assessing the safety of staffing arrangements in the chemical and allied industries
- NASA, Task load index, http://humansystems.arc.nasa.gov/groups/TLX/

4.5 STAFF RETENTION, OUTPLACEMENT COUNSELLING AND COMPETENCY ASSESSMENT

4.5.1 Overview

In the early stages of planning facility decommissioning, it is important to consider the staffing requirements for all phases.

Key members of staff should be retained. It is also important to be realistic about the future of personnel who will not be retained and to provide assistance in helping them to redeploy within the organisation or elsewhere.

> '*An important part of human resource management is the staffing forecast. All positions should have end dates. We openly communicated the end dates of jobs […] and updated on a quarterly basis. Everyone should know where he/she stands. This reduces uncertainty and anxiety, and helps foster trust in senior management. It makes good sense for both the company and its workers.*'
>
> Source: IAEA, *Lessons learned from the decommissioning of nuclear facilities and the safe termination of nuclear activities.*

4.5.2 Issues/problem areas

There will be fear and misinformation, rumour and speculation – it is essential to communicate clearly to all at the facility about their role and prospects within and beyond the current phase to provide reassurance and realism to the workforce.

Some members of the workforce will not have worked anywhere else or will not have had to seek a new job for many years.

> '*All the well trained 'desirable' people went early; it was easy for them to find a new role.They go early for the few jobs available locally. Guys who are about five years off retirement will stay for the duration; incentives help – top up the pension pot. We set up a confidential helpline. Any issues or concerns could be raised – not just work-related.*'
>
> Source: Confidential interview
>
> '*There are few people left who can put the plant into a fit state for handover to contractors.*'
>
> Source: Confidential interview

4.5.3 Possible solutions

'Golden handcuffs' – enhanced pay or project bonuses for key personnel who remain for the duration of the project – but beware of dangerous or conflicting incentives.

Capture experience and knowledge by interview of those who cannot be retained.

Engage the workforce and the wider community.

Impress on the workforce that decommissioning expertise is valuable.

Skills acquired during decommissioning will be valuable; consider training to enhance skills and onward employability of workforce.

4.5.4 Checklist

Table 8: Staff retention, outplacement counselling and competency assessment checklist

Questions		Y	N
1	Have you identified the capabilities, aptitudes, attitudes and behaviours required to carry out each task?		
2	If answering 'yes' to question 1, are these soft skills – communications, people management, counselling – included in the above?		
3	Are you clear on the most appropriate methods to carry out the competency assessments required?		
	Is there specialist help within the company for this?		
	Can the human resource expertise required be outsourced? (caveat – the outsourced organisation should understand the industry, the plant and the new tasks required in decommissioning)		
4	For those personnel who will not be retained for decommissioning activities or beyond decommissioning, have you actively sought to assist them in their future plans by, for example providing:		
	Suitable information and other resources to help with their future? e.g. a library, online facilities for job-seeking, career counselling, time for job-seeking or retraining?		
	Access to local employment services and career advisors?		
	Psychometric testing for job matching?		
	Liaison with further education establishments?		
	In-house training or other skills-enhancement methods to improve employability?		

4.5.5 Further reading

- Bolles, R., What colour is your parachute? (Plus Workbook), http://www.jobhuntersbible.com
- Bronson, P., What should I do with my Life?, http://www.pobronson.com
- Cogent Skills website, http://www.cogent-competence.com/

– EI, Guidance on crew resource management (CRM) and non-technical skills training programmes
– HSE, HSG197, Railway safety principles and guidance: Part 3, section A – Developing and maintaining staff competence
– HSE, RR 0862003, Competence assessment in hazardous industries
– Office of Rail and Road (ORR), Developing and maintaining staff competence
– Schein, E.H., Career anchors, Third edition, Pfeiffer

4.6 PERSONNEL SELECTION

4.6.1 Overview

The range of expertise and competencies required for decommissioning is different to those required for normal operation. Selection of personnel from the existing workforce and from contract organisations should focus on the specific requirements for decommissioning and the available resources for this may be scarce.

4.6.2 Issues/problem areas

> *'The workforce carrying out decommissioning may never have been offshore before.'*
>
> Source: Confidential interview

It may not be clear what types of personnel are required for decommissioning until late into the programme – especially when the organisation has little or no experience of decommissioning. Selection may be based on availability rather than a good match to specific roles.

4.6.3 Possible solutions

Formal methods of selection based on competency assessment apply, but with emphasis on the specific needs of decommissioning where there may be a requirement for flexible personnel willing to take on a number of different roles and responsibilities and able to cope with the potential pressures of this work.

4.6.4 Checklist

Table 9: Personnel selection checklist

Questions		**Y**	**N**
1	Do you have a clear idea of the skills and capabilities required for the range of decommissioning tasks to be carried out?		
2	If you answered 'yes' to question 1, do your selection criteria include:		
	Technical skills?		
	Behaviours/attitudes?		
	Non-technical soft skills (communication skills, teamwork, decision-making, supervision/leadership)?		
3	Do you have clear and comprehensive job descriptions for all of the roles required for decommissioning?		
4	In the selection process, have you used:		
	Competency-based interviewing methods?		
	Formal tests of skills and aptitudes; psychometric tests?		

4.6.5 Further reading

- Cook, M., Personnel selection: Adding value through people, John Wiley & Sons; 4th Edition
- Equality and Human Rights Commission website, http://www.equalityhumanrights.com/
- Iles, P.A., and Robertson, I.T., The impact of personnel selection procedures on candidates, in Herriot, P. (Eds), Assessment and selection in organizations: Methods and practice for recruitment and appraisal, Wiley, Chichester.
- Smith, M., and Robertson, I.T., The theory and practice of systematic personnel selection, Macmillan, London.
- The British Psychological Society, Psychological testing centre website, https://ptc.bps.org.uk/
- The British Psychological Society, Psychological testing: A users guide
- The Chartered Institute of Personnel and Development website, http://www.cipd.co.uk/

4.7 TRAINING AND COMPETENCY

4.7.1 Overview

Tasks performed in decommissioning may require specific competencies. It is essential that personnel performing such tasks have the necessary competencies and receive any additional training required.

As the site moves from one phase to another a different skill set and staffing profile will be required.

> '*As the site transitions from the Defuelling phase to the Care and Maintenance Preparations phase there has been, and will continue to be, an increase in contracted resources […] to undertake the specific decommissioning projects.*
>
> *Throughout the Care and Maintenance phase staffing will be minimal sustaining only the necessary site licence requirements.*
>
> *The Final Site Clearance phase will see a rapid increase in staffing followed by a reduction to zero as the site progresses towards de-licensing.*'
>
> Source: Magnox Sites, Bradwell site summary: Lifetime plan

4.7.2 Issues/problem areas

Many decommissioning tasks will be simple and straightforward physical tasks. Others will require more attention to detail (isolations, purging and draining) and specific skills and knowledge. If tasks are not assigned to the most able personnel, errors and accidents may result. An individual assigned tasks that are clearly outside their skill set may fail to disclose this and may suffer from stress or make errors.

4.7.3 Possible solutions

Conventional competence assessment can be applied but with emphasis on the specifics of decommissioning. Safety critical tasks should be practised on mock-ups or simulators.

> '*'On the job' training is often more useful than training courses. When training is provided […] it is usually more profitable to perform actual work in a decommissioning project than to take courses or make many short technical visits to different facilities. The real world with its hazards is the best teacher.*'
>
> Source: IAEA, *Lessons learned from the decommissioning of nuclear facilities and the safe termination of nuclear activities*

4.7.4 Checklist

Table 10: Training and competency checklist

Questions		Y	N
1	Have you identified the specific competencies required for the task?		
2	Have you identified personnel with the necessary competencies (or those that could be trained in the tasks required)?		
3	Have sufficient resources (time, money, qualified trainers, simulation and test facilities) been assigned to assuring workforce competence?		
4	Can the systems for competence assurance (including training) be demonstrated to be effective? (For example, through results in simulations/trials or independent auditing)		

4.7.5 Further reading

- EI, Human factors briefing note no. 7: Training and competence
- HSE books, ACSNI study group on human factors, First report on Training and related matters
- HSE website, Human factors: Training and competence, http://www.hse.gov.uk/humanfactors/topics/competence.htm
- HSE website, Training, http://www.hse.gov.uk/comah/sragtech/techmeastraining.htm
- HSE, Human factors: Inspectors' human factors toolkit: Competency assurance, http://www.hse.gov.uk/humanfactors/toolkit.htm
- HSE, Managing human performance – Briefing note: Competence
- HSE, RR086, Competence assessment in hazardous industries
- ORR, Developing and maintaining staff competence

4.8 MANAGEMENT DEVELOPMENT

4.8.1 Overview

Management arrangements that were appropriate for operations are unlikely to remain suitable for decommissioning. Management type, number and hierarchy will have to be changed to meet the challenges of decommissioning.

4.8.2 Issues/problem areas

Senior managers may be some of the first to leave the organisation prior to decommissioning, taking with them valuable staff management and leadership skills as well as knowledge of the plant and its history. Managers already in post may not have the skills or essential characteristics to manage during decommissioning. Core staff may be prematurely promoted to compensate for the lack of other options. Contractors bringing specialist knowledge of decommissioning activities may be appointed to manage core staff as well as their own teams, with the potential to cause tension and resentment within the workforce.

4.8.3 Possible solutions

Incentives can be used to retain suitable managers. Coaching can be provided to managers for the new requirements for decommissioning. Communicate with core staff regarding any new arrangements, especially the use of contractors.

4.8.4 Checklist

Table 11: Management development checklist

Questions		Y	N
1	Have you considered the management arrangements necessary for decommissioning?		
2	Have you considered the potential problems of managing decommissioning such as:		
	The lack of appropriate numbers of suitable managers?		
	The need for different skills, aptitudes, knowledge and attitudes for managing in a decommissioning environment?		
	The use of contract staff to manage teams?		
	Are there strategies in place to compensate for the above?		

4.8.5 Further reading

- Cogent Skills website, http://www.cogent-competence.com/
- EI, Hearts and Minds, Improving Supervision, https://heartsandminds.energyinst.org/
- EI, Human factors briefing note no. 21: Supervision
- HSE RR181, Different types of supervision and the impact on safety in the chemical and allied industries

- HSE website, Human factors: Supervision, http://www.hse.gov.uk/humanfactors/topics/supervision.htm
- HSE, Different types of supervision and the impact on safety in the chemical and allied industries
- HSE, Effective supervisory safety leadership behaviours in the offshore oil and gas industry
- Kinlaw, D.C., Handbook of leadership training activities: 50 one-hour designs, McGrawHill
- Ponder, R., The leader's guide: fifteen essential skills, PSI successful business library
- The Association for Coaching website, http://www.associationforcoaching.com/
- The British Psychological Society, Psychological testing centre website, https://ptc.bps.org.uk/
- The British Psychological Society, Psychological testing: A users guide
- The Chartered Institute of Personnel and Development website, http://www.cipd.co.uk/
- Yukl, G., Leadership in organizations, Second edition, Prentice-Hall, Englewood Cliffs, NJ

4.9 KNOWLEDGE MANAGEMENT AND CORPORATE MEMORY

4.9.1 Overview

It is important that information accumulated during the lifetime of the plant that will be important for decommissioning is preserved, and that any lessons learned during the decommissioning phase itself are captured and used for other decommissioning projects.

4.9.2 Issues/problem areas

Facilities undergoing decommissioning are typically older plant with a long operational history. Knowledge acquired during its productive lifetime may have been lost – either because records have not been maintained or knowledge held by individuals was not captured before they left the organisation. As decommissioning approaches, standards for record-keeping may lapse or important documents be disposed of as part of a general clear-out. The plant as it is at decommissioning will almost certainly have undergone modification and is unlikely to be 'as built'.

> '*The pipework had been carefully drained and purged so we were happy there was nothing hazardous left. But when the flanges were loosened for dismantling, the pipes sprang apart suddenly. No-one had remembered until after the fact that the pipes had been bent to make the flanges meet and had stayed under tension for years.*'
>
> Source: Confidential interview
>
> '*There are parts of the plant you see for the first time when you open it up so unless you were there for the construction, you don't really know what to expect.*'
>
> Source: Confidential interview

4.9.3 Possible solutions

In advance of the decommissioning phase, check records for historical information – especially noting any changes made to the facility since it was commissioned. Where documented information is missing or unclear, conduct audits of the plant and create new records. Conduct 'exit interviews' of personnel – especially long-service personnel – to obtain information that was not formally recorded.

> '*It's much easier to get information prior to CoP. Operators should evaluate the data they need for their decommissioning programme at Phase 1 not Phase 4. The current condition of the installation, the status of equipment and items to be decommissioned should be evidence-based, not consultant-assumption-based.*'
>
> Source: Confidential interview

4.9.4 Checklist

Table 12: Knowledge management and corporate memory checklist

Questions		Y	N
1	Are adequate records and other sources of information – drawings, photographs, maps, piping and instrumentation diagrams (P&IDs) – available for decommissioning describing:		
	The materials and construction methods used for buildings and other structures (e.g. the location of asbestos or other hazardous materials)?		
	Underground services: water and gas pipes, electrical cables, drains, conduits?		
	Modifications/history of plant?		
	Incidents and the response to them?		
	Procedures?		
	Training and competency records?		
2	Is there a process in place for capturing learning during decommissioning and passing this on to other sites?		
3	Is there a process for restoring lost information such as site audits and interviews?		

4.9.5 Further reading

– Shadbolt, N.R. and Burton, A.M., Knowledge elicitation, in Evaluation of human work: Practical ergonomics methodology

4.10 ORGANISATIONAL CHANGE

4.10.1 Overview

Decommissioning involves changing the way that people work (including staff numbers) or are managed, therefore the changes should be managed to control the impact they have on human performance and safety.

4.10.2 Issues/problem areas

During decommissioning, many changes will be taking place simultaneously; some of them physical such as the structure, layout and inventories of the plant and the number of different personnel on site; others will be administrative such as changes to the management hierarchy, reporting lines and management processes. If handled poorly, this can lead to confusion, demotivation, stress and resentment, all of which can affect performance and thus safety.

4.10.3 Possible solutions

Apply good practices for managing change. Be aware of the possible detrimental effects of the changes. Communicate intentions and decisions clearly. Involve personnel in the change process where possible.

4.10.4 Checklist

Table 13: Organisational change checklist

	Questions	Y	N
1	Are you confident that the changes that need to be made will not adversely affect:		
	Staffing levels for all tasks envisaged including abnormal situations and emergencies and…		
	…have you applied formal staffing level assessments to confirm the numbers required?		
	Morale/job satisfaction – caused by, for example, uncertainty, changes to roles, new working/shift arrangements, team structures?		
	Available competence – through loss of key personnel, poor selection of contractors, and restrictions on training?		
2	Have you conducted a risk assessment of the proposed changes?		
3	Have you identified criteria for the success or otherwise of the changes made?		
4	Have you retained a flexible organisation able to revert to its previous form or to be reconfigured if required?		

4.10.5 Further reading

- EI, Hearts and Minds, Making change last
- EI, Human factors briefing note no. 3: Organisational change

- EI, Safety information bulletin: Managing organisational change
- HSE, CHIS7, Organisational change and major accident hazards
- HSE, Human factors briefing note no. 11: Organisational change

4.11 SAFETY CULTURE

4.11.1 Overview

Safety culture is the shared beliefs, attitudes and assumptions about safety within an organisation that affect the way that people at all levels of the organisation behave in relation to safety. This is influenced by many things, including the example set by management. In decommissioning, the established safety culture is likely to be disrupted – especially as personnel leave the organisation and contract companies bring their own culture into the organisation.

4.11.2 Issues/problem areas

The mix of possible conflicting cultures within the new organisation and the possible lack of time to establish a coherent and cohesive culture can affect safety behaviours and standards.

> '*During decommissioning, the radiological risks are much lower than during plant operations. However, the risks associated with human behaviour may increase, owing to a combination of factors – people tend to pay more attention to radiological risks than to industrial risks; because of a good safety record, people can be too complacent; many years may have elapsed between the end of operations and the start of decommissioning, with a consequent loss of knowledge and skills (young people do not have sufficient knowledge of the plant); with the lower radiological risks, senior people have become over-confident and less alert and tend to bypass necessary procedures; contractors without even a minimum of nuclear safety culture are participating in the decommissioning; and the 'best' people have moved to other parts of the organization or left the organization altogether.*'
>
> Source: IAEA, Lessons Learned from the Decommissioning of Nuclear Facilities and the safe termination of nuclear activities

4.11.3 Possible solutions

Expectations on behaviour standards and adherence to procedures and rules should be clearly communicated, strongly encouraged and visibly and consistently enforced where deviations are observed. Managers should set an example of the standards to be met ('walk the talk') and use positive feedback to encourage compliance.

4.11.4 Checklist

Table 14: Safety culture checklist

	Questions	Y	N
1	Have you taken positive and effective steps to preserve norms, standards and rules from operations to decommissioning?		
2	Have you assessed in any way (ideally via a recognised safety culture assessment method) the current state of the safety culture on site (staff and contractors)?		
3	Are you clear on the actions to take if safety culture standards are observed to deteriorate?		
4	Are adequate resources available to ensure that a good safety culture is established and maintained on site?		

4.11.5 Further reading

- EI, Hearts and Minds, Understanding your HSE culture
- EI, Human factors briefing note no. 9: Safety culture
- HSE website, Organisational culture, http://www.hse.gov.uk/humanfactors/topics/culture.htm
- HSE, Human factors briefing note no. 7: Safety culture
- HSE, Human factors: Inspectors human factors toolkit, Safety Culture
- HSE, OTR 2000/049, Safety culture maturity model
- IAEA, Safety Series No. 75-INSAG-4, Safety culture
- Taylor, J.B., Safety culture: Assessing and changing the behaviour of organisations, Gower Applied Research

4.12 BEHAVIOUR STANDARDS

4.12.1 Overview

Decommissioning work typically requires operators to adopt higher standards of (safety) behaviour; management should ensure that all those working on site – employees and contractors – are clear about required behaviours.

4.12.2 Issues/problem areas

Workforce and contractors adopt a mindset that the plant is safe because the hazardous inventory has been removed. There may also be a tendency to treat the plant with less care or caution because it is being decommissioned.

> '*Sometimes, risks are taken to retrieve materials that have a high scrap value.*'
>
> Source: Confidential source

4.12.3 Possible solutions

Make it clear that the site is still potentially hazardous. Set clear and achievable standards and demonstrate what meeting them means in practice.

4.12.4 Checklist

Table 15: Behaviour standards checklist

	Questions	**Y**	**N**
1	Are the behaviour standards required clearly understood by everyone: managers, supervisors, workforce, contractors?		
2	Are the behaviour standards appropriate and realistic?		
3	Have criteria for behaviours and the means of measuring them have been developed?		
4	Are the standards clearly communicated to, and understood by, everyone working on site, including visitors?		
5	Is positive feedback given for good performance – including incentives: small rewards or time off?		
6	Are sanctions for non-compliance clear and enforced?		
7	Are standards reinforced by management behaviours (setting the standard)?		

4.12.5 Further reading

- HSE, CRR430/2002, Strategies to promote safe behaviour as part of a health and safety management system
- HSE, HSG 48, Reducing error and influencing behaviour

– HSE, OTR 2000/003, Behaviour modification to improve safety: literature review
– HSE, OTR 2000/048, Behaviour modification programmes: establishing best practice
– PRISM, Behavioural safety application guide, http://epsc.be/PRISM/_/JOMCs_finalised_version_of_Application_Guide.pdf
– Step Change in Safety, Changing minds – a practical guide for behavioural change in the oil and gas industry

4.13 FUNCTIONAL ALLOCATION

4.13.1 Overview

It is important to get the right balance in any human-machine system between the functions carried out by the operator and those carried out by the technology. In decommissioning, this is unlikely to be a major issue as the technology is likely to be simpler than in operational conditions.

4.13.2 Issues/problem areas

Allocation of function is more of an issue in complex systems but, in decommissioning, there may be some poor decision-making about the balance of automation/operator action driven by the costs of automating some functions. Lack of automation could over-burden the operator; over-automation could result in operators losing their situational awareness and engagement with the systems they use.

> *'Prevention of overfilling incidents was previously an automated function – filling would be stopped automatically at 'high high' level. There is now more reliance on the operator to respond to the high high alarm to stop the pumps or even one operator monitors the level indicator and shouts over to the other operator to stop if the level is approaching the high point.'*
>
> Source: Confidential interview

4.13.3 Possible solutions

Conduct risk assessments weighing the benefits and risks of assigning functions to operators vs. technology. Where the decision to assign functions to operators is marginal (i.e. the risk remains high), put in place additional safeguards such as supervision or more rigorous training.

4.13.4 Checklist

Table 16: Functional allocation checklist

	Questions	**Y**	**N**
1	Have you considered the appropriate balance between the use of people and technology to carry out the individual functions required? (e.g. for a critical piece of equipment, will a fault in the system lead to an alarm that a human has to respond to or to an automated shutdown of plant?)		
2	Are you confident that the balance between automation and manual-operation is right?		
3	Has a thorough cost-benefit analysis been conducted on the options?		
4	Have you designed each job against HOF principles of: job enrichment; flexible working; multi-skilling; job rotation (to reduce boredom); maintaining optimum levels of stimulation; user involvement?		

4.13.5 Further reading

- Chapanis, A., Human factors in systems engineering, Wiley & Sons
- ONR, Technical Assessment Guide 064, Allocation of function between human and engineered systems
- Price, H., The allocation of functions in systems, in Human Factors: The journal of the human factors and ergonomics society, 27, 1, pp 33–43
- US Nuclear Regulatory Commission, NUREG/CR-3331, Methodology for allocating nuclear power plant control functions to human or automatic control

4.14 TASK ANALYSIS

4.14.1 Overview

Numerous task analysis methods are available, each with a specific function. They should be applied to ensure that any new tasks are properly assessed and the associated jobs designed accordingly. They are useful as a starting point for: designing tasks; identifying possible errors when performing tasks; designing procedures; developing training, and assessing workload.

4.14.2 Issues/problem areas

Tasks may be assigned in an ad hoc way without carefully considering how to achieve the best performance and how to reduce error potential and possible accidents.

4.14.3 Possible solutions

Task analysis methods are typically simple and straightforward to use. Professional help is available for the more complex methods.

4.14.4 Checklist

Table 17: Task analysis checklist

	Questions	**Y**	**N**
1	Do you know when formal task analysis methods should be used?		
2	Do you have access to the necessary expertise to apply the methods?		
3	If you are not applying any formal methods, are you confident that alternative ways of designing tasks, developing procedures and training are adequate?		

4.14.5 Further reading

- EI, Human factors briefing note no. 11: Task analysis
- Kirwan, B. and Ainsworth, L. K., A guide to task analysis, Taylor and Francis Ltd.
- EPSC, PRISM, Good practice guide on task design

4.15 WORKLOAD ASSESSMENT

4.15.1 Overview

The physical and mental workload imposed by a new or changed task should be understood and assessed.

4.15.2 Issues/problem areas

Workload can have a negative impact on performance and can cause physical strain or injury or mental health problems such as stress. Decommissioning tasks are typically carried out under time pressure. A 'can do' attitude has been known to result in operators over-exerting themselves to meet targets. Under-loading can also be a problem in that it reduces motivation, job-satisfaction and levels of concentration on tasks.

4.15.3 Possible solutions

Methods exist for assessing task physical and mental workload. Strategies can be developed to both types of workload if found to be excessive.

4.15.4 Checklist

Table 18: Workload assessment checklist

	Questions	**Y**	**N**
1	Have you assessed – using formal methods – the physical and mental workload imposed by each task?		
2	Have you introduced measures to eliminate, alleviate or control excessive workload, such as: Job aids/tools – mechanical handling equipment; computers? Additional resources (contractors/specialists)? Lifts/mobile elevated work platforms? Rest breaks (and ensuring these are taken)?		
3	Have the following potential sources of excessive workload been considered and controlled: Physical labour required in: manual handling tasks; accessing the workplace (walking, using stairs, ladders or ramps); insufficient numbers of staff; lack of adequate rest periods or facilities for taking breaks? Mental workload caused by: tasks requiring intense concentration; simultaneous tasks required; lack of familiarity with the task/lack of training; sudden unfamiliar situations (abnormal events/emergencies)?		

4.15.5 Further reading

- EI, Safe staffing arrangements – user guide for CRR348/2001 methodology: Practical application of Entec/HSE process operations staffing assessment methodology and its extension to automated plant and/or equipment
- Gawron, V.J., Human performance, workload, and situational awareness measures handbook, Second Edition, CRC Press, Boca Raton
- HSE website, Human factors: Workload, http://www.hse.gov.uk/humanfactors/topics/workload.htm
- HSE, RR107, Development of internal company standards of good management practice and task-based risk assessment tool for offshore work-related stressors
- NASA, Task load index, http://humansystems.arc.nasa.gov/groups/TLX/
- ONR, T/AST/061, Issue 1, Technical assessment guide: Staffing levels and task organisation
- Wilson J.R. and Corlett E.N., Evaluation of human work: A practical ergonomics methodology, Second edition, Taylor & Francis

4.16 WORKSPACE AND WORKPLACE

4.16.1 Overview

The workplace should be comfortable to work in, in terms of its size, shape and layout but also the environment – lighting, temperature, humidity, noise, vibration, and cleanliness. In decommissioning sites, the ideal workspace is not always available. The size, shape or type of temporary structures built for decommissioning may be dictated by what space is available rather than what is ideal. Anthropometry is about human body size (and also strength): tables of data are available showing different body size dimensions; for example, maximum overhead reach, head height and shoulder width that can be used to help design the workspace.

4.16.2 Issues/problem areas

Issues include the following:

- Working in too large or too small a workspace.
- Operator may be cramped or have to stretch to perform required tasks – this can be made worse if heavy equipment has to be used and personal protective equipment (PPE) is required.
- May lead to difficulty in conducting tasks, as well as postural problems or injuries.
- The operator may make errors or cut short the task by, for example, skipping final checks to avoid continued physical stresses and strains.
- Operators working in a workplace that is not fit-for-purpose will be unable to work efficiently and performance is likely to be less than adequate, leading, in many cases, to loss of productivity and errors.
- As parts of the facility are decommissioned and demolished/removed, the workplace will be constantly changing, requiring those onsite to adapt to new layouts and temporary arrangements:

  '*There was a tight space to access underneath the diesel generator. We needed to tighten a sump plug to stop it dripping. It couldn't be reached without isolating, draining and dismantling lots of pipework in the way. That would have taken hours for a two-minute job. We found the thinnest guy on site and pushed him underneath and shouted instructions about what to do. It worked.*'

  Source: Confidential interview

4.16.3 Possible solutions

Apply standards (including those required by building regulations), and good practices for workplace design. Involve the intended occupants of the workspace in the design and testing processes taking into account their needs and preferences.
Use available body size guidance to design the workspace.
Check tables of push/pull and lifting limits.

Mock up the area and walk through it with the workforce to identify problems early.

Allow rest breaks or share the task between operators to reduce individual burden.

4.16.4 Checklist

Table 19: Workspace and workload checklist

	Questions	Y	N
1	Does any decommissioning task require the operator to work in a different type of workspace/workplace than normal?		
If 'yes' to question 1:			
2	Does the space created require the operator to stretch or strain or adopt an uncomfortable posture when working in/entering or exiting the work area?		
3	Does the workspace size and shape accommodate the number of personnel expected to work in the facility – including additional personnel carrying out inspection, testing or maintenance tasks or training/supervision?		
4	Does the workspace take account of the needs of operators wearing PPE and carrying equipment or materials?		
5	Are there any issues with the location of the workplace – such as the need to climb ladders or stairs, or use elevated platforms for access, or the need to walk long distances across site?		
6	Are there likely to be any unusual environmental problems such as: poor lighting; excessive noise or extremes of temperature; humidity; air movement; exposure to excessive dirt/grease/other contamination?		
7	Has workplace safety been considered in terms of: sharp edges; slippery surfaces; electricity; chemicals to be used, and other hazards?		
8	Is the workspace equipped with all necessary facilities, e.g. computers, workstations, radio/intercom?		
9	Is equipment appropriately designed for its intended purpose?		
10	Is equipment appropriately located for easy access and operation?		
11	Have maintenance tasks been considered in the design of the workplace – for example: space for laydown of equipment and materials; access into cabinets; lifting points for heavy items?		

4.16.5 Further reading

- Department for Trade and Industry, Adult data: The handbook of adult anthropometric and strength measurement – data for design safety
- EI, Safety information bulletin: Integration of human factors into design and major modifications of plant
- HSE website, Human factors: Design, http://www.hse.gov.uk/humanfactors/topics/design.htm
- HSE, Inspectors' toolkit: Human factors in the management of major accident hazards
- International Organisation for Standardisation (ISO), ISO 11064, Ergonomic design of control centres, (Part 1–7)
- Ministry of Defence, DEFSTAN 00-250, Human factors for designers of systems, Parts 0–4

- Pheasant, S. and Haslegrave, C.M., Bodyspace: Anthropometry, ergonomics and the design of work, Third edition, CRC Press
- Stanton, N.A. & Young, M., Guide to methodology in ergonomics: Designing for human use, CRC Press
- The Chartered Institution of Building Services Engineers (CIBSE), Guide A: Environmental design

4.17 HUMAN FACTORS DESIGN STANDARDS

4.17.1 Overview

Decisions regarding equipment, structures and facilities should consider appropriate standards to use and structures to build for decommissioning. Decisions may be influenced by cost and the short-term nature of decommissioning.

4.17.2 Issues/problem areas

Tools, equipment and structures may not be fit-for-purpose and may be of poor quality in decommissioning. Cost may be a primary influence on the choice of equipment and materials; structures may not be intended to last beyond plant decommissioning.

4.17.3 Possible solutions

Awareness should be raised regarding the 'false economy' of apparently cheap solutions. Conduct focused studies to determine the most appropriate options and cost-benefit analysis of the potential risks of poor procurement of equipment and materials.

4.17.4 Checklist

Table 20: Human factors design standards checklist

	Questions	**Y**	**N**
	When procuring equipment or creating structures for tasks:		
1	Do you know the appropriate standards for the equipment?		
2	Do the tools and equipment meet those standards?		
3	If you answered 'no' to question 2, are you sure you know what the implications are if the standards are not met?		
4	Have you assessed the workload associated with the equipment in use? For example, is it complex (mental workload); is it heavy; unwieldy; hard to handle when operated; difficult to maintain a firm grasp?		
5	Have you included the intended users of the facility or equipment in the selection process?		

4.17.5 Further reading

– Department for Trade and Industry, Adult data: The handbook of adult anthropometric and strength measurement – data for design safety
– Department of Defence, MIL-STD-1472D, Human engineering requirements for military systems, equipment and facilities
– HSE, HSG48, Reducing error and influencing behaviour, second edition
– ISO,6385:2016, Ergonomic principles in the design of work systems
– Ministry of Defence, DEFSTAN 00-250, Human factors for designers of systems, Parts 0–4

- Murrell, K.F.H., Ergonomics – Man in his working environment, London, Chapman and Hall
- Norman, D.A., and Draper, S. W. (Eds.), User-centered system design, Hillsdale, N.J., Erlbaum
- Pheasant, S., Ergonomics – Standards and guidelines for designers, Milton Keynes, BSI
- Salvendy, G. (Ed.) , Handbook of human factors, New York, NY: John Wiley & Sons.
- Sanders, M.S., and McCormick, E. J., Human factors in engineering and design, 7th edition, New York: McGraw-Hill
- Wickens, C., Hollands, J.G., Banbury, S. and Parasuraman, R., Engineering psychology and human performance, 4th edition, New York: HarperCollins

4.18 HUMAN FACTORS ENGINEERING DESIGN/ERGONOMICS CHECKLISTS

4.18.1 Overview

Human factors engineering (HFE) is concerned with designing to appropriate design standards and principles. Checklists can be developed from standards and relevant good practice material. They are useful as a means of summarising the key human factors engineering/ergonomic elements of a proposed or existing design.

4.18.2 Issues/problem areas

As indicated in 4.17 Human factors design standards, the facilities, tools and equipment to be used in decommissioning may be less than ideal or, in the worst case, inadequate and hazardous in ways that might not be obvious. It is unavoidable that compromises will be made between the ideal solution and what is practicable and expedient; the implications of any deviations from standards and good practice should be understood.

4.18.3 Possible solutions

Apply ready-made checklists available from HOF literature (most human factors consultants will either have their own checklist or can easily design a bespoke one).Seek specialist HOF help in determining priorities and compromises.

4.18.4 Checklist

Table 21: Human engineering design/ergonomics checklist

	Questions	**Y**	**N**
1	Have you developed HFE specification/ergonomics checklists for application to:		
	Workspaces?		
	Individual items of equipment?		
	Special tools?		
	All uses of the above – operations, maintenance, inspection, testing and removal/disposal of facilities?		
2	Have the specifications/checklists been systematically applied?		
3	Are the specifications/checklists regularly updated to reflect changing requirements?		
4	Is there a process for raising and closing-out queries raised by the application of the specifications/checklists?		
5	Where compromises have been necessary (e.g. less than ideal but considered adequate designs or modes of operation), have these been documented and risk assessed?		

4.18.5 Further reading

- EI, Human factors briefing note no. 8: Ergonomics
- ISO 9241-400:2007, Ergonomics of human-system interaction – Part 400: Principles and requirements for physical input devices
- ISO 9355-3:2006(en), Ergonomic requirements for the design of displays and control actuators — Part 3: Control actuators
- ISO 9355-4:2006(en), Ergonomics requirements for the design of displays and control actuators – Location and arrangement of displays and control actuators
- MacLeod, D., The ergonomics kit for general industry, Second edition, CRC Press
- Salvendy, G., Handbook of human factors and ergonomics, Third edition, John Wiley & Sons
- U.S. Department of Energy (DOE), DOE-HDBK-1140-2001, Human factors/ergonomics handbook for the design for ease of maintenance
- Wickens, C., Lee, J., Yili, L. and Becker S.G., Introduction to human factors engineering, Second edition, Prentice Hall.

4.19 PHYSICAL ERGONOMIC METHODS

4.19.1 Overview

There are tasks during decommissioning that involve a large amount of physical interaction (e.g. manual handling of tools and equipment, moving waste). There may be new or unfamiliar interfaces including computer screens, CCTV and other workstations for on-site or office-based tasks. It should be understood how their design could impact on performance and the health and safety of those using them.

4.19.2 Issues/problem areas

Poor physical ergonomics can lead to injury, ill-health or reduction in overall well-being, as well as errors in task performance requiring rework and thus increased time and cost to the project, that could be caused by, for example:

- incorrect physical handling of materials, tools or equipment, and
- poorly-designed display screens and associated equipment.

4.19.3 Possible solutions

Apply standard risk assessments to the specific hazards of poor design. Apply standards, guidelines and codes of practice for physical work.

4.19.4 Checklist

Table 22: Physical ergonomics methods checklist

	Questions	Y	N
1	Have you identified and risk assessed all significant manual handling tasks?		
2	If you answered 'yes' to question 1, have you put in place suitable measures to eliminate or substantially reduce the risk of sudden or long-term injury, including:		
	Specific training in lifting and moving heavy or bulky items?		
	Design of loads for manual handling (e.g. provision of grip handles, or other lifting aids)?		
	Strict and enforced guidance on when to use mechanical handling methods instead of manual handling?		
	Suitable non-slip flooring and footwear?		
3	Have you applied any methods for assessing mechanical handling such as Ovako working posture analysis system (OWAS) or HSE manual handling assessment charts?		
4	If any display screen equipment or new controls or tools are to be used, do they conform to standards and guidelines in terms of their type/design, placement, ease of use and associated workstation?		

4.19.5 Further reading

- EEMUA, No.201, Process plant control desks utilising human-computer interfaces – A guide to design, operational and human interface issues
- EI, Safety information bulletin: Manual and mechanical handling
- HSE website, Manual handling assessment charts (the MAC tool), http://www.hse.gov.uk/msd/mac/
- HSE website, Musculoskeletal disorders, http://www.hse.gov.uk/msd/index.htm
- HSE website, Working safely with display screen equipment, http://www.hse.gov.uk/msd/dse/index.htm
- HSE, CRR 304/2000, Health and safety of portable display screen equipment
- HSE, HSG115, Manual handling: solutions you can handle
- HSE, Manual Handling Operations Regulations 1992
- ISO 9241, Ergonomics of Human System Interaction, various parts

4.20 USABILITY TESTING

4.20.1 Overview

Many items of equipment – tools, machines, computer systems – used for decommissioning will be new. Some will be improvised from materials available, or easily procured, to solve a specific problem.

4.20.2 Issues/problem areas

Without realistic assessment or testing, equipment may not be easily operable in real-life conditions and may lead to operator frustration, fatigue, inefficiency or even injury. It will be costly in terms of expenditure and time to put untested equipment to use only to find it needs to be redesigned or replaced.

4.20.3 Possible solutions

Tests and dry-runs in realistic conditions can help ensure that the equipment is fit-for-purpose. This is especially important for improvised items that have not been through typical vendors' operations and safety assurance tests.

4.20.4 Checklists

Table 23: Usability testing checklist

	Questions	**Y**	**N**
1	Have you tested (or do you plan to test) all new equipment developed or procured for decommissioning tasks?		
2	If you answered 'no' to question 1, is this because all equipment is vendor supplied with appropriate quality assurance (QA) or other documentation?		
3	Have tests included the intended users 'walking through' the use of the equipment?		
4	Have tests been conducted in realistic conditions (e.g. as part of 'inactive' commissioning)?		
5	Are you confident that the tests will provide valid results?		
6	Have you applied tests to computer or other programmable systems using recognised usability tests?		

4.20.5 Further reading

– Jordan, P.W., An introduction to usability, Taylor & Francis.

4.21 PROCEDURE DESIGN

4.21.1 Overview

The usual process for developing, testing, deploying, updating and revising procedures may not be available or appropriate during decommissioning. HOF principles should be applied to ensure that usable procedures are developed for tasks that require them. Procedures are typically required for hazardous or unusual situations involving novel tasks with unfamiliar equipment.

4.21.2 Issues/problem areas

Personnel responsible for developing procedures may no longer be available, and these may be being written by those without the necessary competence – typically, by the person or crew who will perform the task. Procedures may be ad hoc in some cases – produced and used quickly and not subject to the same quality assurance as normal procedures. There may be a tendency to over-proceduralise – putting a procedure in place where it is not necessary.

4.21.3 Possible solutions

As part of the assessment process for personnel to retain for decommissioning, ensure that competence in procedure writing is retained. Where procedures have been written by personnel with little or no formal training or experience in procedure writing, assess the task steps involved to identify the safety critical steps and ensure that these are clear, the people doing them are well-trained in those tasks, and that those task steps are subject to additional peer or supervisor checks when conducted.

4.21.4 Checklist

Table 24: Procedure design checklist

	Questions	**Y**	**N**
1	Do some decommissioning tasks require a written procedure to aid safe and accurate performance?		
2	If you answered 'yes' to question 1, are the procedures fit-for-purpose as follows:		
	They are based on a clear understanding of the task (e.g. from formal task analysis and involving the end user of the procedure)?		
	They are easy to read in terms of language used, typeface, layout, order of steps, use of illustrations/diagrams?		
	They are suitable for the environment (e.g. outdoor use; use in poor lighting conditions; to be used by an operator wearing gloves)?		
	They are based on good practice standards for procedure writing?		
	They are matched to the users' expertise and prior knowledge of the task?		
3	Before used in live conditions, have they been used in simulated conditions for training purposes and testing the procedure?		

Table 24: Procedure design checklist (continued)

4	Do you have safeguards and strategies in place for conducting tasks safely in the absence of a procedure?		
5	Are procedures subject to regular review (where appropriate) and modification (where required)?		

4.21.5 Further reading

- EI, Human factors briefing note no. 6: Safety critical procedures
- Hartley, J., Designing instructional text, Third edition, Kogan Page
- HSE website, Operating procedures, http://www.hse.gov.uk/comah/sragtech/techmeasoperatio.htm
- HSE website, Procedures, http://www.hse.gov.uk/humanfactors/topics/procedures.htm
- HSE, HSE human factors briefing note no. 4: Procedures
- HSE, Human factors: Inspectors human factors toolkit, Core topic 4: Reliability and usability of procedures, http://www.hse.gov.uk/humanfactors/toolkit.htm
- HSE, Revitalising procedures, http://www.hse.gov.uk/humanfactors/topics/procinfo.pdf

4.22 HUMAN RELIABILITY ANALYSIS/SAFETY CRITICAL TASK ANALYSIS (HRA/SCTA)

4.22.1 Overview

In certain tasks, operator failures can lead to serious incidents with significant economic or safety consequences. Critical tasks (i.e. critical for safety, health, environment, etc.) should be identified and formally analysed to ensure that appropriate safeguards are in place to prevent or reduce the frequency of occurrence or to minimise the consequences.

4.22.2 Issues/problem areas

Decommissioning tasks may be unfamiliar to the workforce and may be done in less than ideal conditions (under time pressure, using new tools and equipment, in makeshift facilities, etc.). These are 'performance influencing factors' which could have a negative effect on performance, with catastrophic consequences if they affect performance during critical tasks.

4.22.3 Possible solutions

Identify critical tasks/task steps using the formal methods of human reliability analysis (also known as safety critical task analysis). In some industries, there is a requirement to generate human error probabilities for quantitative risk assessments. Expertise and guidance are available on the specialised methods of HRA/SCTA.

4.22.4 Checklist

Table 25: Human reliability analysis/safety critical task analysis checklist

	Questions	Y	N
1	Have you identified all (safety, health, environment) critical decommissioning tasks – those with the potential for significant negative consequences?		
2	Have you identified the feasible human failures that could occur during the conduct of those critical tasks?		
3	Do the analyses of those tasks consider the different possible forms of human failures: errors and violations?		
4	As a result of the analyses, have effective safeguards been put in place to reduce failures or mitigate their consequences?		
5	Are the analysts fully competent to carry out the required analyses?		

4.22.5 Further reading

- EI, Guidance on human factors safety critical task analysis
- EI, Guidance on quantified human reliability analysis (QHRA)
- EI, Human factors briefing note no. 13: Human reliability analysis
- HSE website, Human factors: Managing human failures, http://www.hse.gov.uk/humanfactors/topics/humanfail.htm
- HSE, HSE human factors briefing note no. 3: Managing human performance
- HSE, OTO 1999 092, Human factors assessment of safety critical tasks

– HSE, RR679, Review of human reliability assessment methods
– Kirwan, B.A., A guide to practical human reliability assessment, Taylor and Francis, London.
– ONR, NS-TAST-GD-063, Technical assessment guide: Human reliability analysis
– U.S. Nuclear Regulatory Commission, NUREG-1792, Good practices for implementing human reliability analysis (HRA)

4.23 LEADING AND LAGGING INDICATORS

4.23.1 Overview

Leading indicators can identify impending failure, allowing the failure to be avoided. This is more useful than lagging indicators (measures or signs that a failure has already occurred). Leading indicators can be devised for human factors issues such as communications, where an indicator might be, for example, the number of shift handovers conducted incorrectly (revealed by auditing or staff reporting). Positive indicators are also useful signs that arrangements in place are effective, e.g. the number of shift handovers conducted correctly.

4.23.2 Issues/problem areas

It can be difficult to determine useful indicators and to measure them. In decommissioning, an indicator might reveal potential flaws in a system that is short-lived, that is, by the time the measurement is taken, it is no longer relevant.

4.23.3 Possible solutions

Guidance is available on leading and lagging indicators with some ready-made indicators provided (such as in the EI *Human factors briefing notes* and EI, *Research report: Human factors performance indicators for the energy and related process industries*).

4.23.4 Checklist

Table 26: Leading and lagging indicators checklist

	Questions	**Y**	**N**
1	Do you have methods in place for detecting potential failures in advance?		
2	Do you have methods in place for measuring and responding to revealed failures?		
3	Do you have criteria to measure those indicators against? (i.e. given that some problems are inevitable but not serious, what is acceptable/ unacceptable?)		
4	In response to deterioration in performance, are the required actions clear?		
5	Are the indicators known to all personnel (including contractors)?		
6	Are leading and lagging indicators measured continuously (or at suitable intervals) so that they allow time for any necessary interventions?		

4.23.5 Further reading

- EI, Research report: Human factors performance indicators for the energy and related process industries
- HSE, Key process safety performance indicators: A short guide for Directors and CEOs
- Step Change in Safety, Leading performance indicators – A guide for effective use
- HSE, HSG254, Developing process safety indicators – A step-by-step guide
- HSE, HSL/2007/31, Major hazards industry performance indicators scoping study
- EI, Human factors briefing notes, (notes 2–23)

4.24 SLOWLY DEVELOPING FAULTS

4.24.1 Overview

Some system faults are very obvious to the operator. Alarms sound, indicators show unusual readings, the plant itself may provide direct signs of the problem via noises, vibrations, etc. Some faults, however, gradually build up within a system and, although unusual plant conditions may be indicated by instrument readings or results of testing or analysis, operators have a tendency to explain these away as instrumentation faults, temporary anomalies or paperwork errors. This can also apply to more visible indications, such as plant deterioration, which may be gradual and become ignored or accepted as normal.

4.24.2 Issues/problem areas

As the workforce will be observing the destruction of plant and facilities, and encountering defects of all kinds (in plant indications or in the state of the plant itself) the workforce may not identify genuine problems in systems or in the fabric of the plant. Formal administrative systems for monitoring and defect detection may no longer be in use. 'Groupthink' can affect whole shift teams who collectively agree that what should be seen as a problem is actually acceptable and normal.

4.24.3 Possible solutions

There is no fixed procedure for dealing with this problem. It is essentially a problem of recognition and diagnosis and the difficulty human operators have in dealing with complex systems and situations when they become subtly unstable. Part of the solution to the problem is in raising operator awareness of certain unhelpful human tendencies in decision-making situations (i.e. cognitive and social biases).

4.24.4 Checklist

Table 27: Slowly developing faults checklist

	Questions	**Y**	**N**
1	Has the workforce been advised about the need to attend to 'weak signals' that something may be wrong in the workplace?		
2	Are there suitable arrangements for reporting of possible indicators of emerging problems? Indicators would include: Unusual system behaviour Changes in the physical appearance of structures – cracks, peeling paintwork, dampness Unusual sounds, smells or vibrations, changes in temperature, changes in pressure, level, etc., in vessels		

Table 27: Slowly developing faults checklist (continued)

	Questions	Y	N
3	Has the workforce been trained in common pitfalls in problem solving, such as: The tendency to persist in believing an initial (possibly wrong) conclusion when presented with ambiguous information? Ignoring information that contradicts an initial conclusion or making that information fit the conclusion? Denial – refusing to accept there could be a problem? Being overly influenced by and not challenging the group? Focusing on small details at the expense of the bigger picture?		
4	Have other strategies been considered to help in decision-making and problem-solving, such as: Improving training – to improve operators' knowledge and 'mental model' of the system? Ensuring that interfaces provide accurate and unambiguous indications of plant state? Communications – to ensure that sufficient information is available? Instilling a questioning attitude – when problem solving but also regarding working conditions, e.g. to encourage operators to report faults and not tolerate faulty equipment or persistently incorrect information given? Team effort in problem solving – making the best use of co-workers in providing a second opinion? Procedures – to assist in diagnoses; including 'symptom-based' procedures i.e. not based on knowing the problem but on the symptoms the plant is showing e.g. high level, reduced flow, temperature fluctuations? Correct use of audits and inspections to identify problems with the plant?		
5	Are regular audits and site inspections conducted (in order to identify possible indicators of problems)?		

4.24.5 Further reading

- Dekker, S., Slowly developing faults, third edition, Boca Raton, Florida, CRC Press part of Taylor and Francis
- Hopkins, A., Failure to learn: The BP Texas City refinery disaster, Australia

4.25 VIGILANCE, CHECKING ERRORS AND ERROR RECOVERY

4.25.1 Overview

'Vigilance' tasks may be required during decommissioning. These are tasks that require sustained operator attention, entailing the operator to monitor a system (or situation) to detect important changes of state.

Checking is a key part of error recovery – detecting and correcting a failure in the execution of a task. There are different types and levels of checking:

- Self-checking during a routine task where it would be easy to lose focus on the task and fail to break out of 'cognitive autopilot 'to ensure the task is progressing as it should.
- Self-checking at the end of the task in a more formal way – applying a specific test or observation to ensure the task outcome is successful.
- Independent checking by a colleague or supervisor of a task in progress or at the end of the task.

4.25.2 Issues/problem areas

Humans are unable to sustain vigilance tasks for long periods of time without error. Checking, in all its forms, can fail either through being omitted entirely or being carried out incorrectly. Some systems do not allow for easy error recovery – either the failure is hidden in some way or, once the error has been made, it cannot be rectified.

4.25.3 Possible solutions

Avoid vigilance tasks entirely or minimise their duration – e.g. have several people take turns to monitor or observe a situation.

Ensure that:

- The task allows and incorporates appropriate steps for checks.
- The appropriate level of checking is done for the seriousness of the task (self-checking may be acceptable for some tasks, independent checking for others).
- There are sufficient prompts for the checks.
- There is the opportunity to recover from errors identified in checks in a timely manner.
- Auditing or spot checks are done to reinforce the need for checking.

4.25.4 Checklist

Table 28: Vigilance, checking errors and error recovery checklist

	Questions	Y	N
1	Have you eliminated, as much as possible, the need for sustained vigilance in any task?		
2	If vigilance tasks are unavoidable, have you reduced the time any one operator is required to do this (by introducing breaks or sharing the task between the team)?		

Table 28: Vigilance, checking errors and error recovery checklist (continued)

	Questions	**Y**	**N**
3	Is it possible to provide alarms to alert the operator to changes rather than rely on the operator noticing changes?		
4	Have you made operators aware of the pitfalls of routine tasks performed 'on autopilot' and the need for conscious checking?		
5	Have you eliminated distractions that could interfere with checking (for example by rescheduling to less distracting periods of work)? Or, where this is not possible…		
6	…have you introduced specific independent checks for unusual tasks or critical task steps? (and allowed time and resource for these checks)		
7	Are critical checks themselves checked routinely to ensure they are performed correctly?		
8	Are you confident that all significant errors that could occur in a task can be recovered?		
9	Are there proceduralised steps specifically for error recovery?		
10	Does the plant provide clear signs that error recovery is required (from alarms or clear indications)?		
11	Do the indications of error clearly identify the problem to be recovered?		
12	Are recovery steps included in procedures or other job aids?		
13	Are personnel trained to recognise deviations from the norm and the recovery actions needed for the identified deviation?		

4.25.4 Further reading

- DOE, Doe-hDBK-1028-2009, Human performance improvement handbook, Vol. 1: concepts and principles
- IAEA, Managing human performance to improve nuclear facility operation

4.26 QUESTIONING ATTUTUDE

4.26.1 Overview

It is particularly important that those working on a decommissioning site are alert to their surroundings and to any changes that could adversely affect them. It should always be possible and culturally acceptable for anyone on site to ask about the state of the workplace and challenge anything they are concerned about.

4.26.2 Issues/problem areas

Lack of awareness of potentially rapidly-changing conditions, coupled with the general uncertainties regarding plant hazards during decommissioning, can be dangerous to those working on site. A feeling that 'this incident could not happen here' is also a problem. Weak signals that the risk has increased can be missed or ignored. During decommissioning, the workforce can adopt a 'can do' attitude: a willingness to get the job done without carefully considering the risks.

4.26.3 Possible solutions

Instil a 'questioning attitude' into the workforce via briefing/training and example. This is related to risk assessment but encourages the operator to consider hazards, changes and risks before performing a specific task – even if the task is familiar and has not previously caused any problems.

4.26.4 Checklist

Table 29: Questioning attitude checklist

	Questions	Y	N
1	Have you anticipated (or recognised) the problem of risk acceptance/lack of risk awareness?		
2	If the answer to 1 is 'yes' have you:		
	Coached the workforce to be constantly alert to their surroundings and current plant conditions (which are likely to change from day to day) – through training or toolbox talks?		
	Adopted the use of pre-job briefings and risk assessments to ensure risk awareness?		
	Promoted the adoption of a 'questioning attitude' and demonstrated commitment to this?		
	Encouraged everyone to look out for each other (talk about the risks, what worked, what did not work and where they had to improvise, etc.)?		
	Conducted safety observations to identify if risks are being accepted without question?		
	Identified and taken measures of leading indicators that suggest a problem in this area?		
	Empowered the workforce to stop work if concerned about potential risks?		

4.26.5 Further reading

- IAEA, Managing human performance to improve nuclear facility operation
- Joyner, P. and Lardner, R. Mindfulness: Realising the benefits, IChemE symposium series no. 153

4.27 SITUATION AWARENESS

4.27.1 Overview

Being aware of what is going on around you is critical to safe performance of the task. It is therefore necessary to understand what situational awareness is, and how it can be improved.

In three steps, situation awareness is:

1. Perceiving information – via the five senses.
2. Making sense of the information – forming a mental model of the current system condition.
3. Forecasting possible future states of the system.

Everyone working on a decommissioning site should maintain situation awareness because of the likelihood of rapid changes to the hazards on site and the increasing unfamiliarity of the site as it is dismantled and transformed.

4.27.2 Issues/problem areas

It is easy to become complacent as the known hazards on site appear to be removed, and to become oblivious to the possible changes in the risk profile on the site.

4.27.3 Possible solutions

The phrase 'chronic unease' has been used to describe the concept of treating every risk assessment with healthy scepticism – this does not mean living in constant fear of the unknown, but realising that there will remain some uncertainty in any formal risk assessment and that there is a need to be continually vigilant and cautious. The nuclear industry advocates instilling a 'questioning attitude' into personnel – encouraging challenge and avoiding taking things for granted (see 4.26).

When using any new human-machine interface, ensure that it is designed to ensure good situation awareness of the plant or technology it is associated with. Provide coaching or formal training in situational awareness.

4.27.4 Checklist

Table 30: Situation awareness checklist

	Questions	**Y**	**N**
1	Have you identified when situational awareness is particularly important, such as: When performing new, unusual or changed tasks? Using new tools or equipment, including computer interfaces? Working in an unfamiliar environment? Where problem-solving/troubleshooting, judgement, planning or prediction is required?		

Table 30: Situation awareness checklist (continued)

2	If you answered 'yes' to question 1, have you provided suitable coaching or training in:		
	How to approach the task?		
	How the new systems work?		
3	Have you provided procedures for potentially difficult monitoring or information-gathering tasks?		
4	Where new interfaces are being used, do they provide adequate information in terms of their content, format, timeliness, and clarity?		
5	If novices are required to carry out such tasks, are they closely supervised or provided with readily-accessible help?		

4.27.5 Further reading

- Endsley, M.R., Bolstad, C.A., Jones, D.G. and Riley J.M, Situation awareness oriented design: from user's cognitive requirements to creating effective supporting technologies, in Proceedings of the Human Factors and Ergonomics Society 47th annual meeting – 2003
- Patrick, J., James, N., Ahmed, A. and Halliday, P., Observation alassessment of situation awareness, team differences and training implications, in Ergonomics, 49, pp 393–417
- Sneddon, A., Mearns, K., and Flin, R. Situation awareness and safety in offshore drill crews, in Cognition, technology and work, Vol.8, No.4, November 2006, Springer, London

4.28 INCIDENT INVESTIGATION

4.28.1 Overview

When incidents (including near misses) occur, accurate information on the incident should be communicated quickly. Near misses will include findings from planned or casual observations or walkarounds of site that reveal sub-standard conditions.

4.28.2 Issues/problem areas

Conditions on site may be unfamiliar to experienced members of the workforce and to contractors – in particular, there may be different hazards on site compared to those that everyone is used to. Conditions on site may change from day to day, but findings from one incident may be transferrable to other situations or provide some generic learning.

> '*During a routine inspection of the site, several incorrectly-labelled bags of waste were found in a skip. They contained hazardous materials that should have been consigned to a specific disposal route. Work was stopped and a meeting was convened to explore this as soon as it was discovered. Unfortunately, no-one owned up to it but it was made clear that this was a serious incident and not to be repeated.*'
>
> Source: Confidential source

4.28.3 Possible solutions

Ensure that there are specific methods and staff available to conduct investigations and circulate findings rapidly. Pre-emptive discussions such as toolbox talks or morning meetings are useful as a means for discussing site conditions, hazards and recent incidents.

4.28.4 Checklist

Table 31: Incident and accident investigation checklist

	Questions	**Y**	**N**
1	Anticipating that incidents and accidents may occur on site, do you have in place:		
	A suitable repertoire of methods for incident and accident investigation and analysis (able to identify the real root causes)?		
	Enough qualified and skilled personnel to apply those methods?		
	Suitable means of logging and communicating findings from investigations?		
	Efficient ways of fast-tracking the investigation of significant incidents and sending out details quickly to everyone working on site?		
2	Is there a confidential reporting process? (this is useful where there may be some fear of repercussions for reporting without anonymity)		

4.28.5 Further reading

- American Institute of Chemical Engineers (AIChemE), Guidelines for investigating chemical process incidents
- EI, Human factors briefing note no. 15: Incident and accident analysis
- EI, Learning from incidents, accidents and events
- EI, Tripod Beta: Guidance on using Tripod Beta in the investigation and analysis of incidents, accidents and business losses
- HSE, HSG243, Investigating accidents and incidents

4.29 SAFE COMMUNICATIONS

4.29.1 Overview

Practices and tools applied to maintain effective communications between team members (including at shift handovers) should be robust and flexible in the decommissioning environment, where teams of staff and contractors may be unfamiliar with each other's systems and procedures. Information on significant changes made may be more important than in an operational plant.

4.29.2 Issues/problem areas

Decommissioning activities can be fast-moving and plans, plant conditions and hazards can be rapidly-changing. Communications should be clear on any aspect of work on site that could change the risk profile.

Specialist contractors may be unfamiliar with the site and site processes. If from overseas, there may be a 'language barrier' that could lead to unsafe actions or lack of hazard awareness on site.

> '*During November 1983, highly radioactive waste liquor was accidentally discharged to sea from [British Nuclear Fuels Limited] BNFL's Sellafield Works. The subsequent Nuclear Installations Inspectorate investigation found that, due to a failure of communication between shifts, a tank which was assumed to contain liquid suitable for discharge to sea, but in fact contained highly radioactive material, was discharged to sea creating an environmental hazard.*'
>
> Source: HSE Report OTO 96 003
>
> '*The crew that turned up on the lifting barge didn't speak English. Their supervisor's first language wasn't English either. It made toolbox talks and supervision 'interesting'. There was no clear testing of understanding; we had to get translators in eventually.*'
>
> Source: Confidential interview
>
> '*Communication between multiple contractors was a significant problem.*'
>
> Source: Confidential interview

4.29.3 Possible solutions

Use 3-way communications (operator 1 requests operator 2 to do something; operator 2 repeats back the request; operator 1 then confirms the request (if correct) or repeats it). This is similar to the approach adopted in other safety critical industries that rely on accurate communication (e.g. air traffic control).

Use the phonetic alphabet in communications.

Develop formal shift handover procedures.

Some of the key measures that can help in defining handover and communication standards, and improving the effectiveness of communications are detailed in Table 32.

4.29.4 Checklist

Table 32: Safe communications checklist

	Questions	Y	N
1	Have you identified where clear communications are most critical, such as:		
	When safety critical tasks are involved?		
	Where safety critical tasks are passed from one shift team to another?		
	Where safety systems have been disabled or suspended?		
	Where a staff member has just returned to work after a long absence?		
	Where inexperienced personnel are carrying out the work?		
2	If you answered 'yes' to question 1, are there precautions in place to ensure that good communications are achieved, such as:		
	Increased supervision/vigilance and checking of important communication tasks?		
	Procedures for recording key events to be recorded and communicated to others (especially between shifts)?		
	Audits, observations and spot checks of critical communication tasks?		
	Clear expectations regarding critical communications?		
	Training – as required?		
	Workforce involvement in developing good communication procedures and habits?		

4.29.5 Further reading

- EI, Human factors briefing note no. 10: Communications
- HSE, HSE human factors briefing note no. 8: Safety critical communications
- HSE, Human factors: Inspectors human factors toolkit, common topic 3: Safety critical communications, http://www.hse.gov.uk/humanfactors/topics/common3.pdf
- IAEA, Managing human performance to improve nuclear facility operation

4.30 STRESS RISK ASSESSMENT

4.30.1 Overview

Stress risk assessment is key to understanding what, if any, additional stress will be incurred through change in working practices necessary for decommissioning.

4.30.2 Issues/problem areas

The closure of the facility and impending redundancy can cause anxiety, depression and stress. Working on a decommissioning site can also be a source of stress. Stress can affect performance in the immediate term and cause longer-term psychological health problems.

'*People who have worked here for years develop an almost emotional attachment to the plant. They are reluctant to see it destroyed.*'

Source: Confidential interview

4.30.3 Possible solutions

Conduct stress risk assessments and act on the results. Consult specialists in mental health to advise on this.

4.30.4 Checklist

Table 33: Stress risk assessment checklist

	Questions	Y	N
1	Do you have a good understanding of all the possible sources of stress during decommissioning?		
2	Do you have strategies in place to measure workforce stress?		
3	Do you have strategies in place for managing stress?		

4.30.5 Further reading

- EI, Human factors briefing note no. 19: Pressure and Stress
- European Agency for Safety and Health at Work, Research on work-related stress
- HSE website, http://www.hse.gov.uk/stress
- HSE, RR488, Investigation of the links between psychological ill-health, stress and safety

4.31 FATIGUE/FITNESS FOR DUTY

4.31.1 Overview

Decommissioning work can be intense and continuous with strict deadlines and targets. Physical and mental effort can reach a peak during each phase of activity and can lead to fatigue.

Contractors are often required to work at the site for extended periods, involving spending days or weeks away from home. This can increase stress and other mental health problems and more physical problems caused by uncontrolled and unhealthy intake of food, alcohol and drugs.

4.31.2 Issues/problem areas

Operators reporting for work in a fatigued or otherwise impaired state will not work effectively or safely. An unhealthy lifestyle can lead to long-term impacts on wellbeing.

4.31.3 Possible solutions

Introduce an effective and realistic fitness-for-duty assessment programme. Provide advice on sleep and health.

4.31.4 Checklist

Table 34: Fatigue/fitness for duty checklist

	Questions	Y	N
1	Are all workforce members assessed daily for their fitness for duty? (Beyond simply asking 'are you fit for duty today?')		
2	Are spot checks/random tests applied to ensure compliance with fitness for duty rules?		
3	Are there suitable measures in place to manage this issue, such as:		
	A culture sympathetic to genuine cases of illness and unavoidable loss of sleep?		
	The option to assign the person to light/non-safety-critical duties?		
	Confidentiality in dealing with individuals – e.g. private discussion, availability of anonymous reporting system?		
	Awareness of embarrassment or 'macho' attitudes that may stop an individual from reporting fitness for duty problems?		
	Effective sanctions for unjustified breaches?		
4	Have work patterns been designed using guidance for minimising fatigue?		
5	Have formal measurements been taken to assess fatigue and the risks of fatigue for critical tasks – including mental fatigue-inducing tasks?		
6	Are remedial measures readily available to counter any problems found?		

4.31.5 Further reading

- EI, Human factors briefing note no. 5: Fatigue
- EI, Managing fatigue using a fatigue risk management plan (FRMP)
- EI, Safety information bulletin: Using sleep contracts to manage fatigue risk
- HSE, HSE human factors briefing note no. 10: Fatigue
- HSE, Human factors: Inspectors human factors toolkit specific topic 2: Managing fatigue risks
- HSE, RR446, The development of a fatigue/risk index for shiftworkers

ANNEX A
REFERENCES AND FURTHER READING

A.1 REFERENCES

American Institute of Chemical Engineers (AIChemE) – https://www.aiche.org

Guidelines for investigating chemical process incidents

The British Psychological Society – https://www.bps.org.uk

Psychological testing centre website, https://ptc.bps.org.uk/

The British Psychological Society, *Psychological testing: A users guide*

The Chartered Institution of Building Services Engineers (CIBSE) – https://www.cibse.org

Guide A: Environmental design

Department of Defence – https://www.defense.gov

MIL-STD-1472D, *Human engineering requirements for military systems, equipment and facilities*

Department of Energy (DOE)

U.S. Department of Energy (DOE), DOE-HDBK-1140-2001, *Human factors/ergonomics handbook for the design for ease of maintenance*

DOE, Doe-hDBK-1028-2009, *Human performance improvement handbook, Vol. 1: concepts and principles*

Department for Trade and Industry

Adult data: The handbook of adult anthropometric and strength measurement – data for design safety

Energy Institute (EI) – http://publishing.energyinst.org

Effective workforce involvement in health and safety: a guide

Guidance on crew resource management (CRM) and non-technical skills training programmes

Guidance on human factors safety critical task analysis

Guidance on quantified human reliability analysis (QHRA)

Guidance on the preservation and recommissioning of existing combined cycle gas turbine (CCGT) plant

Hearts and Minds, *Improving Supervision*, available at: https://heartsandminds.energyinst.org/

Hearts and Minds, *Making change last*

Hearts and Minds, *Understanding your HSE culture,* available at: https://heartsandminds.energyinst.org/

Human factors briefing note no. 3: Organisational change

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. 9: Safety culture

Human factors briefing note no. 10: Communications

Human factors briefing note no. 11: Task analysis

Human factors briefing note no. 13: Human reliability analysis

Human factors briefing note no. 15: Incident and accident analysis

Human factors briefing note no. 16: Human factors integration

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

Learning from incidents, accidents and events

Managing fatigue using a fatigue risk management plan (FRMP)

Research report: Human factors performance indicators for the energy and related process industries

Safe staffing arrangements – user guide for CRR348/2001 methodology: Practical application of Entec/HSE process operations staffing assessment methodology and its extension to automated plant and/or equipment

Safety information bulletin: Integration of human factors into design and major modifications of plant, available from https://www.energyinst.org/technical/human-and-organisational-factors/human-factors-safety-information-bulletins

Safety information bulletin: Managing organisational change, available from https://www.energyinst.org/technical/human-and-organisational-factors/human-factors-safety-information-bulletins

Safety information bulletin: Manual and mechanical handling, available from https://www.energyinst.org/technical/human-and-organisational-factors/human-factors-safety-information-bulletins

Safety information bulletin: Using sleep contracts to manage fatigue risk, available from https://www.energyinst.org/technical/human-and-organisational-factors/human-factors-safety-information-bulletins

Transient contractor and supplier risk management and assurance during shutdowns, outages and turnarounds

Tripod Beta: Guidance on using Tripod Beta in the investigation and analysis of incidents, accidents and business losses

Workforce involvement (WFI) poster pack

Engineering Equipment and Materials Users Association (EEMUA) – https://www.eemua.org

EEMUA201, *Process plant control desks utilising human-computer interfaces – A guide to design, operational and human interface issues*

European Process Safety Centre (EPSC) – http://epsc.be/

PRISM, *Behavioural safety application guide*, http://epsc.be/PRISM/_/JOMCs_finalised_version_of_Application_Guide.pdf

PRISM, *Good practice guide on task design,* http://epsc.be/PRISM.html

European Agency for Safety and Health at Work (EU-OSHA) – https://osha.europa.eu

Research on work-related stress

Health and Safety Executive (HSE) – http://www.hse.gov.uk

ACSNI study group on human factors, *First report on Training and related matters*

CHIS7, *Organisational change and major accident hazards*

CRR 304/2000, *Health and safety of portable display screen equipment*

CRR430/2002, *Strategies to promote safe behaviour as part of a health and safety management system*

Effective supervisory safety leadership behaviours in the offshore oil and gas industry

HSE human factors briefing note no. 2: Competence

HSE human factors briefing note no. 3: Managing human performance

HSE human factors briefing note no. 4: Procedures

HSE human factors briefing note no. 7: Safety culture

HSE human factors briefing note no. 10: Fatigue

HSE human factors briefing note no. 11: Organisational change

HSG48, *Reducing error and influencing behaviour*

HSG115, *Manual handling: solutions you can handle*

HSG197, *Railway safety principles and guidance: Part 3, section A – Developing and maintaining staff competence*

HSG243, *Investigating accidents and incidents*

HSG254, *Developing process safety indicators – A step-by-step guide*

HSE, CRR 348/2001, *Assessing the safety of staffing arrangements in the chemical and allied industries*

HSL/2007/31, *Major hazards industry performance indicators scoping study*

Human factors: Inspectors human factors toolkit common topic 4: Safety Culture

Human factors: Inspectors human factors toolkit specific topic 2: Managing fatigue risks

Human factors: Inspectors human factors toolkit, Core topic 4: Reliability and usability of procedures

Human factors: Inspectors' human factors toolkit Core topic 1: Competency assurance

INDG 232, *Consulting employees on health and safety: a guide to the law*

Inspectors' toolkit: Human factors in the management of major accident hazards

Involving employees in health and safety

Key process safety performance indicators: A short guide for Directors and CEOs

Manual Handling Operations Regulations 1992

OTO 1999 092, *Human factors assessment of safety critical tasks*

OTR 2000/003, *Behaviour modification to improve safety: literature review*

OTR 2000/048, *Behaviour modification programmes: establishing best practice*

OTR 2000/049, *Safety culture maturity model*

Revitalising procedures

RR 0862003, *Competence assessment in hazardous industries*

RR001, *Human factors integration in the onshore and offshore industries*

RR086, *Competence assessment in hazardous industries*

RR107, *Development of internal company standards of good management practice and task-based risk assessment tool for offshore work-related stressors*

RR181, *Different types of supervision and the impact on safety in the chemical and allied industries*

RR446, *The development of a fatigue/risk index for shiftworkers*

RR488, *Investigation of the links between psychological ill-health, stress and safety*

RR679, *Review of human reliability assessment methods*

The Health and Safety (Consultation with Employees) Regulations 1996

The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996

The Safety Representatives and Safety Committees Regulations 1977

Website, *Human factors: Design*, http://www.hse.gov.uk/humanfactors/topics/design.htm

Website, *Human factors: Managing human failures*, http://www.hse.gov.uk/humanfactors/topics/humanfail.htm

Website, *Human factors: Supervision*, http://www.hse.gov.uk/humanfactors/topics/supervision.htm

Website, *Human factors: Training & competence,* http://www.hse.gov.uk/humanfactors/topics/competence.htm

Website, *Human factors: Workload*, http://www.hse.gov.uk/humanfactors/topics/workload.htm

Website, *Manual handling assessment charts (the MAC tool)*, http://www.hse.gov.uk/msd/mac/

Website, *Musculoskeletal disorders*, http://www.hse.gov.uk/msd/index.htm

Website, *Operating procedures*, http://www.hse.gov.uk/comah/sragtech/techmeasoperatio.htm

Website, *Organisational culture*, http://www.hse.gov.uk/humanfactors/topics/culture.htm

Website, *Procedures*, http://www.hse.gov.uk/humanfactors/topics/procedures.htm

Website, *Training*, http://www.hse.gov.uk/comah/sragtech/techmeastraining.htm

Website, *Working safely with display screen equipment*, http://www.hse.gov.uk/msd/dse/index.htm

Website, *Work-related* stress, http://www.hse.gov.uk/stress

WPS/00/03, *Employee involvement in health and safety: Some examples of good practice*

International Association of Oil and Gas Producers (IOGP) – https://www.iogp.org/

IOGP 454, *Human factors engineering in projects*

International Atomic Energy Agency (IAEA) – https://www.iaea.org

IAEA safety glossary: Terminology used in nuclear safety and radiation protection

Lessons learned from the decommissioning of nuclear facilities and the safe termination of nuclear activities

Managing human performance to improve nuclear facility operation

Safety Series No. 75-INSAG-4, *Safety culture*

International Organization for Standardization (ISO) – https://www.iso.org

ISO 6385:2016, *Ergonomic principles in the design of work systems*

ISO 9241, *Ergonomics of Human System Interaction*, various parts

ISO 9241-400:2007, *Ergonomics of human-system interaction – Part 400: Principles and requirements for physical input devices*

ISO 9355-3:2006(en), *Ergonomic requirements for the design of displays and control actuators — Part 3: Control actuators*

ISO 9355-4:2006(en), *Ergonomics requirements for the design of displays and control actuators – Location and arrangement of displays and control actuators*

ISO 11064, *Ergonomic design of control centres*, Parts 1–7

Magnox Sites – https://magnoxsites.com

Bradwell site summary: Lifetime plan, https://magnoxsites.com/wp-content/uploads/2014/03/Bradwell-Lifetime-Plan.pdf

Michigan Water Environment Association (MWEA) – http://www.mi-wea.or

Decommissioning industrial facilities: practical considerations from an IPP perspective

Ministry of Defence (MoD) – https://www.gov.uk/guidance/uk-defence-standardization

DEFSTAN 00-250, *Human factors for designers of systems,* Parts 0–4

Nuclear Regulatory Commission (NUREG) – https://www.nrc.gov/

NUREG-1792, *Good practices for implementing human reliability analysis (HRA)*

NUREG/CR-3331, *Methodology for allocating nuclear power plant control functions to human or automatic control*

National Aeronautics and Space Administration (NASA) – https://www.nasa.gov/

Task load index, http://humansystems.arc.nasa.gov/groups/TLX/

Office for Nuclear Regulation (ONR) – http://www.onr.org.uk

Developing and maintaining staff competence

New nuclear reactors: Generic design assessment guidance to requesting parties

NS-TAST-GD-061 Revision 3, *Technical assessment guide: Staffing levels and task organization*

NS-TAST-GD-063Revision 3, *Technical assessment guide: Human reliability analysis*

NS-TAST-GD-064 Revision 3, *Allocation of function between human and engineered systems*

Safety assessment principles for nuclear facilities

Technical assessment guide: Human factors integration

Office of Rail and Road (ORR) – orr.gov.uk

Office of Rail and Road (ORR), *Developing and maintaining staff competence*

Step Change in Safety

Changing minds – a practical guide for behavioural change in the oil and gas industry

Step Change in Safety, *Leading performance indicators – A guide for effective use*

Various authors

Bolles, R., *What colour is your parachute?* (Plus Workbook), http://www.jobhuntersbible.com

Bronson, P., *What should I do with my Life?*, http://www.pobronson.com

Byers, J.C., Bittner, A.C. Jr., and Hill, S.G., *Traditional and raw task load index (TLX) correlations: Are paired comparisons necessary?*, found in *Advances in industrial ergonomics and Safety I,* pp 481–485

Chapanis, A., *Human factors in systems engineering*, Wiley & Sons.

Cook, M., *Personnel selection: Adding value through people*, fourth edition, Wiley & Sons

Dekker, S., *Slowly developing faults*, third edition, Boca Raton, Florida, CRC Press part of Taylor and Francis

Endsley, M.R., Bolstad, C.A., Jones, D.G. and Riley J.M, S*ituation awareness oriented design: from user's cognitive requirements to creating effective supporting technologies*, in Proceedings of the Human Factors and Ergonomics Society 47th annual meeting – 2003

Gawron, V.J., *Human performance, workload, and situational awareness measures handbook*, second Edition, CRC Press, Boca Raton

Hartley, J., *Designing instructional text*, third edition, Kogan Page

Hopkins, A., *Failure to learn: The BP Texas City refinery disaster*, Australia

Iles, P.A., and Robertson, I.T., *The impact of personnel selection procedures on candidates*, in Herriot, P. (Eds), *Assessment and selection in organizations: Methods and practice for recruitment and appraisal*, Wiley, Chichester.

Jordan, P.W., *An introduction to usability*, Taylor and Francis

Joyner, P. and Lardner, R. *Mindfulness: Realising the benefits,* IChemE symposium series no. 153

Kinlaw, D.C., *Handbook of leadership training activities: 50 one-hour designs*, McGrawHill

Kirwan, B. and Ainsworth, L. K., *A guide to task analysis*, Taylor and Francis.

Kirwan, B., *A guide to practical human reliability assessment*, Taylor and Francis.

MacLeod, D., *The ergonomics kit for general industry*, Second edition, CRC Press

Murrell, K.F.H., *Ergonomics – Man in his working environment*, Chapman and Hall.

Norman, D. A., and Draper, S. W. (Eds.), *User-centered system design*, Hillsdale, N.J., Erlbaum

Patrick, J., James, N., Ahmed, A. and Halliday, P., *Observational assessment of situation awareness, team differences and training implications*, in Ergonomics, 49, pp 393–417

Pheasant, S., *Ergonomics – Standards and guidelines for designers*, BSI.

Pheasant, S. and Haslegrave, C.M., *Bodyspace: Anthropometry, ergonomics and the design of work*, third edition, CRC Press

Ponder, R., *The leader's guide: fifteen essential skills*, PSI successful business library

Price, H., *The allocation of functions in systems*, in *Human Factors: The journal of the human factors and ergonomics society*, 27, 1, pp 33–43

Salvendy, G., *Handbook of human factors and ergonomics*, third edition, Wiley & Sons

Salvendy, G. (Ed.), *Handbook of human factors*, Wiley & Sons.

Sanders, M. S., and McCormick, E. J., *Human factors in engineering and design*, seventh edition, McGraw-Hill.

Schein, E.H., *Career anchors*, third edition, Pfeiffer

Shadbolt, N. R. and Burton, A. M., *Knowledge elicitation*, in *Evaluation of human work: Practical ergonomics methodology.*

Smith, M., and Robertson, I.T., *The theory and practice of systematic personnel selection*, Macmillan

Sneddon, A., Mearns, K., and Flin, R. *Situation awareness and safety in offshore drill crews*, in Cognition, technology and work, Vol.8, No.4, Springer

Stanton, N.A. & Young, M., *Guide to methodology in ergonomics: Designing for human use*, CRC Press

Taylor, J.B., *Safety culture: Assessing and changing the behaviour of organisations*, Gower Applied Research

Wickens, C., Hollands, J.G., Banbury, S. and Parasuraman, R., *Engineering psychology and human performance*, fourth edition, HarperCollins.

Wickens, C., Lee, J., Yili, L. and Becker S.G., *Introduction to human factors engineering*, second edition, Prentice Hall.

Wilson J.R. and Corlett E.N., *Evaluation of human work: A practical ergonomics methodology*, second edition, Taylor and Francis.

Yukl, G., *Leadership in organizations*, second edition, Prentice-Hall, Englewood Cliffs.

Websites

Management Study Guide, http://www.managementstudyguide.com/what_is_motivation.htm

Cogent Skills, http://www.cogent-competence.com/

The Chartered Institute of Personnel and Development, http://www.cipd.co.uk/

The Association for Coaching, http://www.associationforcoaching.com/

Equality and Human Rights Commission website, http://www.equalityhumanrights.com/

A.2 FURTHER READING

Further information on human factors can be found by searching for various terms at the web addresses in Table A.1.

Table A.1: Further information

Organisation	Website address	Search for
Department for Business Energy and Industrial Strategy (BEIS)	https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy	Decommissioning programme: Template and examples
Oil and Gas Authority (OGA)	https://www.ogauthority.co.uk/	Offshore installations decommissioning guidance
The Nuclear Regulatory Commission (NRC)	http://www.nrc.gov/	Nuclear plant decommissioning Human factors resources
United States Chemical Safety Board	http://www.chemsafety.gov/	Human factors resources

ANNEX B
ABBREVIATIONS AND ACRONYMS

AIChemE	American Institute of Chemical Engineers
BEIS	Department for Business Energy and Industrial Strategy
BNFL	British Nuclear Fuels Limited
CIBSE	The Chartered Institution of Building Services Engineers
CoP	cessation of production
DOE	U.S. Department of Energy
DSC	decommission services contractor
EI	Energy Institute
HAZID	hazard Identification study
HAZOP	hazard and operability study
HFE	human factors engineering
HFI	human factors integration
HFIP	human factors integration plan
HOF	human and organisational factors
HOFCOM	Human and Organisational Factors Committee
HRA	human reliability analysis
HSE	Health and Safety Executive
HVAC	heating, ventilation, and air conditioning
IAEA	International Atomic Energy Agency
IOGP	International Association of Oil and Gas Producers
ISO	International Organization for Standardization
LSA	low specific activity
MMI	minimum manned installation
NORM	naturally occurring radioactive material
NUI	normally unattended or unmanned installations
ONR	Office for Nuclear Regulation
ORR	Office of Rail and Road
OWAS	Ovako working posture analysis system
P&ID	piping and instrumentation diagram
PCB	polychlorinated biphenyl
PPE	personal protective equipment
QA	quality assurance
SCTA	safety critical task analysis
SIMOPS	simultaneous operations

ANNEX C
CASE STUDY

This positive case study of a decommissioning programme on a refinery illustrates some of the challenges covered throughout this publication, and illustrates that, with appropriate effort, they are not insurmountable. It is presented as a transcript from an interview conducted by the author of this publication.

'We had to decommission as the plant was in administration and the administrator wanted to leave the site as soon as possible. A third party carried out the decommissioning – their main concern was that everything was drained down and there were visible air gaps [pipes and cables clearly cut]. We drained down as much hydrocarbon as possible and neutralised pyrophoric scale in pipework with chemical washes. The other main hazards were a lot of asbestos and also anhydrous hydrogen fluoride which we gave away as it was good quality.

We retained a skeleton crew of operators – this was essential as they had the knowledge going way back; it's a well-paid job and the company was a major employer around here so most people had local ties to the area; people knew they'd still have a job for two or three years and, obviously, it's better to look for a job when you have a job already. As well as that, the site had been bought by another company so employees knew there may be job opportunities going forward.

We were fortunate to have good established processes and able to keep those going during decommissioning: safe systems of work, management of change, our strategy for handing over to contractors and auditing procedure – this also kept the training burden to a minimum; we also had excellent records so knew where everything was, including underground services and could include these in the handover package to the contractors. We had long-established contractor relations but we needed the core staff as well to work with them.

The company did make some promises that it didn't keep and things could have gone better if they'd handled the process more professionally.

We visited other sites to get some idea of the reality of decommissioning which was useful.

We always felt that our people and the contractors were working as a team; in effect, we treated it as a turnaround. We spent up to 12 months going around the site to work out what 'safe' would look like to our contractor and learned a lot from the contract companies. We held daily meetings with the whole team – communications were good. We went on site whenever any key demolition tasks were being done (along with regular auditing of our demolition contractor). Housekeeping was excellent; traffic management was good with regular updates on road closure, explosion events etc. We maintained the fence line and made it clear that safety was paramount within the demarcated demolition area. We maintained good welfare facilities in the areas where they were needed.

The Board was fully involved and took the process as seriously as normal operations. There was also good stability in the demolition contractor leadership team with the same key individuals on site throughout the demolition process.'

Source: Confidential interview

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