Oil & Gas UK

the voice of the offshore industry

Guidance on the Management of Ageing and Life Extension for UKCS Oil and Gas Installations

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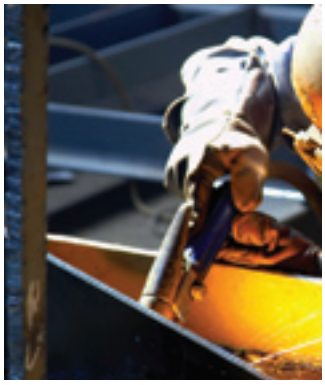

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Andy Lane	Formerly Talisman (Work Group Chairman)
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CONTENTS

Introduction

Issues arising from asset ageing and life extension (ALE) present key challenges for the offshore oil and gas industry. Technological advances in exploration and production mean that the United Kingdom Continental Shelf (UKCS) has many developments that are now operating beyond their originally conceived field life. As equipment ages, increased challenges to maintaining integrity require to be managed. These may be a result of cumulative degradation over time (such as corrosion, wear or fatigue) or where like for like replacements are no longer suitable due to either obsolescence or changes in engineering standards. Additionally, there is an increasing dependence on existing infrastructure to act as hubs for the viable development of new fields. Duty holders have put in place measures to maintain these facilities for the long term, and these arrangements typically address issues of ageing and life extension as they arise. It is clear however that the demand for continued and extended use of existing facilities is likely to increase over time. Duty holders will therefore be required to anticipate and understand the effects of deterioration or changing conditions associated with ageing and life extension, and be prepared to intervene to ensure that this demand can be met without adverse effect on asset integrity or safety.

The ageing process may begin ahead of an asset or component first entering service. Control systems procured by a project team for example, may have obsolete software by the time start-up is achieved, or equipment may have been poorly preserved while awaiting installation. Analysis of the outputs from inspection, testing and maintenance activities enable duty holders to identify trends, respond to performance issues and identify early indicators of ageing and obsolescence. The prime purpose of inspection, testing and maintenance is to ensure that the condition of the asset is always understood and that it remains in a fit-for-purpose condition.

The industry also has assets that are approaching or beyond their anticipated service life and this requires a managed approach to life extension to ensure continued levels of safety and integrity.

The industry is also able to demonstrate a responsible approach to the management of ageing and life extension such that mature or life extended assets can be operated safely. That demonstration supports the view that “old” does not necessarily equate to “unsafe” or “not fit-for-purpose”. A useful analogy in this regard is the Forth road and rail bridges:

- The rail bridge came into service in 1890 and has worked continuously up to the present day. It is subject to rigorous inspection, testing and maintenance and many of its components will have been replaced in its life time due to deterioration or obsolescence;

- The road bridge was opened in 1964 but is now showing signs of deterioration and is no longer considered suitable as the road crossing of the Firth of Forth. Traffic levels using the bridge now significantly exceed those factored into the original design.

In early 2011, the industry in collaboration with the Health & Safety Executive (HSE) embarked on a programme to direct additional attention and effort to asset ageing and life extension issues. Part of that effort was the development of this guidance which will enable duty holders to continue to meet the following key business objectives:

- major accident prevention and continued safe operations;
- sustainable, long term operational viability; and
- ongoing legal compliance

The guidance acknowledges that a significant body of work already exists in the subject area and current duty holder systems make provision for considerations relating to asset ageing and life extension. The guidance document therefore:

- complements related industry guidance addressing subjects such as Asset Integrity and hydrocarbon release reduction;
- recognises and bridges to existing duty holder management systems;
- aids the assessment or measurement of existing duty holder systems for the management of asset ageing and life extension;
- complements hardware-focused technical guidance issued by HSE;
- seeks to define what is in the asset ageing and life extension envelope; and
- reflects the legislative framework.

The guidance document structure is aligned with the well-established HSG65 safety management system model as illustrated at Figure 1 below. HSG65 systematically breaks down the elements of management and is generally accepted as still having relevance to our industry. We have adopted this structure to build the guidance in order to aid understanding and to ensure that ALE issues are addressed across all aspects of asset management as described in this guidance document. The use of HSG65 also allows asset ageing and life extension arrangements to be readily harmonised with other key elements of existing management systems.

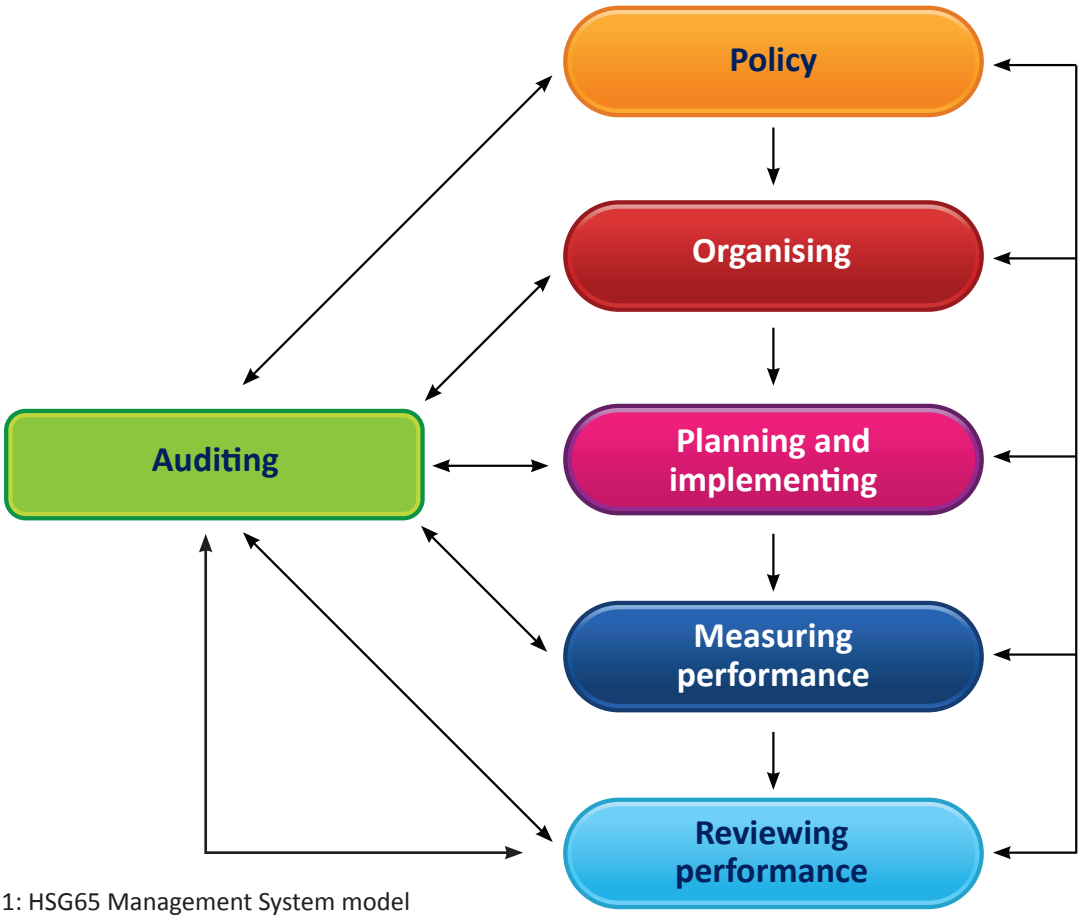


Figure 1: HSG65 Management System model

Figure 2 below illustrates how various key elements of business and operations management interact and relate to the management of ageing and life extension. The illustration provides examples of system elements that are likely to be common across duty holders but is not intended to be exhaustive.

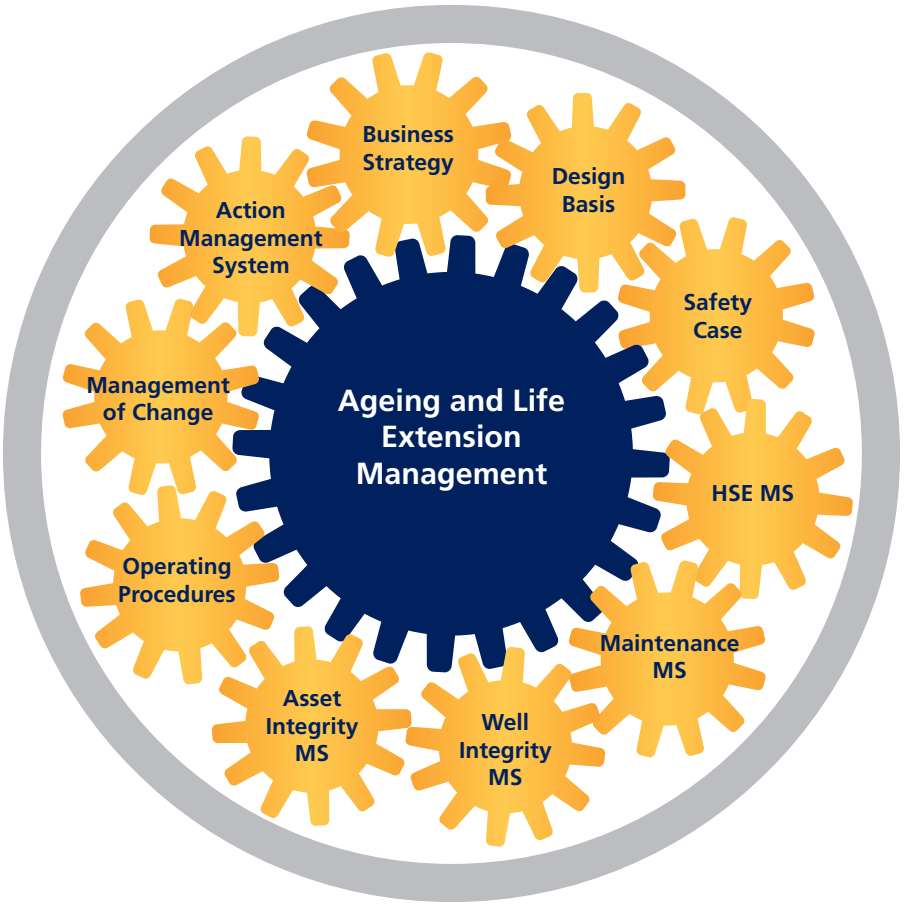


Figure 2: Main elements of Ageing & Life Extension Management.

Scope and Application

This guidance is applicable to the management of ageing and life extension in relation to all structures, topside plant and equipment, wells and pipelines and safety-critical elements (SCE) associated with offshore production installations on the UKCS and to related organisational factors. It applies to both manned and normally unattended installations (sometimes referred to as "not permanently attended installations"). Although not intentionally designed for application to onshore oil and gas facilities; many of the principles set out in the guidance are likely to be transferable and duty holders may choose to apply those aspects to onshore major hazard sites as appropriate.

The guidance is intended for use by duty holder personnel who are involved in management of the asset life cycle as illustrated in Figure 3. The guidance is designed to inform and influence duty holder management systems in respect of asset ageing and life extension factors. The duty holder management systems in turn inform and instruct "end users" (system implementers) on practical considerations of asset ageing and life extension.

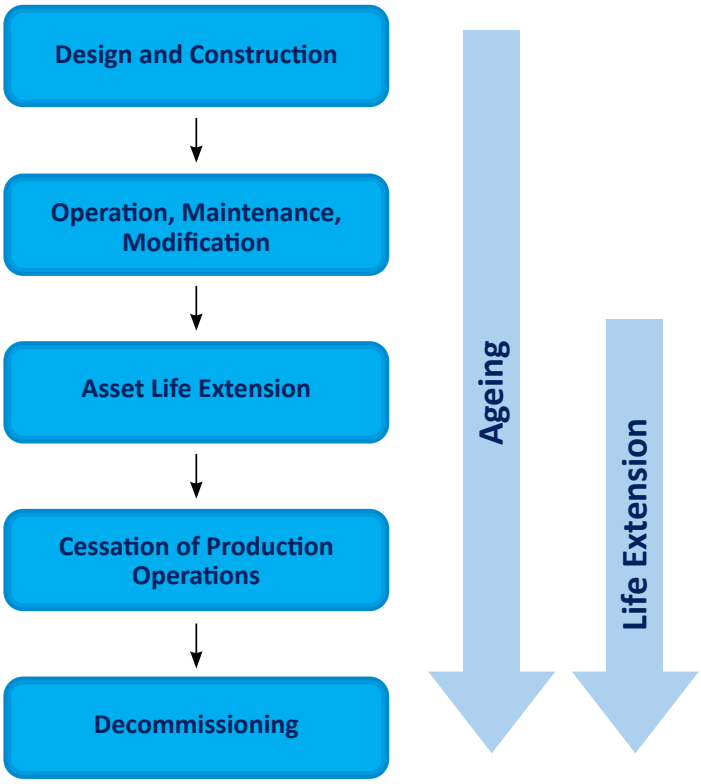


Figure 3. Illustrative Asset life cycle.

Glossary

Asset:
Offshore structures, process plant, subsea equipment, connecting wells, pipelines and the full range of SCEs associated with oil and gas production.

Ageing:
Ageing is any aspect which over time adversely affects the ability of the asset or elements of the asset to perform the desired function. This can include factors such as changes to organisation, process fluids, staff knowledge, changes to standards, obsolescence.

Life Extension:
Period beyond the originally defined period for which a facility is to operate while still maintaining acceptable standards of operational and technical integrity.

Cessation of Production (CoP)
Planned date to stop producing hydrocarbons from the asset. The CoP date can be revised periodically, based on updated economic modelling.

Design Life:
The duration of time that a field, asset, system or component is designed to operate, also expressed in this document as the anticipated service life.

Service Life:
Anticipated life of a component during which it is required to operate.

Deterioration (also referred to as degradation):
A detrimental change from design or as-manufactured condition adversely affecting the ability of the item to perform the required function. Example causes of deterioration include:

- repeated actions causing fatigue;
- wear due to use;
- the effects of improper operation and maintenance of the item;
- unanticipated environmental influences; and
- naturally occurring chemical, physical or biological actions

Obsolescence:
Structures, systems or components passing out of usefulness as a result of changes in knowledge, standards, technology or needs. Typically characterised by absence of necessary spares and technical support in the supply chain.

Maintaining Legal Compliance

The UKCS regulatory regime is designed to allow hydrocarbon exploration and production whilst safeguarding people and the natural environment.

The scope and requirements of these regulations have developed over time to match the increasing demands and complexities of arrangements necessary for exploration and production. In addition they have been modified and amended to support more demanding standards of health, safety, and environmental protection; changes in requirements as a result of incidents and investigations; and as a result of the wider context of UK law in relation to European Law.

Legal compliance is a minimum expectation of UKCS duty holders and it follows therefore that they must have an understanding of regulations that apply to them, have arrangements in place to ensure compliance, and be able to demonstrate such compliance.

The principal Acts and Regulations relating to broad aspects of ALE management are listed below and duty holders should be familiar with those statutes.

1. Health & Safety at Work etc. Act 1974
2. Management of Health & Safety at Work Regulations 1999
3. Provision and Use of Work Equipment Regulations 1998
4. Offshore Installations (Safety Case) Regulations 2005
5. Offshore Installations and Wells (Design and Construction etc.) Regulations 1996
6. Offshore Installations (Prevention of Fire & Explosion , and Emergency Response) Regulations 1995
7. Pipeline Safety Regulations 1996
8. Offshore Installations and Pipeline Works (Management and Administration) Regulations 1995

Specific reference is made to ageing and life extension in section 13 of the Offshore Safety Case Regulations which requires a 'thorough review of the safety case' at five yearly intervals 'to identify ageing processes, design parameters and changes in operating conditions that may limit the life of the installation, the safety critical plant and equipment'. In support of this the HSE has published Offshore Information Sheet No 4/2009 Guidance on management of ageing and thorough reviews of ageing installations.

It is crucial that duty holders maintain good awareness of legal requirements affecting their operations. There are various sources of information which can assist in this and the government and regulators themselves are a good source of information. In particular the reader is directed to the Government website at http://www.legislation.gov.uk/. This is the official website of UK legislation and is a rich source of information. The Health & Safety Executive Offshore Division website also provides access to relevant legislation and guidance at http://www.hse.gov.uk/offshore/index.htm. Use the search function to access information from this source.

Systematic approach to effective management of asset ageing & life extension

This section describes practical approaches to the management of asset ageing and life extension. It provides general guidance on good practice and is geared to enabling duty holders to develop and maintain management systems that fully address these considerations. Adherence to the principles and practices set out in this section will ensure that ageing and life extension feature appropriately in duty holders' management system arrangements.

Policy & Leadership

In common with other aspects of responsible and prudent operatorship; sound management of ageing and life extension issues is largely shaped by effective leadership which should be expressed in the duty holder's HSE policy and management system. The extent to which senior managers drive company efforts in these key areas, significantly influences successful implementation of ALE related activities.

The following aspects are of particular importance in this regard.

Ownership & accountability

Arrangements for the delivery of the duty holder's policy with respect to ALE should be via defined roles, responsibilities and accountabilities and the company management system.
Company leadership needs to assign clear ownership and accountability for matters relating to ALE. That accountability primarily rests at a senior level but leaders also need to ensure that arrangements are in place to manage ALE throughout the organisation and these arrangements need to clearly define accountability for ALE related issues and activities.
Leaders should identify their own individual or collective roles and responsibilities in relation to ALE and communicate those to affected personnel within the organisation. Duty holders may also consider the appointment of a senior management "sponsor" or similar role for ALE issues.

Senior leadership commitment & engagement

Leaders should be engaged in appropriate processes that enable them to understand and contribute to the company's ALE efforts. There are requirements for senior leadership involvement in many cross-discipline ALE related activities, from strategic planning through to review, and these will be expanded upon in later parts of this guidance. Senior leaders should also take an active interest in the management of ageing during site visits, and take those opportunities to identify any particular challenges arising from ageing effects.

Business strategy & life of field planning

Oil and gas exploration and production business strategy and life of field planning has a very obvious linkage to asset ageing and life extension and life of field strategies need to include medium to long term business plans. Cessation of Production (CoP) dates should be communicated to appropriate parties to make a true connection to ALE management. Conversely, the outputs from ALE management activities should influence life of field planning. The organisation directly involved in operating, inspecting and maintaining assets needs to be aware of its intended life span in order to manage ALE accordingly. Leaders setting life of field expectations should review asset condition over time, understand risks and take account of any threats to their CoP date and associated field life extension planning. This will form a key part of due diligence associated with any production commitments made for the late life or life extension period. Decisions on divestment and / or acquisition activity also have an impact on ALE management and ALE considerations should influence those decisions. The cost impact of managing asset ageing and extending the anticipated service life of assets is a business reality requiring the allocation of sufficient competent resources to manage asset ageing and life extension related activities. Business plans should include budget provision for ALE related scope.

Management systems

Duty holders' HSE Management Systems and / or Asset Integrity Management Systems should incorporate lifecycle management principles to asset ageing and life extension, and this guidance provides a framework for that provision.

Organisational Factors

Duty holders should be appropriately organised to manage ALE as set out in the following sections.

Resourcing

Manpower resourcing and allocation arrangements should ensure that adequate, competent resources are in place to identify, manage and execute ALE related activities.

Roles & responsibilities

Roles and responsibilities of personnel involved in the planning, management, execution and assurance of ALE related activities should be clearly defined, documented and communicated.

Technical authorities

The significance of the role of Technical Authorities (TA) or organisational equivalent in ALE management should be stressed in duty holder organisational arrangements. Technical Authorities are appointed to act as prime sources of technical expertise in discipline areas. The wider organisation should be aware of some of these TA assignments and understand how the TA needs to be involved in ALE related issues.

Training & competence

Personnel responsible for managing, inspecting, maintaining and assuring integrity of plant and equipment should have a demonstrable understanding of ageing mechanisms and mitigation measures. Basic professional and technical competence should be supplemented where necessary with training in the management of ageing. Competence levels should be maintained to take account of changes in technology and standards for example, so that personnel have a current understanding of ageing issues and their management.

Communication & cross-functional coordination

Figure 4 opposite illustrates some of the communication interfaces necessary for effective ALE management. Examples of types of communication in relation to ALE management include:

- senior leadership with technical personnel on strategic matters potentially impacting ALE management
- technical personnel with senior leadership on technical or operational matters potentially affecting business strategy or life of field planning activities
- sub-surface specialists with Technical Authorities or other relevant technical personnel on sub-surface issues potentially affecting ALE management (e.g. changes in production profile, reservoir characteristics or fluids)
- between Supply Chain and Engineering disciplines to advise of potential obsolescence challenges (e.g. where Supply Chain has become aware of discontinuation of equipment spares availability)

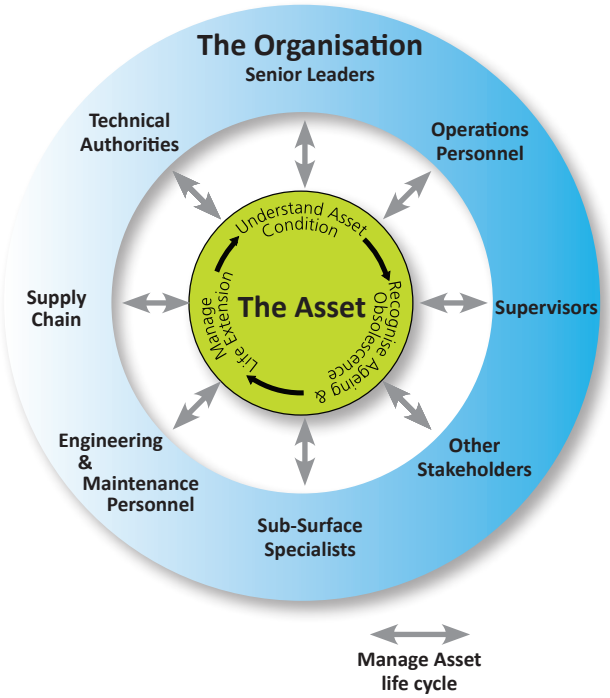


Figure 4: Communication Interfaces

Contracting strategy & interface management

The nature of ALE management dictates that some of the activities involved may be carried out by third party service providers. The duty holder's contracting strategies should identify where such specialist support is necessary and appropriate. Robust contracting processes should then ensure that suitable contractors are identified, assessed for competence and selected to undertake ALE related integrity management activities. Also a performance management system should be in place to quality check work carried out by these third party contractors.

Pre-mobilisation activities should ensure that relevant contractors are suitably aware of the duty holder's ALE management processes and their role in successful delivery of those processes. Ongoing interface management and in-service monitoring should be geared to ensuring that contractors are aligned with the duty holder's ALE management arrangements. Control of, and accountability for ALE management remains with the duty holder and is irrespective of a contractor's responsibility for execution of ALE related activities.

Staff turnover, succession planning & corporate knowledge retention

Arrangements should be in place to ensure that key competencies, skills, knowledge and experience relating to ALE management are not lost permanently when personnel leave or transfer within the organisation. This is of particular importance in relation to key roles such as Technical Authorities but the duty holder should identify all ALE sensitive positions and develop candidate selection criteria for the key integrity assurance positions with effective handover process. In addition to that form of planning, organisations need to ensure a disciplined approach to matters such as record keeping so that the loss of an individual from the organisation does not disproportionately impair operational capability. This is particularly critical to ALE management where local knowledge and an understanding of historical issues or data is often necessary in order to assess and respond to an ALE challenge for example.

Conflicts of interest

In developing organisational arrangements (e.g. departmental structures, reporting lines etc.), duty holders should seek to establish a degree of independence of personnel involved in key integrity assurance roles from operational line management. Personnel performing assurance activities may be part of a stand-alone function or of some other function suitably independent of the operational line.

Planning and Implementation

This section provides guidance on the development and implementation of practical arrangements for the management of ageing and life extension. It addresses a number of aspects that duty holders need to account for in order to ensure that ALE features appropriately in their organisations' management systems.

Management Systems

Duty holders should have management systems with attributes similar to the HSG65 model described earlier in this guidance. As illustrated at figure 2 in this guidance, HSE management systems complement and interact with a range of other management processes and approaches to ensure that ageing and life extension related matters are identified and addressed in a systematic manner. Duty holders should review existing management systems and related processes to ensure that ALE factors impacting integrity management are addressed explicitly where appropriate, or made integral to other aspects of HSE and business management systems. Duty holders developing new or significantly revised management systems should take the opportunity to ensure that ALE features to an appropriate degree in such systems.

Design & procurement

Engineering design and related procurement activities require thorough and careful consideration of asset ageing and life extension factors. This section sets out key elements of design and procurement with the prime focus on those aspects most affecting or affected by ageing and life extension issues.

(i) Design:

All assets should have design documentation available and accessible. This documentation sets out the design criteria by which the asset meets safety, operational and other performance requirements. This supports effective design engineering at all stages of the asset life cycle and in relation to the management of ageing and life extension; the following aspects require attention:

- the original design should be aligned with the anticipated service life and factored into all design considerations;
- the design documentation will be the primary means by which engineers are made aware of key requirements and design assumptions and hence it is essential that it is maintained and up-to-date;
- the design documentation must be controlled to ensure that only current documentation is accessible to users;
- the design documentation should be reviewed and endorsed by relevant technical authorities to ensure that the design basis remains aligned with life of field strategies and life extension plans;
- design documentation should be organised in such a way as to be readily accessible for reference by relevant personnel; and
- design documentation should be subject to audit and review.

All engineering activity undertaken throughout the anticipated service life of an asset should properly address ALE considerations. Engineers should be kept informed of ALE related decisions and plans, and factor those into modifications and other forms of engineering activity to achieve good alignment. Particular areas of focus will be modification interfaces between new and ageing equipment, or where inspection has shown some degradation to the existing systems compared to design assumptions.

(ii) Procurement:

Procurement should be aligned with the anticipated service life of asset and associated engineering, inspection, testing and maintenance to ensure that ALE considerations address the following:

- ensuring that to the extent possible, procured items have a service life and supplier support commitment that takes account of asset lifecycle business plans;
- identifying and responding appropriately to potential obsolescence issues such as critical spares availability and changes to level of vendor support;
- supporting effective ongoing inspection, maintenance, testing, repair or replacement of plant and equipment;
- Spares management; and
- Vendor sharing of lessons learned and upgrade proposals based on subsequent design development.

Management of Change

In relation to ALE management, the primary objective of a Management of Change (MoC) process is to ensure that sufficient rigour is applied to asset ageing and life extension and the planning, assessment, documentation, implementation and monitoring of changes affecting an installation or operation such that any potentially adverse effects of or on ALE are identified and managed effectively.
Set out below is a typical list of headings and sub-headings designed as prompts to help duty holders identify ALE related changes;

Plant & Equipment (including critical software); including

- Changing standards
- Recognising ageing and obsolescence as a trigger for change at any stage in the service life of an asset
- Changing CoP date, extending asset service life beyond the originally anticipated service life, or beyond a specified life extension period
- Modifications, upgrades and repairs
- Process operating conditions and safe operating limits
- Decommissioned items
- Impact of any and all changes to SCEs and related performance standards
- New and advancing technologies
- Overall layout and space challenges

Processes, procedures and programmes; including

- Reservoir management (existing and new)
- Production profile and produced fluids chemistry
- Changes to asset register
- Degradation risks management; corrosion, fatigue, thermal and pressure cycling, mean time between failures (MTBFs), wear out models
- Defined life repair management
- Spares management
- Inspection, testing and maintenance strategies and programmes
- Operating standards and procedures

People & Organisation; including

- Organisational structure
- Competency/Training Requirements
- Succession planning
- Human factors
- Ergonomics standards

Regulatory & Industry; including

- Legislative change
- Original build standards vs. current industry standards
- Safety case thorough review
- Demonstration of safety and integrity
- Safety case impacts
- Verification scheme
- Well examination scheme
- Pipeline major accident prevention document

Commercial Agreements; including

- Export transportation agreements
- Gas sales contracts

All of the above are guide words to prompt triggers for change or change impacts. Duty holders should anticipate these and implement a process to, initiate change, define change scope/plan, execute plan, conduct pre ALE review and follow-up.

Managing Change - Asset Life Extension

Managing the change or transition from the originally anticipated service life to a period of life extension requires special consideration.

Where assets are expected to be operated beyond their anticipated service life, duty holders should be able to demonstrate that the asset has sufficient integrity and remains or is expected to remain fit-for-purpose for the specified life extension period. Asset life extension planning will be required, and the items below provide guidance on how this can be managed. The guidance can be applied to the asset as a whole or to parts thereof and may be scaled accordingly:

- Long term planning:
  - meeting asset life extension goals requires long term planning that commences before the point at which an asset is required to operate beyond its original intended life, or beyond an already specified asset life extension period.
  - the long term plan for an asset should flag when the original intended life of an asset ends. Planning of life extension implications should be an integral part of the business decision to change the CoP date and will therefore allow the current condition of the facilities (wells through to export systems), anticipated cross-discipline future integrity risks, assurance actions and outline long term work programme to be identified and managed to ensure that the facility can continue to operate safely and efficiently through the extended life cycle to final removal.

- Identify potential asset life extension issues – understanding of current condition, asset risk register and where applicable historical review:
  - a systematic assessment of asset performance history should be conducted to support asset life extension goals and requirements.
  - a review of available asset documentation should be conducted in support of this. Data gathering in preparation for this includes, for example: asset design basis, operating history, component repair and replacement history, inspection, testing and maintenance history, SCE impairments history, verification history, modifications history, Metocean data – history and latest view, Hazard Identification study (HAZID), Hazard and Operability study (HAZOP) status.
  - assimilation of the gathered data is a precursor to identifying and evaluating any issues required to be resolved in support of asset life extension.

- Identify potential asset life extension issues via gap analysis. This involves a critical review of what is and isn't currently known about asset condition. This should consider:
  - asset plant and equipment register,
  - original and current and any anticipated standards applicable to the plant and equipment
  - potential degradation mechanisms,
  - ageing/wear out models,
  - potential life extension strategies.
  - Known anomalies and defects
  - Best practice

- Review of asset plant and equipment items including wells and pipelines should be against credible degradation types, asking:

  - Does current condition of equipment/system and credible threats to integrity of the equipment/system give confidence that this can remain fit-for-purpose for the proposed life extension?
  - Could the degradation/failure occur?
  - If this degradation occurred, would it be identified through the current inspection /testing regime?
  - If this degradation occurred could it be rectified or would it be life-limiting for the facility?
  - Has the degradation/failure occurred in the asset's history or in other business units?
  - Could the issue occur or re-occur during the Life Extension period?
  - What action is required in each of the above cases?

This assessment should identify any gaps that should be addressed to support any proposed period of life extension. The assessment needs to involve the relevant stakeholders in order to identify all credible gaps on a cross-discipline basis.

- Develop Asset Life Extension scope:

  - the output from the gap analysis is the basis for establishing the work scope required to support the specified asset life extension goals.
  - an Asset Life Extension report should be generated which captures the output from this process. The report should make clear recommendations as to what should be done in support of the case for asset life extension and when these activities should be scheduled

- Assess Asset Life Extension costs, cost phasing and asset economics

- Review options and decide next steps: Assuming that asset life extension is economically viable, then this should lead to development of an asset life extension plan and schedule

- Implement asset life extension plan:

  - The above process should lead to action definition, execution and closure. The evaluation helps determine the asset life extension strategies to be applied to asset plant and equipment such as:

    > additional inspection, testing and maintenance
    > repair, or replacement,
    > fitness for service/Engineering criticality assessment re-rating or re-design

  - And management system sub elements, such as:

    > modify operating procedures and safe operating limits.
    > update of asset integrity programmes
    > update of operating procedures
    > thorough review of the asset's safety case to include any material changes
    > funding provision in the asset's long term plan

In summary, asset life extension planning involves the systematic identification of all issues and actions required to secure asset life extension. Implementation of these actions should enable demonstration of the suitability of the asset for the specified life extension period and its ability to deliver the duty holder's business objectives.

Operational controls

Listed below are examples of operational controls established to ensure that plant and equipment continue to be operated within specified safe working design envelopes. Each of these elements can be impacted by ageing or obsolescence issues and need to be continuously assessed against the requirements of 'life of field' requirements including new technologies, improved standards and best practice, and reservoir performance such as changes in flow rate, temperature, pressure and fluid composition.

- People aspects such as;
  - resourcing & manning levels
  - organisational structures (supervisory levels etc.)
  - competency
  - succession planning

- Documentation such as;
  - operations manuals
  - safety case

- Software such as;
  - control systems
  - emergency shutdown (ESD) systems
  - fire & gas detection systems

- Hardware such as;
  - central control rooms
  - instrumented systems providing control and protection
  - relief, blowdown and ESD equipment
  - active firefighting systems and passive fire protection
  - power generation & distribution systems
  - instrument air distribution systems
  - sea water lift and distribution systems
  - hydraulic control systems

Inspection, test and maintenance regimes

An important element in Asset Ageing and Life Extension is the assessment of the changing condition of an asset. This is achieved by inspection, testing and maintenance of its integrity throughout an asset's life. This requires a systematic approach supported by timely repairs, replacements and restoration of asset condition so that the asset remains fit for its operational purpose and that safety critical performance is maintained throughout asset life, including any period of life extension. Without these, assets will deteriorate, leading to reduction of performance, ageing and unreliability of safety critical function.

The management of inspection, testing and maintenance has to be a continual learning process that targets the degradation mechanisms that will affect plant and equipment and an assets SCEs and their sub systems and components. The process should anticipate, assess and respond to degradation risks, including all forms of corrosion, erosion, fatigue and all other failure mechanisms presenting risks to an asset so that deterioration is detected and addressed before failure can occur. The inspection testing and maintenance process that supports this approach is defined below:

(i) Asset Register

This should be a comprehensive list of in-service components, the failure of which could compromise asset major accident prevention goals. This is typically incorporated into computerised systems designed for inspection, testing and maintenance management. Each safety critical asset component should be linked to a safety critical element and performance standard, as necessary. The following should be included in the asset register:

- All permanently installed assets and components
- Temporary equipment
- Defined life repairs
- New assets and components arising from modifications

All supporting inspection, testing and maintenance databases should be aligned with the asset register. Therefore, periodic reviews are required to ensure the asset register and supporting databases are maintained. A rigorous management of change process will ensure that that the asset register remains as built.

(ii) Integrity Risk Assessment

This involves assessment of the asset register to determine the asset's plant & equipment failure risks. The type of assessment depends on the component type and can include failure modes, effects and criticality assessment, risk based inspection assessment, or other types of assessment appropriate to a component's critical function and operator's accepted RA methodologies.
The integrity risks assessments should lead to an inspection testing and maintenance strategy that defines the appropriate interval and method – with the goal of detecting deteriorating condition, or degraded performance before failure can occur.

(iii) Inspection, Testing and Maintenance Programme

This is derived from the integrity risk assessment and is based on a selected inspection, testing and maintenance strategy. This can be one of several strategies depending on the component type and safety criticality, including:

- Reliability centred maintenance
- Planned predictive and preventative maintenance
- Risk based inspection
- Function testing of SCEs

(iv) Planning & Scheduling

All programmed inspection, testing and maintenance should be planned in accordance with a documented inspection, testing and maintenance schedule. This should be dynamic, allowing optimisation based on results analysis, described later in this section.
Deviations from plan and schedule should be avoided as far as possible but where this is necessary they should be subject to deferment controls. Deferments of safety critical element inspection, test and maintenance should only be permitted when the risks are understood and are tolerable for a specified deferment period.
A SCE deferment risk assessment or equivalent assessment is conducted when SCE inspections, testing and/or maintenance or verification cannot be performed on or before its specified due date. The duration of the postponement should; i) avoid significant risk escalation, ii) be stated in the risk assessment, iii) be subject to periodic review, and iv) require demonstration that additional risk reduction measures have been enacted.
SCE deferment risk assessments are subject to reviews by line and senior management depending on risk severity, and may also be subject to independent verification depending on those same criteria.

(v) Task Implementation

All programmed inspection, testing and maintenance should be conducted in accordance with specified work plans and instructions. These should include sufficiently detailed inspection, testing and maintenance tasks and associated acceptance and rejection criteria related to the required SCE performance.

(vi) Reporting results and defects/anomalies

Inspection, testing and maintenance results should be recorded into the appropriate database to maintain equipment condition history and for subsequent review and analysis. This includes the reporting of as found condition, i.e. defects and anomalies which were resolved or repaired at the time of conducting the inspection, testing and maintenance.

(vii) Defect/Anomaly Assessment & Corrective Actions

Defects and condition anomalies should be subject to Corrective Maintenance and/or Fitness for Service Assessment.

Deviations from SCE performance standards should be risk assessed and analysed to determine root cause in order to understand the reasons for impairment of function. SCE impairment risk assessments or other equivalent form of operational risk assessment should specify and implement specified risk reduction measures. Such assessments are conducted when inspection, test and maintenance and/or independent verification reveals an asset condition that threatens SCE performance and therefore an asset's ability to respond to major accident scenarios described in asset safety cases.

The duration the impairment may be tolerated is governed by similar criteria as for deferment risk assessment described earlier, i.e.; that the duration of the impairment should, i) avoid significant risk escalation, ii) be stated in the risk assessment, iii) be subject to periodic review, and iv) require demonstration that additional risk reduction measures have been enacted.

Note; The SCE risk assessment processes exist to ensure that issues affecting Asset Integrity are identified, reported, and risk assessed. This is to ensure that asset safety can be demonstrated and that any risks are acceptable. This includes:

- Demonstrating that the Asset can continue to be operated safely, provided risk mitigation measures have been clearly defined and implemented;
- Resolving SCE risks and performance as a matter of Asset safety priority; and
- The decision is made to shut down an Asset where this is the only safe way to respond to an SCE issue, pending resolution of the issue.

SCE risk assessments are subject to reviews by line and senior management depending on the severity of the issues. It is essential for management to know that all SCEs are under active control, that any risks are acceptable and that any and all deferment and impairment risks are managed effectively.

(viii) Inspection, testing and maintenance programme review

Inspection, testing and maintenance programmes require periodic formal review to ensure they remain valid, on schedule and to identify any adjustments that need to be made. Documented reviews involve assessment of:

- What was planned and what was done
- What was found and what was done about it
- What is there left to do?
- SCE performance/reliability

The reviews should also address what has changed, i.e.:

- Describe what is new for inclusion in the asset register due to:
- Modifications
- Repairs
- Replacements
- The updates that should be made to integrity risk assessments due to:
- Change to asset register
- Change of operation/operating condition
- Change of ownership
- Defects and anomalies
- Corrective maintenance
- Industry alerts
- SCE incidents and associated root cause analysis
- What independent verification revealed about the suitability good order and repair of SCEs?

Then, applying management of change principles to the inspection, testing and maintenance programme, identify:

- What changes should be made to:
    - programme arising from changes to risk assessments
    - Integrity task instructions arising from changes to programme

- Changes to standards and regulatory requirements which will influence the programme
- That all necessary SCE deferment and impairment risks assessments are in place and current
- Signs of degraded performance and ageing, or obsolescence that need to be captured in asset improvement plans, e.g. due to changing standards, unreliability, unavailability, diminished vendor support, lack of spares availability or expertise

(ix) Asset Improvement - Updates and programme improvements

Capturing the output from the programme review enables optimisation and continuous improvement of inspection, testing and maintenance programmes, requiring recommendations and actions to be tracked to completion.

The inspection testing and maintenance process described above can only be effective in assessing asset condition when it anticipates the deterioration, degradation and failure of asset components. The scope of the process has to be supported by various strategies that address the specific risks with discrete parts of an asset.

In summary, the purpose of the inspection testing and maintenance process is to ensure that the condition of the asset is understood and maintained to a satisfactory standard. The process should be designed to ensure an asset's integrity is always known, how it is changing with the passage of time, provide indication of ageing and obsolescence, and implement the required upgrades and restoration to preserve asset integrity.

Strict observance of the foregoing will ensure asset integrity is a continuous process throughout an asset's life and is a major contributor to demonstrating the case for asset life extension.

Information management

The continued integrity of an asset is largely dependent on the manner in which the facility was designed, constructed, commissioned, operated and maintained over its life time. A key component of effective integrity management is the maintenance of complete and accurate records through all stages of the life cycle. The availability and quality of data on historical and current asset condition supports effective ALE management. A lack of reliable data can potentially affect life extension assessment and decision making for example, and introduce a requirement for enhanced monitoring to assess and assure asset integrity in the extended life period. The following are some examples of ALE-critical information requiring management throughout the asset life cycle.

- Design stage documentation including;

  - Statement of Requirements (SoR) documentation
  - Process definition and design criteria
  - Equipment specifications (e.g. process and mechanical data sheets)
  - Design codes and standards (recording year and revision of code or standard)
  - Design drawings e.g. piping & instrument diagram (P&ID), process flow diagram (PFD), layouts etc.
  - Construction & installation stage documentation including;
  - As-built drawings
  - Technical and engineering queries and variations
  - Close-out and certification packs (hydro-test certificates etc.)
  - design records required for final decommissioning planning should be identified. This may differ from design documentation required during the operational phase. Storage locations and media (i.e. paper or electronic) should be recorded and kept available for future access.

- Inspection, test and maintenance documentation

A detailed description of inspection, test and maintenance activities is provided earlier in this guidance. Records of these activities support effective ALE management and in particular will aid robust life extension assessment and decision making. Examples of relevant inspection, test and maintenance documentation include;

  - Asset register
  - Risk Based Inspection (RBI) strategy
  - Maintenance strategy
  - Inspection reports
  - Condition monitoring reports
  - SCE function test reports
  - Computerised maintenance management system (CMMS) data
  - Anomaly, repair and replacement records
  - SCE Risk Assessments (also referred to as Operational Risk Assessments)
  - Independent Competent Person (ICP) Verification reports

- Operational documentation

There is a distinction to be made between permanent data and process variable data for the purposes of ALE management and that required for the day to day operation of the plant. Permanent data can be described as documentation such as operating procedures, set point parameters etc.

Day to day data operational data records details such as tank levels, temperatures, pressures etc. and these data are usually only retained for a short period of time. Certain operational data may be useful however, when analysing the frequency of certain events such as shutdowns, pressure and temperature fluctuations that may be indicators of or may exacerbate ageing. Duty holders should consider ALE management in defining operational data management requirements and make provision for the appropriate retention of relevant data.

Acquisition & divestment

Acquisition and divestment of offshore oil and gas assets in the UK sector typically involves the sale and purchase of mature assets. Such transactions bring into focus the requirement for sound asset life cycle management in order to effect a safe and effective transfer of operatorship. There is an expectation that the selling party will be able to satisfy the prospective buyer's due diligence requirements and provide evidence of the asset's continued integrity. The following are examples of the kinds of information a buying organisation will be interested in and hence these are aspects that the divesting party should manage in the period of their ownership and / or operatorship

- design documentation
- production profiles
- operational expenditure (OPEX) trends indicating major plant replacement spend
- maintenance management system records (e.g. defect trending, backlog, plant uptime etc.)
- major equipment inspection records
- structural integrity management records (e.g. weight control, fatigue life assessment etc.)
- pipeline integrity records where appropriate
- SCE performance standard reviews
- ICP reports, notes of reservation and actions taken
- Well examination records
- anomaly registers
- incidents and equipment failures history
- management of change records
- repair and replacement history
- safety case maintenance (e.g. Thorough Review status, remedial action plans etc.)
- HSE enforcement actions and other relevant HSE correspondence
- Key Performance Indicator (KPI) history

Safety Case Maintenance & Thorough Review

The Safety Case should demonstrate that the installation can continue to be safely operated and that the structure, together with its associated plant, can continue to meet the necessary performance standards through to the projected end of field life. The Safety Case Thorough Review is a key process in completing this evaluation. Specific reference is made to ageing and life extension in section 13 of the Offshore Safety Case Regulations which requires a 'thorough review of the safety case' at five yearly intervals 'to identify ageing processes, design parameters and changes in operating conditions that may limit the life of the installation, the safety critical plant and equipment'. In support of this the HSE has also published Offshore Information Sheet No 4/2009 Guidance on management of ageing and thorough reviews of ageing installations.

This should involve the consideration of the changes which may have occurred as a result of the ageing of the installation, and how these are related to the effective control of hazards, covering fire and explosion, structural integrity, organisational and other ageing issues.

Duty holders must review the impact of ageing of an offshore installation on the risk from major accidents involving the structure, wells, process, export and inter-facility fluids (pipelines) for inclusion in the demonstration required in the safety case.

While the duty holder's safety management system (SMS) is required to address ageing issues, the thorough review is one tool to assist the process. It may also be appropriate to address ageing issues and life extension when a safety case is revised to address a material change.

The Thorough Review is expected to confirm that issues concerning ageing have been identified, that they are being adequately managed, and that reasonably practicable improvements are identified and implemented.
The Thorough Review Summary should be clear that the thorough review has included consideration of ageing, and should include brief details of:

- the ageing issues, which have been considered;
- the impact of ageing issues on risk analysis
- any extended life assessment or revision to the fire and explosion risk assessment;
- any changes to the management arrangements to take into account ageing; and
- conclusions as to the impact on the case for safety.

Anticipated Service Life

Asset components such as plant, structures and systems normally have an anticipated service life for which they are required to operate and function to acceptable standards of operational and technical integrity. The anticipated service life drives the technical design requirements.

Ageing can impact the service life of such components through either;

- changing conditions; or
- operation beyond the specified service life

For changing conditions, there are two ageing considerations, namely;

1. Environmental
2. Operational

Component integrity should be re-evaluated against the new conditions to establish that it still meets currently acceptable standards in line with MOC.

An example for (1) could be where process plant contained in an enclosed module is exposed to outside ambient conditions through modification. Vessel and pipework integrity would need to be re-evaluated due to increased risk to external corrosion and corrosion under insulation.

An example for (2) could be a pipeline that is subjected to a fluid composition change that impacts internal corrosion and hence predicted corrosion life. In this case the expected service life may be significantly reduced.

There are essentially three options that can be considered to manage ageing as follows;

(1) Replace the component at or before the point of reaching its defined service life or where it is no longer fit-for-purpose (e.g. minimum wall thickness).
(2) Repair or upgrade/protect the component in order to extend service life
(3) Justify an extended service life through assessment of condition and/or change in maintenance/inspection strategy

An example for (1) could be a dynamic flexible riser in a high pressure hydrocarbon service, that is approaching its defined service life and it is difficult to establish/confirm integrity through inspection.

An example for (2) could be a platform crane, where repairs and upgrades could justify continued operation by extending service life.

An example for (3) could be a platform structure, where past inspections have revealed no significant deterioration, and a future enhanced inspection regime can justify extended service life through an adequate demonstration of continued integrity.

Obsolescence

Obsolescence can be defined as structures, systems or components passing out of usefulness as a result of changes in knowledge, standards, technology or needs. Obsolescence is typically characterised by the absence of necessary spares and technical support in the supply chain. This can also occur due to changes in standards or technology, but excludes physical deterioration. In reality for equipment related to the production of oil and gas, typically this can result from any of the following (or a combination of more than one):

- vendors will no longer support equipment;
- vendors are out of business;
- spare parts are no longer available;
- upgrades made to software systems;
- equipment functionality no longer meets industry requirements or standards.

The duty holder organisation should be aware of current and potential obsolescence areas affecting the asset, so that suitable plans can be developed to deal with issues, minimising unplanned/ unexpected problems. Note that obsolescence should not necessarily be considered to be synonymous with age, as it is possible for relatively young equipment to suffer obsolescence issues; e.g. control equipment software where anti-virus upgrades for older operating systems are a particular vulnerability. Where obsolescence issues are noted but no action is taken, it is important that the reason is documented and properly risk assessed.

All action resulting from obsolescence issues should be identified, planned and executed as detailed elsewhere in this document.

Acceptable actions might include:

- replacement with suitable alternatives (this may involve sourcing from non-standard routes, e.g. from other equipment in the asset/company portfolio);
- replace with new component (functionality may be different from existing one and changes require to be assessed);
- identify an alternative solution to replacement (note that identification of an alternative solution can reduce the consequence of failure to an acceptable level in some instances and all such proposals must be fully risk assessed);
- identify operating mode which allows equipment to be used for remainder of required life.

Where like for like replacement is not possible it is important to carry out a thorough review applying management of change principles to ensure that safety implications are properly understood and considered. Interfaces between new and original equipment should also be carefully evaluated, considering the facility lifecycle and potential for any future replacement of the original equipment.

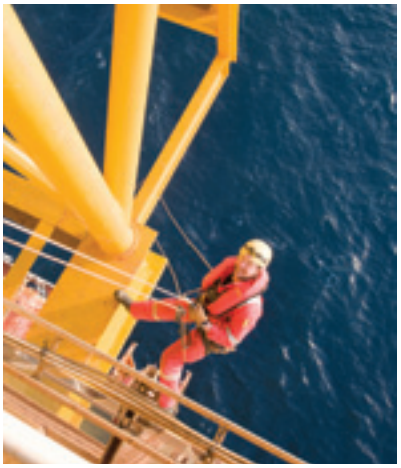
Note that for major pieces of equipment, e.g. compressors, control systems, the equipment vendor may be able to advise on obsolescence issues and it is recommended that these vendors are included in discussion and plans.

Decommissioning

All platforms will require to be decommissioned, with current legislation requiring the majority to be completely removed. Experience has shown that this could involve several years of additional operation post production depending on complexity, removal strategy and resource availability.

Accordingly service life requirements and maintenance strategies for identified critical components shall take into account the decommissioning phase, which will include well P&A, hydrocarbon cleaning and isolation of systems prior to the final removal. Elements typically key to this phase are structural components including safe access, cranes, drill equipment, power generation and safety critical equipment.

Monitoring, Audit & Review



Duty holders should have monitoring, audit and review arrangements in place as part of their HSE or related management systems. Steps should be taken to ensure that these processes make adequate provision for ALE management and this section offers guidance as to key elements of approaches to assurance of ALE management processes and status. In addition to monitoring, audit and review; the section also provides guidance on other critical aspects of overall performance management.

Monitoring

The following examples of monitoring processes will provide reasonable assurance that there is compliance with ALE management arrangements and that the arrangements continue to be effective in practice;

- active line monitoring by site-based supervisors and managers as part of routine operations. All such personnel should have an appropriate awareness of ageing effects and of the duty holder's ALE management processes and should be alert to both in monitoring site operations and hardware condition. Processes should be in place to encourage active monitoring and to enable status reporting as an input to overall ALE management. Site based personnel are ideally placed to monitor and report on incipient change that in turn would initiate any necessary preventive or corrective action
- active monitoring by shore-based support personnel and in particular by engineering Technical Authorities. These personnel should be monitoring closely outputs from inspection, test and maintenance activities and the active line monitoring referred to above. This provides an opportunity for early and effective intervention in ALE related issues
- monitoring by shore-based line management in the course of routine business / operational meetings and during offshore visits. Managers should be conversant with ALE issues and able to ask the right questions to gain assurance that ALE matters are well managed, or to identify any particular ALE challenges
- regular monitoring of performance against key performance indicators to assess achievement of operational objectives, or identify and correct any deterioration in performance
- reactive monitoring in the form of the investigation of incidents and other failures to identify ALE related issues, causation and corrective / preventive measures. Investigations should identify ALE related root causes so that effective long term improvement actions are identified and implemented

Audit

- duty holder management systems should include a requirement for audit as part of internal assurance processes. Audits will typically be carried out by competent personnel who are suitably independent of the audited operation and function. The duty holder audit arrangements should make provision for audit of ALE management and should ensure that auditors are sufficiently competent in ALE matters
- audits should assess compliance with documented ALE management processes, and on another level should assess the effectiveness of those processes in managing ALE.
- the duty holder management programme should also include audit of third parties (e.g. key suppliers and contractors) who are influential in ALE management.
- audits of duty holder management systems and practices by external parties (e.g. certification bodies) will address ALE related matters to the extent that these are features of the management system being audited.

Review

- management review processes should provide a reliable overview of ALE management by assessing outputs from monitoring and auditing activities, providing assurance that ALE is being well managed or identifying and addressing areas for improvement.
- the management review process should inform management decision making by raising senior leadership awareness of ALE related issues and challenges.

Key performance indicators

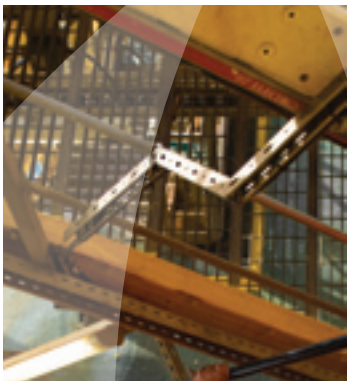
Duty holders typically have KPIs in place to aid the evaluation of HSE or operational performance against defined leading and lagging indicators. These arrangements should include KPI designed to monitor and measure the effectiveness of ALE management.

Action management systems

Arrangements should be in place to ensure that all ALE related corrective or improvement actions arising from monitoring, audit and review activities described above are recorded, documented and tracked to closure. Such action tracking should be suitably visible and accessible and should be subject to audit to provide assurance that ALE related actions are managed effectively.

Lessons learned

ALE related lessons learned from assurance activities or from incidents should be captured and communicated within the duty holder organisation and across the wider industry as necessary.

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