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1. INTRODUCTION

- 1.1 The Office for Nuclear regulation (ONR) has established safety assessment principles (SAP) [3]. These principles apply to assessment by ONR specialist inspectors of safety cases¹ for potential and existing nuclear facilities. The SAPs are supported by a suite of guides to further assist ONR's inspectors in their technical assessment work of making regulatory judgements and decisions. This technical assessment guide is one of these guides.
- 1.2 Technical assessment guides (TAGs) primarily provide guidance to ONR inspectors on the interpretation and application of the SAPs. They also contain guidance relevant to principles underlining the enforcement of licence condition compliance which supplements the technical inspection guides (TIGs) [2]. Thus the TAGs have relevance to all inspectors within ONR, regardless of function. The guides also provide information to licensees regarding ONR's expectations of the nature and content of relevant technical elements of licensees' submissions.
- 1.3 Asset management has been identified by ONR as a key strategic factor to the safe and secure management of the UK's new and existing nuclear infrastructure. ONR considers Asset Management to be important for duty-holders in order to effectively manage all facilities on a nuclear licensed site that have the ability to result in significant consequences. ONR understands the need to support UK duty-holders in applying asset management effectively.
- 1.4 This guide sets out what ONR considers relevant good practice (RGP) taken from national and international guidance. This guidance may be used for assessment of activities and safety submissions such as: periodic reviews of safety cases, construction or installation of new plant, modification or experiment on existing plant or changes to examination, inspection, maintenance and testing.

2. PURPOSE AND SCOPE

- 2.1 This guide presents additional information to support SAPs [3] that relate to Asset Management. This guidance seeks to highlight the need to expand duty holders thinking and planning to take account of whole-of-life risks in respect to physical assets. It sets out regulatory expectations beyond those covered by routine examination, inspection, maintenance and testing (EIM&T).
- 2.2 This guidance is underpinned by existing standards and publications such as ISO 55001. It should be noted, where a duty-holder's arrangements are found to meet recognised asset management standards, and adequately demonstrate compliance with the licence conditions, this guidance should not make additional demands upon them.
- 2.3 This guidance discusses issues ranging from initial design to decommissioning in order to drive proportionate consideration of long term issues. These issues include supply-chain, contract management and diversity and control of spares. The guidance also considers the need for through-life asset management, comprising strategies, plans and programmes for the effective delivery. These include consideration of preservation plans as well as pro-active replacement projects, supply chain needs and their associated funding requirements.
- 2.4 The guidance has been developed to provide guidance to inspectors on assessing the adequacy of duty holder's asset management arrangements, and how they are applied to ongoing safe operations. ONR recognises that through future updates, the need for

¹ The term 'safety case' may for the purpose of this document be substituted throughout for 'environment case' and/or 'security case'.

- a specific asset management TAG may be removed. This would be facilitated through the periodic update other ONR guidance documents, to include the respective requirements of asset management. This process would be controlled through the ongoing TAG review process. The integration of this TAG by ONR into routine business should also be reflected in the duty-holders own approach to asset management. As such, asset management should become integrated into ongoing operations.
- 2.5 Specialism specific annexes may be developed and published in support of this guidance. If required, these annexes will offer detailed advice and guidance on discipline specific asset management issues. It is intended that the annexes will provide further support to inspector's decisions and judgements. Annexes will be produced and published as required. These annexes may be published as assessments guides (TAG) or inspection guides (TIG) depending on their content and focus.
- 2.6 ONR recognises that asset management can apply to intangible assets such as knowledge and information, however for the purpose of this guidance, only physical assets are included. This guidance applies to all physical assets with the ability to impact on safety² and security. This includes assets that, through their failure, may increase the frequency of demand placed on plant protection equipment. These may include active and passive assets, not explicitly discussed within the safety case. They may however hold the potential to degrade existing lines of protection. For the purpose of this document these will be referred to as Identified Assets.
- 2.7 In considering physical assets only, reference within the guide is focused exclusively on nuclear activities. It is however recognised that duty holder decision making is multifaceted, taking account of many commercial factors of which safety and security are but two. ONR existing guidance in setting out ALARP justification includes financial considerations relating to cost when balancing investment decisions with reducing risks to as low as reasonably practicable.
- 2.8 The term "asset management system" (AMS) applies to any arrangements used to control and manage tasks associated with delivery of asset management activities. This may be a stand-alone, bespoke system or a process by which existing systems are utilised to deliver asset management objectives.
- 2.9 The guide contains additional advice to assist inspectors in applying their professional judgement. The guidance provides information to support regulatory decisions relating to assessment of licensees' safety submissions. The guidance provides a summary of relevant good practice taken from national and international standards. ONR published guidance and commissioned research has also been included. Links back to the relevant source material are included throughout the guidance, relating to the reference section and denoted by ^[#].
- 2.10 The guide is applicable to all plants, new and existing. The guidance should be applied to all stages of a facilities life-cycle, through the design, construction, commissioning, operation and decommissioning. Due to on-going development of safety standards, existing facilities may not comply in every respect with the revised SAPs. Where this is the case, the licensee should develop appropriate ALARP arguments. Its arguments should take account of factors such as the age of the facility and projected lifetime, including decommissioning.

² The term 'Safety' within this document refers to the control of recognized hazards in order to achieve an acceptable level of risk to persons, property and the environment.

- 2.11 This guide considers the claims made on Identified Assets that have the potential to affect Safety, Security or Environmental (SSoE) functions. These claims can be in respect to the support or delivery of SSoE functions through normal and fault conditions. The guide takes account of the changing modes of operation that a facility may undergo during its life-cycle.
- 2.12 This guide was developed in line with RGP [7] and industry standards. [5] It reflects the approaches and methods implemented by duty holders in managing Identified Assets throughout their life-cycle.

3. RELATIONSHIP TO LICENCE AND OTHER RELEVANT LEGISLATION

- 3.1 Under the Nuclear Installations Act 1965, a set of 36 standard licence conditions (LC) attached to each nuclear site licence [1]. These conditions cover the facility lifecycle from design, construction, and operation through to decommissioning and include management oversight and reviews. They require licensees' or duty-holders to implement arrangements to ensure compliance. The licence conditions (LCs) [1] SAPs [3] considered applicable to this TAG are presented below.

- **LC 10 Training:** *The Licensee shall make and implement adequate arrangements for suitable training for those on site who have responsibility for and operations which may affect safety.*
- **LC 11 Emergency Arrangements:** *The licensee shall make and implement adequate arrangement for dealing with any accident or emergency arising on the site and their effects.*
- **LC 12 Duly authorised and suitably qualified and experienced persons:** *The licensee shall make and implement adequate arrangements to ensure that only suitably qualified and experienced persons perform any duties which may affect the safety of operations on the site or any other duties assigned by or under these conditions or any arrangements required under these conditions.*
- **LC 15 Periodic review:** *The licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases.*
- **LC 17 Management Systems:** *Without prejudice to any other requirements of the conditions attached to this licence, the licensee shall establish and implement management systems which give due priority to safety.*
- **LC19 Construction or installation of new plant:** *Where the licensee proposes to construct or install any new plant which may affect safety the licensee shall make and implement adequate arrangements to control the construction or installation.*
- **LC 20 Modification to design of plant under construction;** *The licensee shall ensure that no modification to the design which may affect safety is made to any plant during the period of construction except in accordance with adequate arrangements made and implemented by the licensee for that purpose.*
- **LC 22 Modification or experiment on existing plant:** *The licensee shall make and implement adequate arrangements to control any modification or experiment carried out on any part of the existing plant or processes which may affect safety.*

- **LC 23 Operating rules:** *The licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interests of safety. Such conditions and limits shall hereinafter be referred to as operating rules.*
- **LC 24 Operating Instructions:** *The licensee shall ensure that all operations which may affect safety are carried out in accordance with written instructions hereinafter referred to as operating instructions.*
- **LC 25 Operational records:** *The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant which may affect safety.*
- **LC 27 Safety mechanisms, devices and circuits:** *The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant which may affect safety.*
- **LC 28 Examination, inspection, maintenance and testing:** *The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant which may affect safety.*
- **LC 34 Leakage and escape of radioactive material and radioactive waste:** *The licensee shall ensure, so far as is reasonably practicable, that radioactive material and radioactive waste on the site is at all times adequately controlled or contained so that it cannot leak or otherwise escape from such control or containment.*
- **LC 35 Decommissioning:** *The licensee shall make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety.*
- **LC36 Organisational capability:** *The licensee shall provide and maintain adequate financial and human resources to ensure the safe operation of the licensed site.*

4. RELATIONSHIP TO SAPS, WENRA REFERENCE LEVELS, IAEA SAFETY STANDARDS ADDRESSED AND BS ISO STANDARDS

4.1 SAPs

4.1.1 The SAPs [3] directly addressed by this TAG are:

- *SC.3 - For each lifecycle stage, control of the hazard should be demonstrated by a valid safety case that takes into account the implications from previous stages and for future stages.*
- *SC.7 - A safety case should be actively maintained throughout each of the lifecycle stages, and reviewed regularly.*
- *EKP.4 - The safety function(s) to be delivered within the facility should be identified by a structured analysis.*
- *ECS.3 - SSCs that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate codes and standards.*

- *ECS.5 - In the absence of applicable or relevant codes and standards, the results of experience, tests, analysis, or a combination thereof, should be applied to demonstrate that the structure, system or component will perform its safety function(s) to a level commensurate with its classification.*
- *ERL.1 - The reliability claimed for any SSC should take into account its novelty, experience relevant to its proposed environment, and uncertainties in operating and fault conditions, physical data and design methods.*
- *ERL.2 - The measures whereby the claimed reliability of systems and components will be achieved in practice should be stated.*
- *ERL.3 - Where reliable and rapid protective action is required, automatically initiated, engineered safety measures should be provided.*
- *ERL.4 - Where safety-related systems and/or other means are claimed to reduce the frequency of a fault sequence, the safety case should include a margin of conservatism to allow for uncertainties.*
- *EMT.1 - Safety requirements for in-service testing, inspection and other maintenance procedures and frequencies should be identified in the safety case.*
- *EMT.2 - SSCs should receive regular and systematic examination, inspection, maintenance and testing as defined in the safety case.*
- *EMT.3 - SSCs should be type tested before they are installed to conditions equal to, at least, the most onerous for which they are designed.*
- *EMT.4 - The continuing validity of equipment qualification of structures, systems and components should not be unacceptably degraded by any modification or by the carrying out of any maintenance, inspection or testing activity.*
- *EMT.5 - Commissioning and in-service inspection and test procedures should be adopted that ensure initial and continuing quality and reliability.*
- *EMT.6 - Provision should be made for testing, maintaining, monitoring and inspecting SSCs (including portable equipment) in service or at intervals throughout their life, commensurate with the reliability required of each item.*
- *EMT.7 - In-service functional testing of structures, systems and components should prove the complete system and the safety function of each functional group.*
- *EMT.8 - Structures, systems and components should be inspected and/or re-validated after any event that might have challenged their continuing reliability.*
- *EAD.1 - The safe working life of structures, systems and components that are important to safety should be evaluated and defined at the design stage.*
- *EAD.2 - Adequate margins should exist throughout the life of a facility to allow for the effects of materials ageing and degradation processes on structures, systems and components.*
- *EAD.3 - Where material properties could change with time and affect safety, provision should be made for periodic measurement of the properties.*

- *EAD.4 - Where parameters relevant to the design of plant could change with time and affect safety, provision should be made for their periodic measurement.*
- *EAD.5 - A process for reviewing the obsolescence of structures, systems and components important to safety should be in place.*
- *ENC.2 - The design of non-metallic components or structures should include the ability to examine the item through life for signs of degradation.*
- *ECE.3 - It should be demonstrated that structures important to safety are sufficiently free of defects so that their safety functions are not compromised, that identified defects can be tolerated, and that the existence of defects that could compromise safety functions can be established through their lifecycle.*
- *ECE.2 - For structures requiring the highest levels of reliability, multiple independent and diverse arguments should be provided in the safety case.*
- *DC.1 - Facilities should be designed and operated so that they can be safely decommissioned.*

4.2 WENRA

4.2.1 This TAG considers the Western European Nuclear Regulators' Association [4] (WENRA) for specific applicability. Whereas the WENRA Reactor Safety Reference Levels are intended for existing reactors, the SAPs are intended for all existing and new nuclear facilities. However, there is little difference between the general requirements of each. The WENRA and IAEA documents considered in this TAG are focused on nuclear reactor power plants. For this reason they do not have the same breadth of scope and intent of the SAPs and this TAG. Section 4 of NS-TAST-GD-005 identifies the WENRA Reference Levels as Relevant Good Practice for existing civil nuclear reactors

4.2.2 WENRA Reference Level 'I' is dedicated to "Ageing Management". It is considered within this TAG that ageing management is a sub-set within the broader scope of Asset Management. The main themes discussed within the ageing management reference levels, which are listed below, are encompassed by the Asset Management points in section 5 of this guide:

- *"The operating organisation shall have an AMP to identify all ageing mechanisms relevant to SSCs important to safety, determine their possible consequences, and determine necessary activities in order to maintain the operability and reliability of these SSCs."*
- *"The licensee shall assess structures, systems and components important to safety taking into account relevant ageing and wear-out mechanisms and potential age related degradations in order to ensure the capability of the plant to perform the necessary safety functions throughout its planned life, under design basis conditions"*
- *"The licensee shall provide monitoring, testing, sampling and inspection activities to assess ageing effects to identify unexpected behaviour or degradation during service."*
- *"The Periodic Safety Reviews shall be used to confirm whether ageing and wear-out mechanisms have been correctly taken into account and to detect unexpected issues."*

- *“In its AMS, the licensee shall take account of environmental conditions, process conditions, duty cycles, maintenance schedules, service life, testing schedules and replacement strategy.”*
- *“The AMS shall be reviewed and updated as a minimum with the PSR³ in order to in-corporate new information as it becomes available, to address new issues as they arise, to use more sophisticated tools and methods as they become accessible and to assess the performance of maintenance practices considered over the life of the plant.”*
- *“Ageing management of the reactor pressure vessel and its welds shall take all relevant factors including embrittlement, thermal ageing, and fatigue into account to compare their performance with prediction, throughout plant life.”*
- *“Surveillance of major structures and components shall be carried out in a timely manner to detect the inception of ageing effects and to allow for preventive and remedial actions.”*

4.2.3 WENRA Reference Level Issue ‘K’ is dedicated to EIM&T. The following points are worthy of note during assessment of Licensees’ SSC management arrangements:

- *“The need for the preparation and implementation of documented programmes of EIM&T of SSCs important to safety to ensure that their availability, reliability, and functionality remains in accordance with the design over the lifetime of the plant;”*
- *“The programmes should include periodic inspections and tests of SSCs important to safety in order to determine whether they are acceptable for continued safe operation of the plant or whether any remedial measures are necessary;”*
- *“The extent and frequency of preventative EIM&T should be determined using a systematic approach;”*
- *“The impact of maintenance on plant safety is to be assessed using data from plant EIM&T;”*
- *“Proven alternative approaches may be specified and other safety precautions taken to compensate for the potential for undiscovered failures where EIM&T provisions are not attainable;”*

4.3 IAEA

4.3.1 There are several International Atomic Energy Agency [5] (IAEA) publications with direct relevance to Asset Management. The following documents are of particular note in respect to assessing licensees’ Asset Management arrangements.

- *IAEA Safety Guide No NS-G-2.12 (IAEA, 2008) on Ageing Management of Nuclear Power Plant provides recommendations on meeting the IAEA’s requirements for the management of the ageing of SSCs important to plant’s safety. It is intended for use by nuclear power plant operators establishing*

³ For further guidance on the requirements and expectations of periodic review of safety, see reference 11.

Ageing Management Programmes and for regulators in setting standards and verifying that ageing is being effectively managed.

- *Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety – Technical Report Series No: 338*

4.3.2 This TAG has taken account of the above IAEA guidance which is reflected within the high level asset management principles and the supporting detailed guidance.

4.4 International Standards Organisations (ISO)

4.4.1 The following International Standards were included in the development of this TAG

- *ISO 55000 - This document specifies the overview, concepts and terminology in Asset Management.*
- *ISO 55001 -This document defines the requirements for a "management system" for Asset Management.*
- *ISO 55002 - This document provides interpretation and implementation guidance for such a management system.*

5. ADVICE TO INSPECTORS

5.1.1 Asset Management is the **through life** approach to **effectively manage risks** that may **challenge an identified assets** capability to support or deliver a **safety, security or environmental (SSoE) function**.

- **Through life:** Management of Identified Assets should begin at the time of initial design. It should continue through to the final decommissioning of the facility. The IAEA ageing management guidance breaks the facility lifecycle down into 6 stages; design, fabrication, construction, commissioning, operation and decommissioning.
- **Effectively manage risks:** An appropriate risk-informed approach should be utilised to evaluate the importance of Identified Assets. The approach should recognise and address the on-going ability to source replacement parts and services. It should recognise the reliance a facility places on Identified Assets, and how these may change with time. Early identification of Identified Asset allows their condition to be accurately tracked. This provides pro-active opportunities to identify long term resolution activities such as contract management, thus minimising future risks and resource demands.
- **Challenge:** Identified Assets that support or deliver SSoE functions should be identified with clear links back to any safety case reference. All reasonably foreseeable failure modes that can affect the Identified Assets capability to support or deliver an SSoE function should be identified. Appropriate activities should be put in place to monitor Identified Assets condition and minimise potential impact.
- **Safety, Security or Environmental (SSoE) function:** This guidance is written such that it may be applied universally across ONR and other regulatory bodies such as the EA. The guidance recognises that Identified Assets may be identified due to their requirement to support or deliver an SSoE function.

- 5.1.2 The advice in this guidance has been broken down into 10 key Asset Management points. ONR considers these points to be fundamental to delivering an effective Asset Management System.

5.2 AM Scope:

AM1: Asset management should be applied proportionately to the lifecycle of all Identified Assets.

- Effective asset management requires that ageing and degradation mechanisms are properly understood. Single point vulnerabilities should be suitably understood and identified. The duty holder should be undertaking appropriate monitoring, trending and analysis of degradation rates and mechanisms. This information should be taken into account at each stage of the plants lifecycle. [5] [7]
- The life-cycle should include the following stages; design, manufacture, fabrication, construction, commissioning, operation (including long term operation and extended shutdown and inactive state) and decommissioning through to final site clearance. [5] [7]
- The AMS should be adapted to reflect changes in a facilities operational mode, throughout the lifecycle. This is required to ensure the functional service provided by Identified Assets is not degraded, as many of the Identified Assets in operation will at some point need to be maintained. This may require partial, progressive or complete replacement. Managing the ageing of nuclear plant, means ensuring the availability of the required SSoE functions, throughout the service life of the facility. This should take account of changes that occur with time and use and not fully catered for by routine EIM&T.[7]
- The AMS should consider all Identified Assets in a proportionate manner. This should reflect the importance to the activity been undertaken. The risks associated with the asset's SSoE significance should be recorded. An appropriate method of prioritising should be clearly defined. [7]
- Key stakeholders should be identified to support the success and longevity of the AMS; they will be the owner or responsible person for: activities, decision making, emergency responses, site security issues, maintenance, operations and regulatory interfaces. [7]

5.3 Policy:

AM2: The purpose of the asset management system should be defined by strategic objectives, underpinning the delivery of Safety, Security or Environmental functions.

- The principles and framework by which the duty holder intends to apply AMS to achieve its objectives should be defined including ALARP justification. The categorisation and classification definition should be explicit within the AMS policy. It should be unambiguous, and not open to interpretation. [7]
- Commitments and expectations for senior leadership should be set out. It should define the processes for decisions, activities and appropriate behaviours [10][13] concerning management of the Identified Assets. Responsibilities and accountability should be clearly assigned to appropriate positions within the

duty holder's arrangements acting as intelligent customer if the AMS is managed by a contractor. [7] [8]

- The AMS should have a clear line of sight back to the relevant safety cases, and provide details of; SSoE functional requirements; engineering and plant maintenance schedules and consider legal and other regulatory obligations. [8]
- The AMS should outline the whole of life approach to the management of the Identified Assets. [7]

AM3: The asset management system should detail the organisation required for the management of assets.

- The AMS should define its organisational structure. It should include details of authority, accountabilities, roles and responsibilities. The AMS should define the terms of reference associated with each role, to ensure they are filled by suitably qualified and experienced people. [9]
- The AMS should be appropriately integrated with other systems. It should deliver a comprehensive programme for the overall management of Identified Assets. This may include financial governance, supply chain, and resourcing. There should be direct inputs from operational areas such as condition monitoring, quality assurance (QA) and other operating experience. [7]
- The AMS should support the duty holders Identified Asset's management activities. It should provide sufficient information and context to assist in the decision-making process. [5] [6] [7]
- The AMS should identify all end users (board members, senior leadership, operations, engineering etc.) that require AMS information. It should include the purpose for which information is being provided (e.g. Senior leadership receiving intelligence applied summaries and engineering staff receiving less processed data for analysis). The AMS should detail the most appropriate method and frequency of communication, providing fit for purpose reports. [9]
- The AMS should include links out to the supply chain function. It should have strategies for the delivery of services and spares. Appropriate contract management and funding plans should be developed and maintained through the life of the facility [5] [9]. These should be updated regularly to reflect any changes to the needs of the organisation or to the specific Identified Assets. Reviews and their associated changes should be recorded to develop an auditable trail of decision making.

5.4 Planning:

AM4 Asset management planning should record all system, structures and components that deliver a safety, security or environmental function.

- The AMS should include identification of all Identified Assets that support or deliver SSoE functions. The method for categorising functions should be referenced within the AMS. Conclusions from the evaluation of the consequences of an Identified Asset failing to support or deliver the SSoE function should be stated within the AMS. [3] [7]
- All Identified Assets should have appropriate classification applied to them. The classification should be linked to the Identified Asset's significance, with a description of all of its functional requirements and any associated

categorisations. Where applicable this should be directly linked to the safety case. [7]

- The duty holder should collate all the knowledge, skill, expertise and experience available. This should include different perspectives to ensure comprehensive coverage of all hazards and failure modes. The approach should also promote consistency. [5][6][7][8]

AM5: The asset management system should define the arrangements for managing Identified Assets through the facilities life-cycle.

- The AMS should represent a whole of life view of the facility. It should reflect all SSoE functions, as well as the Identified Assets that support and deliver those functions. [7]
- Consideration should be given at concept, design and manufacture stages of a facility as to how the Identified Assets will operate and degrade over time. Suitable consideration of design, process and material selection should be given with respect to the facility life-cycle. [5] [6] [7]
- Changes of function, operation and stages of care and maintenance should be specifically recorded. Appropriate arrangements should be set out for preparation of care and maintenance activities during these stages. Plans should be prepared for periods of care & maintenance or outage (e.g. cranes that may be required for decommissioning, but not plant operations).[5] [6] [7]
- The duty holder should establish long term AMS strategy and short/medium term AM plans that are ALARP. These should recognise and reflect the changing state of the Identified Assets and their significance in terms of SSoE functions. [5] [7]
- AM plans should consider whole-of-life risks. They should reflect the operational limits, external requirements as well as extant EIM&T arrangements and whole-of-life supply chain requirements for the Identified Assets .[7]
- AM plans should apply a proportionate approach to ensure that a higher level of rigour is applied to Identified Assets assessed to be most important. These should be identified and prioritised against their potential to impact on SSoE functions. [7] [8]
- The AM plans should be informed by, and regularly reviewed against asset condition. The frequency of these reviews should be established and documented. The frequency should consider the significance of the SSoE function, the current condition of the Identified Assets and observed rate of degradation, including mechanism and cause (e.g. environment, operation etc). Duty holders should supplement this position through operational experience where available. Details should be recorded within the AMS, and early reviews should be considered. [5] [7] [8]
- The AMS should be unambiguous, providing details of Identified Asset's location, ownership and current condition of the Identified Assets. Dates of the previous and next review period should be recorded.
- An appropriate programme of self-assessments and peer reviews should be conducted to maintain confidence in the effectiveness of the AMS. Where possible, this should be based on information and intelligence gathered from

EIM&T. Where this is not practicable, engineering judgment should be applied based on operational experience. [7]

- AMS strategies and plans should hold sufficient levels of detail relating to resource requirements necessary to successfully deliver the activity [5] [6] [7].
- Activities should take specific account of whole-of-life risks. This should include consideration and identification of long term supply chain requirements. Identification of alternate and diverse suppliers of services and/or equipment should be included. Suitable funding should be identified and secured to deliver this.
- Changes or re-prioritisation of part, or all of the AMS resource allocation (people, money & time) should be recorded with clear justification for the decision. [5] [6] [7]

5.5 IMPLEMENTATION & OPERATION

AM6: The asset management system should contain details of the safety, security and environmental functions of the Identified Assets.

- There should be appropriate levels of detail recorded within the AMS outlining the operation of Identified Assets under both normal and fault conditions. Prioritisation should be based on a risk informed approach. This should recognise unmitigated consequences relating to the function of the Identified Assets. [2]
- Demonstration of a Identified Asset's ability to deliver its functional requirement should, so far as is reasonably practicable, be undertaken according to written arrangements and technical instructions. These should be undertaken commensurate with safety significance and consequence in a proportionate manner. Reviews of these instructions should highlight practices that are detrimental or beneficial to the condition of the Identified Assets. [7]
- Where SSoE functions are delivered or supported by human interactions, these interfaces should be specifically identified. Associated risks should be understood, and assessed. [7]
- Operating histories of Identified Assets should be reviewed by suitably qualified and experienced persons in a way that is proportionate to their SSoE significance. These reviews should include transient records, maintenance histories, periods of normal operation and operating experience from similar Identified Assets. Ideally this information should be collated into a database such that information can be used (e.g. inputs to safety cases or as an aid for processes such as reliability centred maintenance). This approach will accurately reflect the current condition, effectiveness of AMS and inform future AMS plans [5] [6] [7]

AM7: The asset management system should ensure that all modifications to Identified Assets are adequately specified and controlled.

- The AMS should be linked to a process for tracking all Identified Asset modifications. It should include their design function, operational use, special tools & test equipment. Special note should be made to any modification to the interface between Identified Assets. Modifications to Identified Assets should include consideration of changes necessary to the AMS and place appropriate actions to resolve. These changes should be assessed within the AMS, with

changes to AMS plans (and strategies) if so required [5] [7]. Attention should be paid to cumulative effects of modifications and impact these may have holistically.

- The Identified Asset AMS plans should be reviewed by suitably qualified and experienced individuals to consider changes to documentation, operations and / or physical plant. Periodicity of the reviews should be defined and undertaken on a risk informed approach based on safety significance and consequences. These reviews and any subsequent changes should be adequately recorded and managed. [5] [7]
- The requirement to modify an Identified Assets, its SSoE function or operation may be prompted by any of the following, the most common reasons being: ^{[5][7]}
 - LC15 periodic review;
 - Relevant good practice;
 - Changes in operational requirements
 - Environment conditions;
 - Ageing and obsolescence; or
 - Events or incidents

5.6 ASSURANCE

AM8: The asset management system should monitor and record the performance of the Identified Assets and identify corrective actions as necessary.

- The AMS should identify appropriate performance indicators for each of the Identified Assets, linked to their SSoE function. The indicators should reflect significance, and classification. They should comprise leading and lagging indicators that define the operating effectiveness and efficiency of the Identified Assets. [7]
- Operations associated with Identified Assets should involve the timely detection and characterisation of degradation. This should be achieved through a combination of inspection and monitoring of the Identified Assets. Assessment of the observed condition should be undertaken to determine the type and timing of any corrective actions. Any decision making that impacts Identified Asset care or the AMS should be evidence based. It should be supported by analysis and recorded in such a way that demonstrates an auditable trail. [5] [6] [7]
- The visibility of an asset's performance, functional and physical attributes should, where appropriate, be provided through pictorial representation (e.g. dated photographs, graphs and sketches). This promotes consistency between different members of the organisation and / or third party contractors, when determining plant condition over protracted periods of time. It also serves to provide accurate records for periods of change and handover. [5] [6]
- A corrective action process should input into the AMS. It should provide up to date information on issues and plant abnormalities. This data should be trended to allow patterns to be identified, with learning applied to other similar systems and operations. The AMS should identify how investigation findings and recommendations, taken from failures, incidents and non-conformities are

to be integrated in into the AMS. This should be supported by a time-frame for implementation. [7]

- Operating experience should be applied to the AMS through the lifecycle of the Identified Assets. Experience from similar high-hazard, but non-nuclear industries should also be considered. [5] [6] [7]
- Ageing and obsolescence strategies should be developed in conjunction with the supply chain in identification and tracking of mitigation and replacement options. Suitable arrangements should be developed for end-of-life replacement or refurbishment of Identified Assets. Supply chain management should be included within these arrangements and controlled by the AMS. Identified Assets that are identified as difficult to manage or replace should have enhanced monitoring applied with longer term risk mitigation strategies developed.[5] [7]
- The AMS should identify the Identified Asset monitoring regime, which should be based on a graded approach. Monitoring should be undertaken according to the associated risk level. [5] [7]

AM9: The asset management system should be part of the organisations assurance process and contain a means by which its effectiveness can be monitored and measured.

- The AMS should be routinely reviewed by senior leadership to determine the continued suitability of the chosen strategy and policies. The results of an AMS review should be documented in an appropriate report. The report should address the understanding of the condition of the Identified Assets, its on-going monitoring and the mitigation effects. Any recommendations for improvements in AM from the review should include plant, process and procedures. . [7]
- A risk-based AMS audit programme should be established, led by suitably qualified and experienced people. The audit programme should be commensurate with the size and nature of the process or Identified Assets being audited and have appropriate controls and supervision. [7]

5.7 RESOURCING

AM10: The asset management system should identify the organisation resources required for maintaining Assets.

- The senior leadership team should demonstrate their commitment by providing an enabling environment for AM. They should support delivery of AM tasks and actively seek information on the past and current condition of Identified Assets. [5] [6] [7]
- The AMS should consider the long term funding required for AMS. This should be recognised through the development of resource achievable AMS plans derived from the high level strategy. These should be prioritised against the current Identified Asset condition, their SSoE function and classification. [7]
- Removal of part or all scope, resource, equipment or plant associated with delivery of an AMS plan should be justified and recorded. Suitable mitigation plans should be available, agreed with the identified Asset owner. [5] [6] [7]
- The AMS should be integrated with supply chain. Outsourcing asset management to a third party should be effectively monitored and controlled.

This should also include sharing of Identified Asset's information between organisations. [7]

- Impact of long term storage of spares should be assessed to identify degradation mechanisms. This should be supported within suitable spares strategies. Specific attention should be paid to spares that have been in storage for extended periods, with suitable QA process in place to provide ongoing confidence in the condition of the asset.
- The AMS should consider the suitably qualified and experienced person roles, responsibilities and accountabilities for those persons who contribute to the effectiveness of the AMS throughout its life-cycle. Any specific training should be captured and linked with the relevant AMS plans. [7]
- The AMS should demonstrate that the duly authorised, and other suitably qualified and experienced persons are part of the control and supervision across the AMS. The level of experience and qualifications required to maintain oversight and control should be clear. Responsibilities and authorisations should be set out. [5] [6] [7]

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7. GLOSSARY AND ABBREVIATIONS

ALARP	As low as reasonably practicable
AMS	Asset Management System
BS ISO	British Standards International Standards Organisation
DAP	Duly Authorised Person
EIM&T	Examination, inspection, maintenance and testing
IAEA	International Atomic Energy Agency
LC	Licence Condition
NEDF	Nuclear Engineering Directors Forum
PSR	Periodic Safety Review
RGP	Relevant Good Practice
SAP	Safety Assessment Principle(s)
SDF	Safety Directors Forum
SQEP	Suitably Qualified and Experienced Person
SSC	Structure, System or Component
SSoE	Safety, Security or Environmental (function)
TAG	Technical Assessment Guide(s)
TIG	Technical Inspection Guide(s)
WENRA	Western European Nuclear Regulators' Association