



ONR GUIDE			
Examination, Inspection, Maintenance and Testing of Items Important to Safety			
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1. INTRODUCTION

- 1.1 ONR has established its Safety Assessment Principles (SAPs) which apply to the assessment by ONR specialist inspectors of safety cases for nuclear facilities that may be operated by potential licensees, existing licensees, or other duty-holders. The principles presented in the SAPs are supported by a suite of guides to further assist ONR's inspectors in their technical assessment work in support of making regulatory judgements and decisions. This Technical Assessment Guide (TAG) is one of these guides.
- 1.2 Nuclear processes are designed on the premise that the facility and equipment in use will retain the reliability claimed in the facility Safety Case, thus ensuring that the hazard presented by, and the risk associated with the process is kept at an acceptably low level. The reliability of the facility will only be assured through the facility's full lifecycle by a process of maintenance which may include refurbishment or replacement of Structures, Systems and Components (SSCs). This process is based upon a sound understanding of the facility, the identification of SSCs important to safety, knowledge of the equipment's ageing mechanisms and the support of a programme of Examination, Inspection, Maintenance and Testing (EIMT).
- 1.3 Comments on this TAG, and suggestions for future revisions, should be recorded on the appropriate registry file.

2. PURPOSE AND SCOPE

- 2.1 This TAG directly addresses those ONR SAPs [Ref 1] which relate to in-service and throughout facility life EIMT; EMT.1 to EMT.8. It has been written primarily in general terms so that it applies to all engineering disciplines. It should also be noted that EIMT is considered to be an integral part of the operation of a nuclear facility. Many other TAGs make reference to EIMT but more as an adjunct.
- 2.2 The SAPs and this TAG address the need to ensure adequate arrangements are (or will be) in place for the EIMT of the safety systems, and safety related SSCs identified in a safety case. These arrangements should address the need to plan, specify, implement, monitor and review the EIMT activities. Additionally where changes are made to either the facility, equipment or the EIMT regime, they do not result in a lowering of the level of nuclear safety defined in the safety case.
- 2.3 This TAG contains guidance to assist and inform ONR Inspectors in the exercise of their professional regulatory judgement.

3. RELATIONSHIP TO LICENCE AND OTHER RELEVANT LEGISLATION

3.1 **Site Licence Condition 28:** Examination, inspection, maintenance and testing - is of direct relevance to this TAG. LC 28 requires:

1. The licensee shall make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety.
2. The licensee shall submit to ONR for approval such part or parts of the aforesaid arrangements as ONR may specify.
3. The licensee shall ensure that once approved no alteration or amendment is made to the approved arrangements unless ONR has approved such alteration or amendment.
4. The aforesaid arrangements shall provide for the preparation of a plant maintenance schedule for each plant. The licensee shall submit to ONR for its approval such part or parts of any plant maintenance schedule as ONR may specify.
5. The licensee shall ensure that once approved no alteration or amendment is made to any approved part of any plant maintenance schedule unless ONR has approved such alteration or amendment.
6. The licensee shall ensure in the interests of safety that every examination, inspection, maintenance and test of a plant or any part thereof is carried out.
 - a) by suitably qualified and experienced persons;
 - b) in accordance with schemes laid down in writing;
 - c) within the intervals specified in the plant maintenance schedule; and
 - d) under the control and supervision of a suitably qualified and experienced person appointed by the licensee for that purpose.
7. Notwithstanding the above paragraphs of this condition ONR may agree to an extension of any interval specified in the plant maintenance schedule.
8. When any examination, inspection, maintenance or test of any part of a plant reveals any matter indicating that the safe operation or safe condition of that plant may be affected, the suitably qualified and experienced person appointed to control or supervise such examination, inspection, maintenance or test shall bring it to the attention of the licensee forthwith who shall take appropriate action and ensure the matter is then notified, recorded, investigated and reported in accordance with arrangements made under Condition 7.
9. The licensee shall ensure that a full and accurate report of every examination, inspection, maintenance or test of any part of a plant indicating the date thereof and signed by the suitably qualified and experienced person appointed by the licensee to control and supervise such examination, inspection, maintenance or test is made to the licensee forthwith upon completion of the said examination, inspection, maintenance or test.

3.2 These requirements apply to all plant which may affect nuclear safety, and this is taken to include plant which has the potential to affect the safety of nuclear SSCs. Therefore, before a licensee can develop arrangements to address LC28, it must identify all plant which may affect nuclear safety, so that appropriate maintenance may be specified.

3.3 The need for, or performance of, EIMT is considered to be an integral part of the operation of a nuclear facility and hence other Site Licence Conditions are also of relevance, namely:

Site Licence Condition 7: Incidents on the site - any incidents involving EIMT activities which had or may have had an effect on nuclear safety should be recorded, investigated and notified to ONR.

Site Licence Condition 10: Training - the Licensee shall make and implement adequate arrangements for suitable training for all those on site who have responsibility for any EIMT operations which may affect safety.

Site Licence Condition 12: Duly authorised and other Suitably Qualified and Experienced Persons - only Suitably Qualified and Experienced Persons shall perform EIMT activities which may affect nuclear safety.

Site Licence Condition 14: Safety documentation - the safety case for the facility, including the identification of EIMT, is produced and assessed by the licensee under this condition, which also requires documentation to be submitted to ONR on request.

Site Licence Condition 15: Periodic review - the adequacy of the Licensee's safety case should be reviewed in terms of EIMT against the current operating conditions, Operating Experience (OpEX), statutory requirements and modern techniques to ensure that there have been no significant changes sufficient to invalidate the safety case.

Site Licence Condition 17: Management systems - adequate quality assurance arrangements shall be implemented for all EIMT activities.

Site Licence Condition 20: Modifications 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.

Site Licence Condition 21: Commissioning – the Licensee should take the opportunity to both demonstrate the practicality of EIMT activities and gather baseline plant data during commissioning.

Site Licence Condition 22: Modification or experiment on existing plant - such modifications should be assessed to ensure that they do not impact adversely on EIMT and any additional EIMT for new equipment should be identified.

Site Licence Condition 23: Operating rules 23(1) - 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 interest of safety. Such conditions and limits shall hereinafter be referred to as operating rules.

Site Licence Condition 24: Operating instructions 24(1) - 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.

Site Licence Condition 25: Operational records - the licensee shall ensure that adequate records are made of EIMT activities which may affect nuclear safety.

Site Licence Condition 26: Control and supervision of operations - EIMT activities which may affect nuclear safety shall be carried out under the control and supervision of suitably qualified and experienced persons appointed for that purpose by the licensee.

Site Licence Condition 27: Safety mechanisms, devices and circuits - EIMT activities shall not be carried out unless suitable and sufficient safety mechanisms, devices and circuits are properly connected and in good working order.

Site Licence Condition 29: Duty to carry out tests, inspections, and examinations - the licensee shall carry out such tests, inspections and examinations in connection with any plant (in addition to any carried out under LC28) as ONR may specify.

Site Licence Condition 30: Periodic shutdown - when necessary for the purposes of enabling any EIMT of any plant or process to take place, the licensee shall ensure that any such plant or process shall be shut down in accordance with the requirements of its plant maintenance schedule referred to in LC28.

Site Licence Condition 31: Shutdown of specified operations - the licensee shall, if so directed by ONR, shut down any plant, operation or process on the site within such period as ONR may specify.

- 3.4 The Energy Act 2013 has the nuclear safety sections of the Nuclear Installations Act 1965 as Relevant Statutory Provisions. Other relevant regulations also place legal obligations on licensees for EIMT, some of these being, the Ionising Radiations Regulations, Management of Health and Safety at Work Regulations, Lifting Operations and Lifting Equipment Regulations, Provision and Use of Work Equipment Regulations ; Pressure Systems Safety Regulations; and Construction (Design and Management) Regulations. Such legislation applies to nuclear installations and should be considered by Nuclear Inspectors in addition to the specific requirements of the Licence Conditions. **Users should assure themselves that they are using the current version of these Regulations.**

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

4.1 The SAPs (2014 Edition Revision 0) directly addressed by this TAG are:

4.1.1 EMT.1 to EMT.8 in the section of the 2014 SAPs entitled Maintenance, inspection and testing.

4.1.2 The Key Engineering Principle EKP.3 'Defence in Depth' states that "Nuclear facilities should be designed and operated so that defence in depth against potentially significant faults or failures is achieved by the provision of multiple independent barriers to fault progression". Table 1 of the SAPs identifies the first level as 'prevention of abnormal operation and failures by design' with maintenance identified as one of the essential means of achievement.

4.1.3 There are numerous other SAPs within the Engineering Principles where the need for maintenance is addressed. Instead of drawing these out here, they are referenced as appropriate in the section of this TAG devoted to advice (Section 5).

4.1.4 There are a number of other SAPs that are relevant to the assessment of EIMT. The list below provides guidance on these in the listing order of the 2014 Edition of the SAPs:

- MS.2: Capable organisation
- SC.2: Safety case process outputs
- SC.4: Safety case characteristics
- SC.6: Safety case content and implementation
- SC.7: Safety case maintenance
- EQU.1: Qualification procedures
- ERL.2: Measures to achieve reliability
- EAD.2: Lifetime margins
- ELO.1: Access
- EMC.22: Material compatibility
- EES.4: Sharing with other facilities

4.1.5 An inspector assessing the provisions for EIMT should be aware of ONR's general expectations for the Licensees' development of safety cases (NS-TAST-GD-051) and from experience of the assessment of the EIMT arrangements the following TAGs may also be relevant:

- NS-TAST-GD-005 Demonstration of ALARP
- NS-TAST-GD-026 Decommissioning
- NS-TAST-GD-030 Probabilistic Safety Analysis
- NS-TAST-GD-050 Periodic Safety Reviews
- NS-TAST-GD-057 Design Safety Assurance
- NS-TAST-GD-094 Categorisation of Safety Functions and Classifications of Structures, Systems and Components

4.1.6 Inspectors in particular disciplines will have recourse to specific TAGs (for example NS-TAST-GD-016 & /017 for metal components and structures and civil structures respectively).

4.2 WENRA Reference Levels (RLs) and IAEA Safety Standards and Guide

4.2.1 The update of this TAG considers the Western European Nuclear Regulators' Association [Ref 2] (WENRA) and International Atomic Energy Agency [Ref 4 to 9] (IAEA) publications for specific applicability. It should be noted that the SAPs are intended for both existing and new facilities whereas the WENRA Reactor Safety Reference Levels are intended for existing reactors. 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 and so do not have the same broad scope intent of the SAPs and this TAG. Section 4 of NS-TAST-GD-005 identifies the WENRA RLs as Relevant Good Practice for existing civil nuclear reactors

4.2.2 WENRA Reference Level Issue K is dedicated to EIMT with the following worthy of note during assessment of Licensees' EIMT arrangements:

- the need for the preparation and implementation of documented programmes of EIMT 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 EIMT should be determined using a systematic approach;
- the impact of maintenance on plant safety is to be assessed using data from plant EIMT;
- SSCs important to safety are to be designed with ease of EIMT to demonstrate integrity and functional capability over the plant lifetime;
- proven alternative approaches may be specified and other safety precautions taken to compensate for the potential for undiscovered failures where EIMT provisions are not attainable; and
- the need for configuration control to permit plant to be removed from service before testing and then for return to service.

4.2.3 The comprehensive EIMT requirements that are reflected in many of the ONR SAPs demonstrate that WENRA RL Issue K requirements are addressed in the UK approach to regulation. Indeed many of the other RL Issues, not directly related to EIMT, mention the need for EIMT in much the same high level way as in the SAPs.

4.2.4 The following IAEA Safety Standards and Guides make reference to the need for EIMT as a means of gaining assurance that the design intent is maintained in all disciplines of nuclear engineering and safety assurance. Appendix 2 provides further details from the IAEA publications in so far as they address EIMT and how it is an integral part of the design and operation of nuclear power plant:

- SSR-2/1 Safety of Nuclear Power Plants: Design [Ref 4]
- NS-G-2.6: Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plant [Ref 5];

- INSAG 19: Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life [Ref 6];
- INSAG 14: Safe Management of the Operating Lifetime of Nuclear Power Plants [Ref 7].

4.3 The guidance for EIMT contained in the above IAEA documents is addressed in the UK approach to regulation of nuclear facilities.

5. ADVICE TO INSPECTORS

5.1 Fundamentals

5.1.1 EIMT requirements, including specification of what is to be done and its periodicity should be identified in the safety case, taking account of any reliability claims.

5.1.2 There should be traceability of EIMT requirements from the safety case through the Plant Maintenance Schedule to Maintenance Instructions.

5.2 Background to Nuclear Industry Examination, Inspection, Maintenance and Testing Practices and Operational Experience

5.2.1 In preparation for assessment of any nuclear safety related documentation on EIMT submitted to ONR, it is important to understand the evolution of the processes involved in developing such documents. Nuclear industry EIMT practices have evolved over the last six decades from when there were no nuclear facilities and hence no operational experience. Nuclear facility development, Research and Development (R&D) activities, pilot programmes and operational experience have all contributed to an improved understanding of nuclear safety, and evolving operational practices including EIMT.

5.2.2 It follows that the likelihood of being required to assess a totally novel nuclear facility with its operational requirements for EIMT is low, however, there is a likelihood that novel design features for modifications to existing facilities and for new build facilities will be encountered. Such novel features should require R&D programmes and pilot testing prior to consideration of deployment in an operational environment. Testing, Inspection and Examination is required during any installation and commissioning phase (SAPs ECM.1), and operation (SAPs EMT.7), coupled with maintenance, to confirm the adequacy of the facility in safety terms. (SAP para 281 is typical of the statements ONR makes about accepting sound engineering, or novel approaches backed by R&D, plus testing before service, and monitoring during service.)

5.3 Examination, Inspection, Maintenance and Testing through Facility Life

5.3.1 The provisions of EIMT are relevant to the whole life cycle of a nuclear facility from 'cradle to grave'. The nature and balance of these provisions, and hence the associated regulatory expectations, change during the various stages of the life cycle. Ref. 10 provides a narrative of the various lifecycle stages including the development of the design and safety assessment, construction, commissioning, operations and finally decommissioning. The narrative provides an overview as to how EIMT requirements should be developed and subsequently implemented along with a number of examples.

5.3.2 Inspectors should consider the following areas during a review of Licensee's EIMT arrangements.

5.3.3 Design & Safety Case Development

- Inspectors should confirm that the developing safety case identifies the nature and periodicity of EIMT proposed and provides a justification for any long term performance claimed without such EIMT. Whenever the latter claim is made, the Inspector should confirm the adequacy of the additional design measures incorporated to justify the absence of EIMT or the alternative arguments cited in support of such a claim.
- Inspectors should consider whether the EIMT being specified, and standards selected, for the various SSCs are to a level of quality commensurate with their Safety Classification (SAPs EKP.5, ECS.2 & ECS.3). The Classification of SSCs, which is discussed further in NS-TAST-GD-094, is based on their nuclear safety significance.
- Inspectors should consider the Licensee's arrangements for developing a listing of all facility EIMT, selecting those items that will be undertaken as routine maintenance and those items important to nuclear safety that will be placed on the Plant Maintenance Schedule as required by Licence Condition 28(4).
- A key element of the arrangements should be continuity from the identification of SSCs in the safety case through to the Plant Maintenance Schedule, to the maintenance instructions (which may be termed job plans). This continuity should include the ability to readily identify the SSC classification and safety functional requirement for an SSC from anywhere within the chain of documents, e.g. by clear SSC cross-references between the different layers of documents.
- Inspectors should note that whilst the requirement for a Plant Maintenance Schedule in Licence Condition 28(4) is applicable to plant that may affect nuclear safety, Licensees' may produce a Plant Maintenance Schedule that includes other plant. In such instances, the Inspector should determine whether it is clear as to the items that may affect nuclear safety. A Licensee may split the Plant Maintenance Schedule in to sections such as:
 - Plant (Nuclear Safety) Maintenance Schedule;
 - Statutory Maintenance Schedule;
 - Environmental Maintenance Schedule; and
 - Residual Routine Maintenance Schedule.
- A project manual, or equivalent, should be available defining a process whereby a group of SQEPs from the project team, the safety analysts, the Responsible Engineers and the Licensee's operations staff meet regularly throughout the design, build and inactive commissioning phases to:
 - Review the totality of the Maintenance Catalogue and populate the Plant (Nuclear Safety) Maintenance Schedule, any Statutory or Environmental Maintenance Schedules, and the Residual Routine Maintenance Schedule, based on a shared understanding of the importance of SSCs to nuclear safety, statutory requirements and environmental considerations;
 - Document the reasons for accepting only condition monitoring, or operator surveillance with breakdown maintenance on some plant items; and

- Endorse maintenance instructions generated for all safety significant plant.
- Inspectors should determine whether Licensee's operations staff review the Safety Case Design Basis and Probabilistic Safety Analysis to ensure that the worst plant configurations assumed allow for equipment outages for EIMT activities (SAP FA.6, NS-TAST-GD-036 Diversity, redundancy, segregation and layout of mechanical plant).
- Inspectors should confirm that adequate provisions have been made during the design process for through life EIMT of the facility with particular attention given to ensuring that radiation doses to EIMT operatives remain as low as reasonably practicable throughout the facility life and that adverse interactions with other SSCs are minimised, as described by SAP ELO1.
- Inspectors should look for evidence that the proposed EIMT is adequate to maintain the equipment design intent in terms of the nuclear safety functions identified in the safety analysis.
- Licensees should have a process for capturing project assumptions related to EIMT generated by the ongoing design and safety analyses, along with an auditable record of where these assumptions are discharged in operational documents.
- Where appropriate, Inspectors should look for evidence that Probabilistic Safety Analysis (PSA) has been used in determining appropriate EIMT strategies, both in terms of identifying when it is acceptable for safety important equipment to be released for EIMT and the extent to which the proposed EIMT activities provide the required level of assurance that safety case reliability claims are met (SAP FA.14).
- Inspectors should look for evidence that adequate development work on novel systems or components is undertaken between concept design and manufacturing as such work may have significant impact on the EIMT tasks defined within the evolving maintenance schedules.
- Licensee's maintenance and operations staff should be involved in the project from an early stage so that they can both ensure that adequate provisions are made for EIMT and gain an appreciation of the design intent to support the Licensee's Design Authority and Intelligent Customer roles.

5.3.4 Manufacture and Works Tests (Factory Acceptance Tests)

- Inspectors should look for evidence of the trialling of EIMT instructions during the manufacturer's works tests / trial builds for more complex and large plant.
- Works tests should be formally documented and captured in the Licensee's operational documentation as the baseline for ongoing demonstration that the design intent of the facility is maintained.

5.3.5 On Site Plant Installation, Facility Acceptance Tests and Commissioning (Site Acceptance Tests)

- Inspectors should look for evidence that plant changes during installation and testing are adequately assessed in terms of identifying commensurate effects on the proposed EIMT arrangements. Such

changes may result in the need to modify the Maintenance Schedules and Maintenance Instructions.

- For equipment of particular concern and where it is not possible for tests to confirm the ability to operate under the most onerous design conditions the Inspector should look for justification of the components performance and reliability from additional analysis utilising available data from commissioning or rig testing. Reference data should be taken from type testing to establish a baseline for comparison against in-service performance (SAPs EMT.3).
- Inspectors should confirm that inactive commissioning includes the validation of Maintenance Instructions, particularly where access will be restricted once active commissioning has commenced.
- Inspectors should confirm that human factors assessments of EIMT tasks are undertaken, as appropriate, during testing and commissioning looking in particular for error traps, and common cause failure mechanisms created by the procedures or by actions of operatives.
- Inspectors should look for demonstration during inactive commissioning as to the effectiveness of plant and equipment isolations or plant substitutions required for EIMT. Part of this demonstration should also prove any return to service procedures as these may differ from plant isolation procedures.
- As a project proceeds Inspectors should look for evidence that changes to the Maintenance Schedule and Maintenance Instructions are documented along with records of the consideration and agreement by all relevant project, safety, and operations disciplines, thus demonstrating comprehensive acceptance.
- Inspectors should consider to what extent the commissioning will demonstrate the proposed in-service test regime for each part of any such system as well as the whole system (SAPs EMT 5 and 6 - Adoption of test procedures and provision of EIMT commensurate with the reliability required).
- Where an EIMT activity to satisfy a safety requirement is shown on the appropriate assumptions database, cross references to where its safety role is defined within the nuclear safety case, unique numbers for the test documents, maintenance instruction number and completion sign off for inactive commissioning should be evident.
- Inspectors should determine that a Licensee has appropriate arrangements for declaring and justifying when the periodicity or written scheme requirements for each entry on the Maintenance Schedule are to start.
- Inspectors should confirm that the Completion of Inactive and Active Commissioning Reports not only describes what has been tested, but changes that have resulted from construction modifications, facility testing and commissioning and any changes to the Maintenance Schedules and Maintenance Instructions.
- Inspectors should determine whether a Licensee has adequate arrangements for maintaining installed plant and equipment prior to it being put into operational service.

5.3.6 Operations

- Inspectors should consider whether EIMT for the various SSCs is specified, standards selected and the work undertaken to a level of

quality commensurate with their safety Classification (SAPs EKP.5, ECS.2 & ECS.3).

- Attention should be paid to the following safety case concerns:
 - Confirmation that any safety case requirements for staggered testing are translated into the Maintenance Schedule;
 - Confirmation that, in constructing the Maintenance Schedule, the Licensee has considered and demonstrated that the minimum configurations of operational safety systems justified in the safety case will be maintained, and in compliance with any requirements on plant availability derived from consideration of the Single Failure Criterion;
 - Where equipment important to safety is taken out of service for examination, inspection, maintenance or testing, the continuing safety of operations should be justified. Furthermore, the potential for the examination, inspection, maintenance or testing to initiate a fault should be analysed and the risks so arising justified.
- Inspectors should confirm that in service testing of SSCs important to safety prove the complete system and the safety function of the individual components (SAP EMT.7). In all cases the associated reliability analysis should reflect the actual testing carried out.
- Where it is not feasible to test a system end-to-end, Inspectors should look for justification of partial testing, and how the results of each part can be linked to demonstrate continuing achievement of design intent for the whole system.
- The safety case may preclude full in situ testing, in which case alternative arrangements may be necessary, for example the removal and rig testing of a device. Inspectors should consider the adequacy of any alternative arrangements a Licensee has made in such situations (SAP EMT.7).
- Inspectors should pay particular attention to the Licensee's arrangements to ensure re-establishment of the correct plant configuration following EIMT.
- Inspectors should confirm that the safety case assumptions regarding component reliability, which can influence mean time between tests, and performance along with unavailability for EIMT, are adequately reflected in implementation documentation such as Maintenance Schedules and Instructions.
- Inspectors should confirm that the EIMT instructions provide for full and accurate reporting. This should include the recording and reporting of any defects and of any properties or parameters which may need to be monitored to confirm continuing safe operation. Clear criteria for successful completion of the work should be stated and the procedures should provide for the reporting and rectification of non-conformances.

- Arrangements should include monitoring of recorded data to identify trends in failures or gradual degradation over time. (SAPs Para 216)
- The implementation arrangements should ensure that activities are performed and supervised by competent staff using equipment and tools which have been demonstrated to be adequate for the task. In certain circumstances the personnel and equipment may require validation.
- The Maintenance Instructions usually only address direct measurements required or require achievement of pre-defined acceptance criteria. Inspectors should seek confirmation that further examination and trending of lifetime data is undertaken as appropriate by SQEP resource from the Design Authority.
- Inspectors should look for evidence that both safety case and plant changes are adequately assessed by appropriate SQEP to identify commensurate effects on the existing EIMT arrangements and the need for any additional EIMT. Such changes may result in the need to modify the Maintenance Schedules and Maintenance Instructions.
- Inspectors should establish whether the Licensee has adequate EIMT arrangements for equipment provided to support the facility's emergency arrangements.
- Inspectors should confirm that the Licensee has adequate arrangements for identifying (OpEX) of relevance to EIMT and responding accordingly (this should include both OpEX from the Licensee's activities and external OpEX).
- Licensees should have adequate arrangements for managing Foreign Material Exclusion (FME) during EIMT activities on the facility (e.g. FME control points, FME covers, use of lanyards and logging of tools). See Ref. 11 for further guidance.
- Inspectors should visit Licensee's maintenance facilities / workshops for safety important SSC's to determine whether the housekeeping and work practices are adequate with respect to both FME and quality control. See Ref. 11 for further guidance.
- Licensees should make adequate provisions for the secure, quarantined storage of overhauled safety important equipment prior to it being re-installed on the facility. See Ref. 11 for further guidance.
- Inspectors should seek confirmation that a Licensee has a formal process for EIMT operatives to identify shortfalls, inconsistencies or discrepancies in EIMT procedures, along with evidence that the operatives are encouraged to use the process and that the process provides a mechanism for dealing with the observations raised.
- Where a Licensee's maintenance arrangements are based on generic approaches Inspectors should seek evidence that the facility safety case provides appropriate justification. Such approaches include:

- Reliability Centred Maintenance
- Condition Monitoring
- Planned Maintenance
- Preventative Maintenance
- Risk Based Maintenance
- Run to Failure (Corrective) Maintenance
- Inspection Based Maintenance

5.3.7 Outages

- Inspectors should establish prior to Licensee's pre-planned facility shutdowns (usually termed Outages) that a programme of work has been prepared such that all nuclear safety significant Plant Maintenance Schedule items needing EIMT are covered.
- Inspectors should establish that the programme of work provides the necessary coverage of the facility (within an overall long term plan) and includes all additional work identified as necessary as a result of previous inspections, commitments or safety concerns identified during operation of the facility or arising from generic concerns.
- The outcome from such EIMT should be assessed by SQEP personnel from the Licensee's Operational and Design Authority Organisations.
- Inspectors should confirm that all EIMT activities will be carried out to written procedures, and that appropriate arrangements are in place for the independent checking (by sampling) of inspections to confirm that appropriate quality is maintained.
- Licensees' arrangements for the reporting and review of results, categorisation and sentencing of defects, including where appropriate independent assessment, and reporting the overall results should be assessed to confirm overall acceptability.
- Particular attention should be given to the process whereby the licensee ensures that, where there is a regulatory or procedural control over restart, all findings which are pertinent to the safety justification for the restart are provided for timely consideration by Inspectors.
- Procedures should be sampled to confirm that they contain clear and adequate instructions, guidance on reporting criteria and provide adequate means of spatially identifying and recording both items inspected and any features or defects observed.
- Inspectors involved in the review of a sample of inspection findings should, while guided by the need to concentrate particularly on matters of greatest safety significance, include in the sample a range of

inspections to confirm the general adequacy of conformance to relevant procedures.

- Inspectors should review the final outage inspection reports or any equivalent reports and appropriately advise if any of the matters reported raise new concerns which should be considered in the context of restart. They should also review the reports to confirm that the licensee has considered and adequately addressed any trends in the results of the inspection etc.
- Outage periodicity has to be demonstrated to be consistent with the requirements of design integrity assurance. Such assurance requirements are drawn out from within design reports or safety analyses and are defined within Safety Cases. When changes to outage periodicity are requested by a licensee there may be a need for a multi-discipline review by the nuclear regulator.

5.3.8 Plant Not Used Continuously

- Some Licensees use some of their plant and equipment when required, e.g. to support the work carried out on a submarine in a dock, and do not set a periodicity for its EIMT. Instead, the Licensee identifies that appropriate EIMT is to be carried out prior to the plant being used.
- Inspectors involved in the review of the planned EIMT for such plant should consider whether the Licensee has adequately addressed the potential deterioration of the plant in periods between use in determining the required EIMT.

5.3.9 Verification of EIMT

- The Licensee should have a process for verification of maintenance implementation, with the depth and breadth of verification graded in relation to the importance to nuclear safety of the equipment and associated EIMT. This should specifically include an appropriate level of physical verification of EIMT on the facility.

5.3.10 Periodic Safety Reviews

- The Periodic Safety Review (PSR) process should demonstrate the ongoing adequacy of EIMT regimes by describing plant failures, anomalies and the means found for rectification.
- Confirmation should be provided that cumulative data from EIMT continues to support the reliability claims made within the safety case.
- Inspectors should look for evidence that Licensees are adopting the latest good practices for EIMT.
- For further guidance on PSRs refer to NS-TAST-GD-050 Periodic Safety Reviews.

5.3.11 End of Routine Operations

- Inspectors should consider the extent to which any reductions in EIMT are supported by revised safety cases for the various phases of facility decommissioning.
- For further guidance on Decommissioning refer to NS-TAST-GD-026 – Decommissioning on Nuclear Licensed Sites.

6. REFERENCES

1. Safety Assessment Principles for Nuclear Facilities ONR 2014 edition Revision 0
2. Western European Nuclear Regulators Association (WENRA). Reactor Harmonization Group. WENRA Reactor Reference Safety Levels. WENRA. September 2014. www.wenra.org.
3. International Atomic Energy Agency (IAEA) documentation

A listing of IAEA documents, showing current status may be found at:

<http://www-ns.iaea.org/committees/files/CSS/205/status.pdf>

4. IAEA Safety of Nuclear Power Plants: Design, Specific Safety Requirements SSR-2/1 (Rev.1) 2016.
5. IAEA NS-G-2.6, Safety Guide, Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plant, 2002.
6. IAEA International Nuclear Safety Advisory Group series of reports, Report INSAG 19, Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life.
7. IAEA International Nuclear Safety Advisory Group series of reports, Report INSAG 14, Safe Management of the Operating Lifetimes of Nuclear Power Plant
8. IAEA, Nuclear Energy Series, No. NP-T-3.8, Maintenance Optimization Programme for Nuclear Power Plants, 2018.
9. IAEA, Safety Guide, Maintenance, periodic Testing and Inspection of Research Reactors, 2006.
10. ONR archive, Trim 2015/433840 (former Appendix 3 of this TAG), EIMT requirements throughout the lifetime of a nuclear facility.
11. ONR General Guidance for Mechanical Engineering Specialism Group, NS-TAST-GD-102.
12. NNVF Discussion Document – Guidance on Maintenance of Nuclear Ventilation Systems, Draft A, Nov 2018, TRIM 2018/385488. [it is noted that, at the time of writing, this is a draft document and so ONR cannot endorse it at present].

7. GLOSSARY AND ABBREVIATIONS

ALARP	As low as reasonably practicable
BPEO	Best Practicable Environmental Option
BSL	Basic Safety Level
BSL(LL)	Basic Safety Level (legal limit)
BSO	Basic Safety Objective
CBA	Cost Benefit Analysis
CCF	Common Cause Failure
CNS	Civil Nuclear Security (Office for Nuclear Regulation)
DBA	Design Basis Analysis
DBE	Design Basis Earthquake
DEPZ	Detailed Emergency Planning Zone
EIMT	Examination, Inspection, Maintenance and Testing
FM	Foreign Material
FME	Foreign Material Exclusion
HSE	Health & Safety Executive
HSWA74	The Health and Safety at Work etc Act 1974
IAEA	International Atomic Energy Agency
LC	Licence Condition
NDA	Nuclear Decommissioning Authority
NEPLG	Nuclear Emergency Planning Liaison Group
NNVF	National Nuclear Ventilation Forum
OBE	Operating Basis Earthquake
OEM	Original Equipment Manufacturer
ONR	Office for Nuclear Regulation
OpEX	Operational EXperience
PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
R&D	Research and Development
RCA	Radiologically Controlled Area
RL(s)	Reference Level(s)
SAP(s)	Safety Assessment Principle(s)
SFAIRP	So far as is reasonably practicable
SEPA	Scottish Environment Protection Agency
SM(s)	Safety Mechanisms
SQEP	Suitably Qualified and Experienced Person

SSCs	Structures, Systems and Components
TAG(s)	Technical Assessment Guide(s)
WENRA	Western European Nuclear Regulators' Association

8. APPENDICES

Appendix 1: Definitions

A1.1 Examination

In this TAG the term 'Examination' is considered interchangeable with the term 'Inspection'

A1.2 Inspection

The observations and taking of measurements associated with structures, systems and components using visual, electronic or other means, and the recording of data obtained along with assessment against predefined acceptance criteria.

A1.3 Facility

An asset (including associated buildings and equipment) in which nuclear material is produced, processed, used, handled, stored or disposed of, if damage to or interference with such facility could lead to the release of significant amounts of radiation or radioactive material.

A1.4 Maintenance

The replacement, repair or adjustment of plant, equipment or components.

A1.5 Testing

The monitoring of the operation, actuation, condition or state of the facility, equipment or components under either normal operation or special conditions.

A1.6 Surveillance

A programme of observations and EIMT used to maintain and improve equipment availability, to confirm compliance with operational limits and conditions, and to detect and correct any abnormal condition before it can give rise to significant consequences for safety. These abnormal conditions include not only deficiencies in SSCs and software performance, procedural errors and human errors, but also trends within the acceptable limits, an analysis of which may indicate that the facility is deviating from the design intent. (From WENRA Reference Level H).

A1.7 Safety System

A system which acts in response to a fault to prevent or mitigate a radiological consequence.

A1.8 Safety Related System

A plant system, other than a safety system, on which radiological safety may depend.

A1.9 Design Authority

No formal ONR definition exists but for the purposes of this guide the following definition (which comes from Ref 9) for 'Design Authority' may be used: the entity that has the overall responsibility for the design process; approves design changes; and is responsible for ensuring that the requisite knowledge is maintained.

APPENDIX 2: IAEA SAFETY STANDARDS AND GUIDES

A2.1 Design

Within the Safety Standards Series the IAEA has produced a Safety Guide “Safety of Nuclear Power Plants Design” SSR-2/1 [Ref 4]. The document develops a concept of moving from the principles of design for defence in depth through a process of documented design development. Within this process knowledge of the design integrity is maintained under a formally designated entity within the Architect/Engineer/Vendor area. Later, in a manner and at a time described in the Nuclear Power Plant’s Project Manual, the knowledge base moves from this design organisation to the operating organisation’s technical offices during the phased commissioning part of the plant’s life cycle, and in so doing becomes the Design Authority. There will be formal arrangements for the Design Authority to retain the services of the design organisations to maintain assurance of design intent after this move. This design process is complemented by a comprehensive safety analysis process, running in parallel, which is also under the responsibility of the designated entity. The SSR-2/1 document has many sections dealing with the need for use of EIMT to gain assurance that design intent is met in all disciplines of nuclear engineering, and in safety assurance.

A2.2 Maintenance, Surveillance, and In Service Inspection

The IAEA has also produced a Safety Guide on “Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plant” NS-G-2.6 [Ref 5]. This document again covers the need for a systematic approach for evaluation of the safety importance of SSCs to determine the necessary maintenance, surveillance and in service inspection activities, suggesting a proactive, reliability centered approach. This systematic approach is to be performed in such a manner that it establishes which maintenance tasks are to be performed and at what periodicity. The content of the guide is similar to that for SSR-2/1 [Ref 4] however, a few topics of importance are to be highlighted.

NS-G-2.6 [Ref 5], paragraphs 3.9 and 3.10 give prominence to the involvement of designers and manufacturers. This is necessary to ensure that the EIMT programme is based on clear understanding of the design philosophy and/or the manufacturing technology plus the technical details of the plant. These design and manufacturing organisations can also contribute to the training of the operating organisation’s staff. It is suggested that the operating organisation should have long-term access to the design and manufacturing organisations, possibly requiring special commercial arrangements to ensure continuity of access. Additionally the guide states that it is essential that when faults occur or modifications are required effective assistance from these organisations must be ensured. In assuming this role the design/manufacturing organizations become responsible engineers/designers under the Design Authority.

The generic term surveillance is used throughout the document whereas in the SAPs specific terms such as examination, inspection, monitoring or testing are used. Definitions from the IAEA Glossary and other definitions of some of these terms are included in Appendix 1 of this TAG.

A2.3 Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life

In the IAEA International Nuclear Safety Advisory Group series of reports, Report INSAG 19 [Ref 6] discusses the problem of maintaining the design integrity of a nuclear power plant over its entire lifetime and also offers some solutions. Although the technical offices of the operating organisation will be the entity with an overview of the whole plant design (the Design Authority lead), it may assign some responsibility for design integrity of defined parts of the plant to “responsible designers”, whilst retaining Intelligent Customer status. This combination of formally designated parts of the operating organisation’s technical offices and contracted

responsible designers is the Design Authority mentioned in IAEA Safety Documents. Consultation with the Design Authority becomes important when determining the adequacy of results from EIMT and agreeing to design or EIMT changes that may be needed as a result of such activities.

A2.4 Safe Management of the Operating Lifetime of Nuclear Power Plants

In the IAEA International Nuclear Safety Advisory Group series of reports, INSAG 14 [Ref 7] is a further report that suggests general safety objectives for safe management of the operating lifetime of nuclear power plant, reflecting on the ageing processes that can degrade the integrity of structures and components over time.

In paragraph 15 of the report it states that:

“There is an essential linkage between the operating lifetime of a nuclear power plant, which depends on the evaluation of age related degradation effects and on the determination of the capability to manage those effects, and the surveillance, monitoring, inspection, testing and engineering evaluation activities.”

“It requires a comprehensive assessment of all of the relevant factors, including the periodicity of the programmes, the rigor of acceptance criteria, the extent of corrective actions and the exposure of personnel. This assessment ensures that the management of ageing effects through operation and maintenance strategies guarantees that the safety functions of the structures systems and components will continue to be performed.”

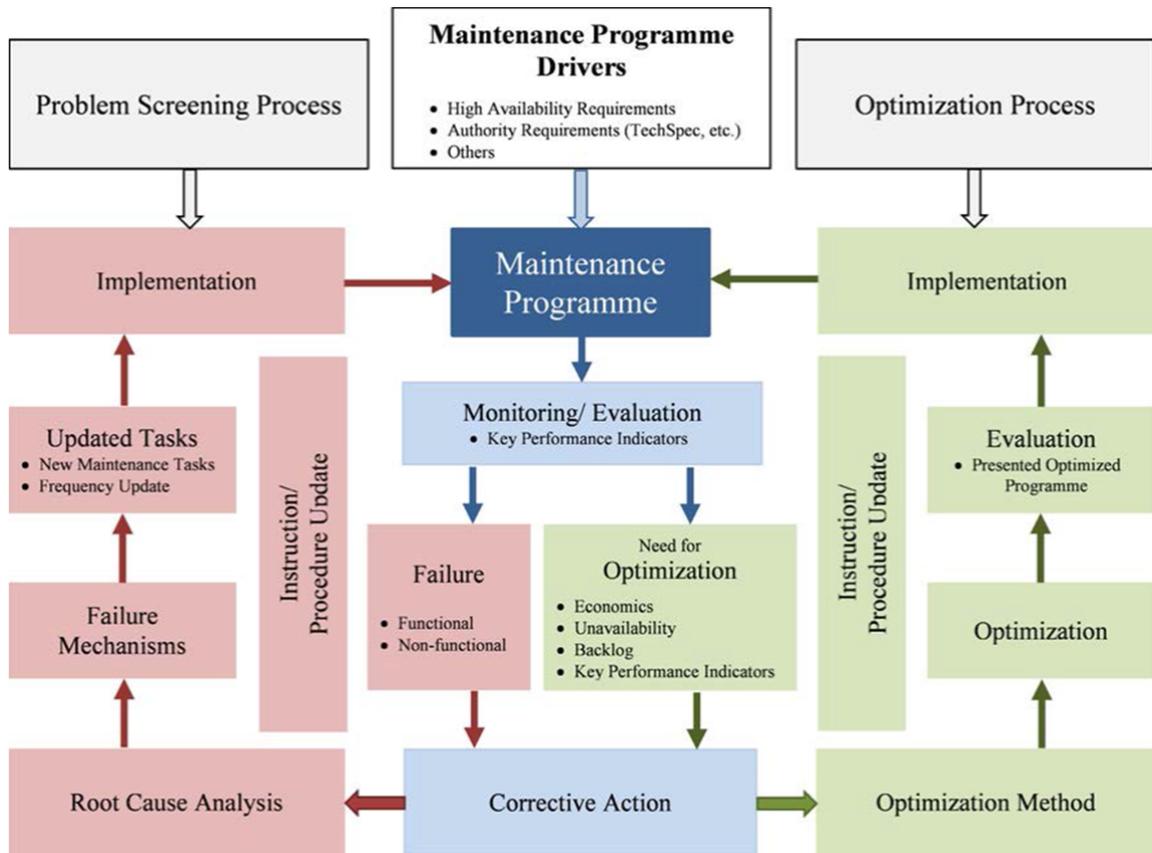
In order to meet the safety objectives, adequate provision is made to confirm that the characteristics of the various structures, systems and components related to the safety of the plant remain better than the limiting characteristics considered at the design stage. The effective application of this implies:

- The limiting functional characteristics are defined and reviewed;
- Degradation mechanisms are identified and monitored;
- Results are used to predict residual lifetime; and
- A maintenance policy is put in place to keep the safety characteristics within allowable ranges by adjustment, repair or replacement.

A2.5 IAEA, Nuclear Energy Series, No. NP-T-3.8, Maintenance Optimization Programme for Nuclear Power Plants, 2018.

This new document advises that “Maintenance optimization helps to ensure that the right tasks are being performed on the right equipment at the right time. A systematic and continuous approach in establishing which maintenance tasks and at what frequency are to be performed on which SSCs help to optimize the use of resources, increase equipment reliability and minimize risks to workers and to the environment.”. Figure 3 of the document (copied as Fig 1 below) is a useful diagram in order to both consider maintenance optimization and also any OPEX that the organisation is aware of. Ref. 12 also seeks to optimize maintenance but is concerned only with nuclear ventilation systems.

A review of the ONR INF1 database over the 2015 to 2018 period was undertaken to identify any incidents linked to EIMT. It was noted that EIMT does uncover issues with SSCs and so consideration should be given to the adequacy of the frequency of EIMT activities. Similarly, some SSCs were failing before EIMT is due, which again indicates a potential issue with the frequency of EIMT activities. Some evidence was found for poor record keeping of EIMT activities and there were also several examples of EIMT activities being missed without any justification. There was one example of EIMT actually causing damage to SSCs as a result of the activity.



Appendix 2, Figure 1 – Lifecycle of the maintenance programme (© IAEA, 2018)

APPENDIX 3:

REMOVED IN REVISION 3 SEE FILENOTE TRIM 2015/0433840 FOR REVISION 2 TEXT.

APPENDIX 4: GUIDE TO INSPECTION OF MAINTENANCE FACILITIES

The contents of this appendix have been removed in Revision 4 and moved to a new ONR TAG - **General Guidance for Mechanical Engineering Specialism Group, NS-TAST-GD-102 (Ref. 11)**.