Office for Nuclear Regulation

ONR GUIDE			
Examination, Inspection, Maintenance and Testing of Items Important to Safety			
Document Type:	Nuclear Safety Technical Assessment Guide		
Unique Document ID and Revision No:	NS-TAST-GD-009 - Revision 3		
Date Issued:	November 2015	**Review Date:**	November 2018
Approved by:	D Senior	Programme Director, Regulatory Assurance	
Record Reference:	TRIM Folder 1.1.3.563. (2015/442925)		
Revision commentary:	Routine Update – Appendix 3 removed to file note, Appendix 4 added. SAP and Licence Condition updates Minor text changes for clarity		

TABLE OF CONTENTS

Published 11/15

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 the Licensee to:

- make and implement adequate arrangements for the regular and systematic EIMT of all plant which may affect nuclear safety;
- provide in the arrangements for the preparation of a plant maintenance schedule for each plant;
- ensure in the interests of nuclear safety that EIMT is carried out by and under the control and supervision of suitably qualified and experienced persons in accordance with written schemes and within the intervals specified in the plant maintenance schedule;
- take appropriate action should EIMT reveal any matter indicating that the safe operation or safe condition of the facility may be affected;
- ensure that a full and accurate report of every EIMT activity is made.

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

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

Site License 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 License 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 License 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 License 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 License 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 1999, Management of Health and Safety at Work Regulations 1999, Lifting Operations and Lifting Equipment Regulations 1998, Provision and Use of Work Equipment Regulations 1998 and Pressure Systems Safety Regulations 2000. Such legislation applies to nuclear installations and should be considered by Nuclear Inspectors in addition to the specific requirements of the Licence Conditions.

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 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 Principles 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 3] (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;
- 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. Appendix 3 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;
    - 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.

    - 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 Appendix 4 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 Appendix 4 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 Appendix 4 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. Weston 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 2012 (which replaces NS-R-1)
5. IAEA NS-G-2.6, Safety Guide on Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plant.
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

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
HSWA74	The Health and Safety at Work etc Act 1974
IAEA	International Atomic Energy Agency
NDA	Nuclear Decommissioning Authority
NEPLG	Nuclear Emergency Planning Liaison Group
OBE	Operating Basis Earthquake
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	Reference Level
SAP	Safety Assessment Principle(s)
SFAIRP	So far as is reasonably practicable
SEPA	Scottish Environment Protection Agency
SM	Safety Mechanisms
SQEP	Suitably Qualified and Experienced Person
SSC	Structure, System and Component
TAG	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.

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 3.10 and 3.11 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
- A maintenance policy is put in place to keep the safety characteristics within allowable ranges by adjustment, repair or replacement.

APPENDIX 3:

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

APPENDIX 4: GUIDE TO INSPECTION OF MAINTENANCE FACILITIES

A4.1. INTRODUCTION

A4.1.1 SCOPE OF THIS GUIDANCE

A4.1.1.1 ONR has seen examples where plant condition falls short of expected standards despite adequate written arrangements under LC28 - Examination, Inspection, Maintenance and Testing. The root cause can be attributed to a combination of not properly carrying out EIMT in accordance with the written arrangements, not using suitably qualified persons, not adhering to correct intervals and not having appropriate supervision.

A4.1.1.2 Guidance on EIMT is often limited to preparing the written arrangements with little information about how to properly carry them out. The aim of this appendix is to address this shortfall by presenting examples relevant good practice for EIMT implementation that will help ensure that the licensee satisfies their duty carry out EIMT in accordance with their arrangements.

A4.1.1.3 The guidance may assist ONR inspectors or others responsible for judging a duty holders ability to adequately carry out EIMT in accordance with their written arrangements. The principles in this appendix are relevant to a number of disciplines where implementation of EIMT is of interest.

A4.1.2 STATEMENT OF THE PROBLEM

A4.1.2.1 Intelligence from ONR inspections indicates that shortfalls can be categorised into one of the following types:

- Foreign materials remaining inside critical plant after maintenance activities;
- Foreign materials dropped into open plant during maintenance;
- Incorrectly specified, damaged, un-traceable or incompatible components used during maintenance activities;
- Non serviceable parts inadvertently fitted during maintenance;
- Incorrect parts fitted during maintenance;
- Poor quality assurance and quality control arrangements leading to fitting spare parts that do not meet original design specification:
- Incorrect maintenance procedure selected, or correct procedure selected but not properly implemented;
- Use of equipment or tools that are out of calibration or inappropriate for the intended purpose;
- The wrong plant inspected, tested or maintained.

A4.1.2.2 The expectation is that adequate implementation of EIMT is achieved when good practice is evident in the following areas:

I. Foreign material exclusion
II. Control of spares
III. Housekeeping
IV. Appropriate maintenance facilities
V. Suitably Qualified, Experienced and Skilled Persons (SQEP)

VI. Appropriate written instructions

VII. Appropriate work standards

VIII. Appropriate control and supervision of EIMT activities

A4.1.3 SOURCE MATERIAL FOR THIS APPENDIX

A4.1.3.1 Industries requiring a higher degree of reliability including, nuclear, oil and gas, chemical and aviation all require higher standards of implementation for maintenance arrangements. The consequences of plant failures due to poor EIMT can be mitigated by having diverse and redundant plant. However, diversity and redundancy should not be relied upon, instead of good EIMT, to ensure plants will remain safe.

A4.1.3.2 To ensure adequate implementation of EIMT it is necessary to adhere to strict arrangements that ensure EIMT is adequate for the plant in question. For example, the aviation industry follows implementation principles based on Civil Aviation Authority guidance [CAA guidance document B-150]. ONR inspectors visited the aircraft maintenance and servicing facility of a major passenger airline to observe the implementation of such standards. The same ONR inspectors also visited several nuclear power generation sites and areas of good practice from both these sources have been referred to in this appendix.

A4.2. GUIDE FOR INSPECTION OF MAINTENANCE FACILITIES AND MAINTENANCE PRACTICE

A4.2.1 ORGANISATIONAL FACTORS

A4.2.1.1 Maintenance should be well planned allowing sufficient time to complete tasks safely. Managers should ensure staff are not subjected to pressures that might lead to them taking shortcuts. Planning should be supported by an open and transparent process where operatives are able to report concerns to management without recrimination.

A4.2.1.2 A continuous improvement culture should be evident. For example management should continually review performance, reinforce and share good practice and correct deficiencies. Maintenance professionals should be capable of reviewing the effectiveness of maintenance programmes and suggesting corrective action if appropriate.

A4.2.2 DOCUMENTATION REQUIREMENTS

A4.2.2.1 Valid up to date maintenance manuals should specify each task with sufficient detail and be referenced on the work instructions. The level of detail in the manual may vary but must be sufficient to ensure appropriate standards and ensure consistency. Maintenance manuals can also assist with knowledge management by capturing sufficient written knowledge and experience form senior technicians for use by those with less experience. Suitable contingency arrangements should be in place to ensure key maintenance documents are available in emergency situations.

A4.2.2.2 Maintenance documentation should be followed at all times and even experienced technicians should avoid making seemingly obvious decisions outside of procedures. Any deviation from procedure should follow internal arrangements for change. If deviations from procedure are foreseeable due to the nature of the plant, it may be beneficial to nominate authorities who can decide to deviate from procedure. Amended (red penned/lined) documents should be submitted through the official review process. However, this should be a rare occurrence used only to drive up standards and levels of consistency.

A4.2.2.3 Manuals should be readily available in a clear, organised and structured manner. Colour coding is a useful way to distinguish between similar tasks or for highlighting safety critical tasks. Photographs, drawings, and diagrams all help with consistency.

A4.2.2.4 When exiting a Radiologically Controlled Area (RCA), there is sometimes a requirement to manually copy information onto 'clean' paper to control the spread of contamination. To avoid the potential for copying errors, consideration should be given to providing facilities in the RCA for electronically scanning documents. Similarly, electronic media, sent to monitor screens near workstations, reduces the amount of paper taken into radioactively controlled areas and gives greater flexibility for handling, storing and presenting information.

A4.2.3 TRAINING

A4.2.3.1 Suitable training is essential to establish, maintain and develop SQEP resource. Training programmes for maintenance technicians should include a focus on safety critical tasks and address the possible consequences of failing to follow the associated maintenance procedures. Training programmes should endeavour to capture knowledge from experienced maintenance staff and experts.

A4.2.3.2 Arrangements should be in place for staff, at every level to capture the knowledge necessary for those doing the job. For example, having procedures to enable technicians to suggest improvements to the way in which maintenance is undertaken not only boosts quality improvements but also encourages ownership of challenges. Successful arrangements require willingness of management to take all suggestions seriously, commit to any necessary investment and be prepared to give reasonable deadlines for a response. Positive and negative responses may be offered although management should justify a negative response in an open and transparent manner.

A4.2.4 MAINTENANCE OF SAFETY MECHANISMS

A4.2.4.1 Maintenance standards may not be consistent across all plant categories. Maintenance of Safety Mechanisms (SM's) or essential systems are likely to require additional organisational considerations. The determination of SM's is beyond the scope of this appendix and is likely to involve a combination of probabilistic and deterministic assessments. Maintenance schedules should provide sufficient information to ensure the identification of critical tasks, critical durations and critical functional requirements. This can be linked with LC 27 (safety mechanism, devices and circuits) providing the licensee has adequate arrangement under LC27.

A4.2.4.2 For maintenance of SM's or essential systems, individuals should not be permitted to work on more than one system at once or to allow several similar components to be dis-assembled in close proximity. This approach improves diversity by avoiding repeated mistakes and avoiding mixing up parts.

A4.2.4.3 Alternating maintenance schedules can help avoid multiple units being maintained in a similar time frame. This avoids common cause errors, e.g. if several rogue parts are fitted together on multiple units they are likely to fail together whereas an alternating pattern could identify the rogue parts prior to multiple failures. Similarly, consideration should be given to having independent teams of technicians performing maintenance on duplicated plant to avoid duplication of human error or poor practice. Where more than one similar unit needs to be worked on, separate supervisory processes may be necessary to eliminate the risk of information crossover or quality control related issues.

A4.2.4.4 Safety critical maintenance tasks require a degree of independent validation, either by a third party or a separate team, covering different stages of the maintenance with actual checking of different components or activities. The aim is to confirm each stage is undertaken consistently to the same standards. Persons undertaking functional checks or validation after maintenance operations should be SQEP.

A4.2.5 EXPECTED STANDARDS IN MAINTENANCE FACILITIES

A4.2.5.1 The term ‘maintenance facility’ is applicable to any area where maintenance and repair takes place and should not just be limited to permanent maintenance workshops. It is acknowledged that maintaining components outside of a workshop environment is often more difficult to control especially when routine plant operations are still taking place or if the area is outdoors. Good housekeeping, control of tools, control of parts and exclusion of foreign material are all essential regardless of where the work takes place.

A4.2.5.2 The following sections provide examples of relevant good practice when implementing good standards for maintenance facilities.

- *Tool Storage*

A4.2.5.3 Photograph 1a below shows a poor example of tool storage. In this all too common example there is a high risk that the technician could leave a hand tool inside a critical plant item because he has no easy way of knowing that the tool is missing. In contrast, photograph 1b indicates good practice with all tools having a designated storage position making it obvious when tools are missing. Regular assessment of the tool stock holding, together with a check of anticipated future requirements, is encouraged. Individual tool identification also aids control. The storage and condition of the tools should reflect the importance of the tasks they perform.

Photograph 1a –Poor Practice for storing tools in a cabinet

Photograph 1B – Good practice where each tool has designated storage locations.

- *Work Environment*

A4.2.5.4 Even minor deterioration of the building fabric can lead to foreign material ingress. For example, photograph 2a and 2b show examples where there is a risk of paint flakes entering components due to minor deterioration of the building fabric. The condition can also be a sign of water leakage into the room leading to further component degradation. Furthermore, poor quality facilities can present the wrong corporate message leading to a culture of poor workmanship. Photograph 2c shows the same facility after basic repairs bringing it back to the expected standard and demonstration of relevant good practice.

Photograph 2a – Examples of poor building standards leading to foreign material generation.

Photograph 2b - Poor building standards leading to foreign material generation.

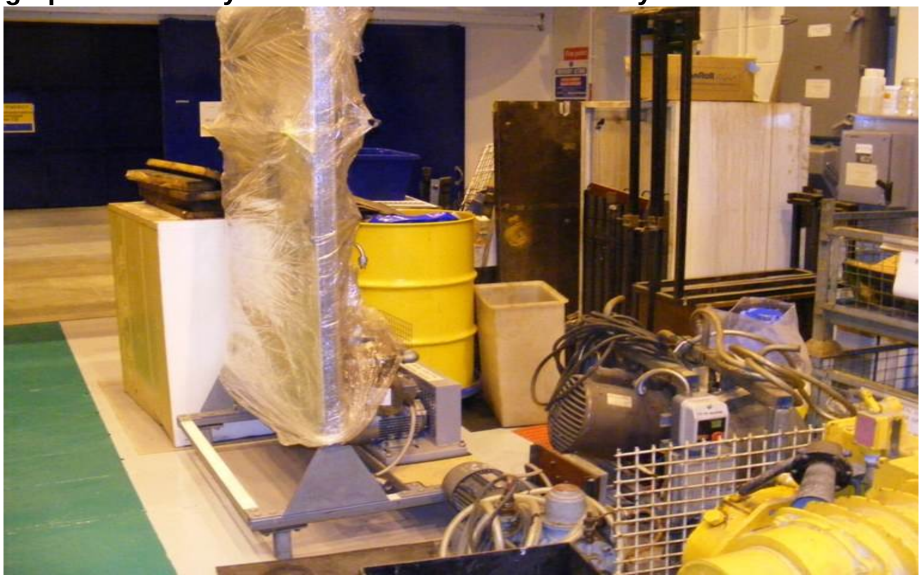
Photograph 2c – Expected workshop standards reducing the risk of foreign material generation and promoting good safety culture.

- *Housekeeping*

A4.2.5.5 Good housekeeping requires that everything has a suitable location including work in progress. Appropriate racks, shelves, cabinets and bespoke storage units avoid an accumulation of redundant items and also make it easier to identify poor housekeeping. . Strict policies of parts disposal should prevent a culture of hoarding. Photograph 3a, 3b and 3c show examples of poorly thought out storage with little or no control of components presenting a risk that items can become foreign material or to lead to faulty components being fitted. In contrast, photograph 3d and 3e show examples of relevant good practice.

Photograph 3a - Poorly stored items with no traceability and no segregation of different plant items.

Photograph 3b – Poorly stored items that are not easily retrievable



Photograph 3c – Some attempt to store components but with little or no traceability and a mixture of different plant items.

Photograph 3d – Good use of dedicated spares and tool cabinets

Photograph 3e – Properly designed lay down areas for storage with good access.

- *Parts Control*

A4.2.5.6 Stores are vital for control of quality assured spare parts, foreign material exclusion and serve to remove some of the errors that technicians can make if parts are not properly controlled. Duty holders should consider having a main stores and satellite stores to ensure that only essential parts are held at the work face. Furthermore, large stores can assist with removing the need to house large items that can clutter up small workshops.

A4.2.5.7 All spares and tools in stores should be properly managed making use of shadow boards or tool cabinets to assist with tool control. The use of maintenance specific vending machines, operated via personal identification numbers, facilitates traceability. Vending systems can be programmed to specific jobs such that they will only dispense the correct type and quantity of materials or consumables.

A4.2.5.8 Dedicated tooling and parts kits offer better control for specific tasks. For example, technicians can be presented with all the tools and parts they need to do the particular task and nothing else. This is particularly useful for spare parts as it enables the removed part to be placed back into the empty position in the parts container making it easy to count parts in and out. It also enables OEM suppliers to provide spares kits which further assist to ensure that the correct parts are fitted. Photograph 4a and 4b shows an example of good practice for dedicated tools and spares kits respectively.

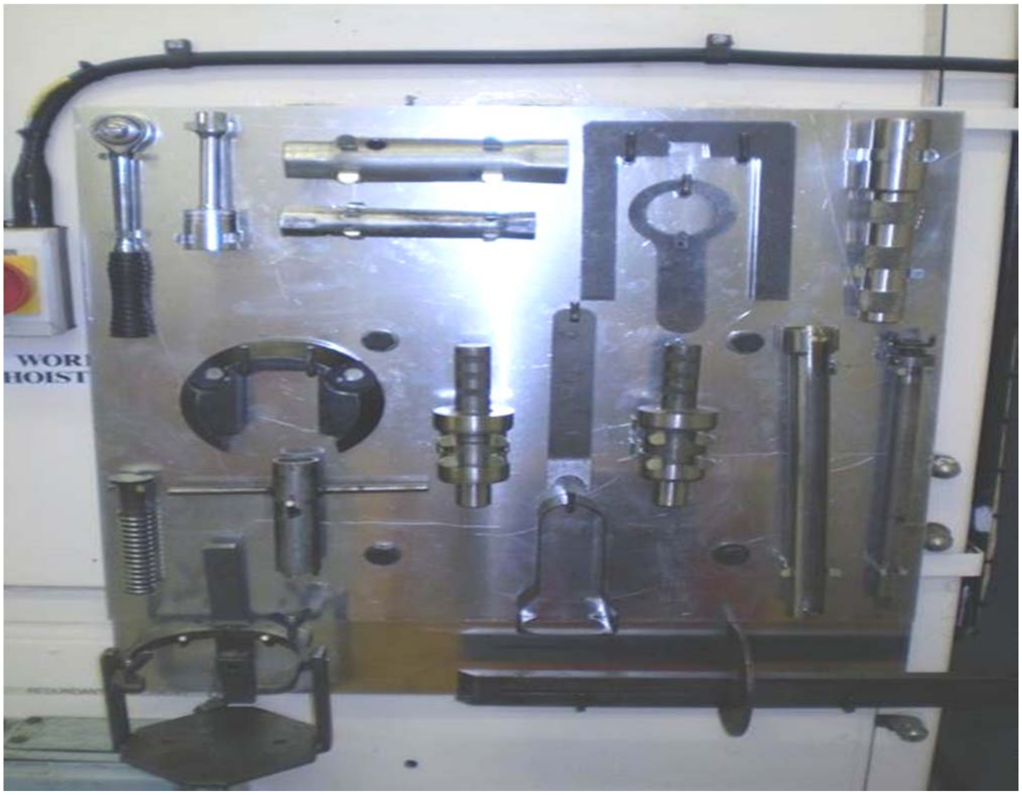
Photograph 4a - Dedicated tool kit

Photograph 4b – Dedicated Spares Kit

A4.2.5.9 For general purpose tools, duty holders should decide whether each technician needs their own or whether dedicated tool kits can be held in a central store. Where each technician needs their own tools they should be supplied by the duty holder so that the quality and quantity of tools in the facility can be controlled. Similarly, special purpose tools and those that need calibration should be managed appropriately, deciding whether it is better to hold certain tools centrally (as shown in Photograph 6a &b).

Photograph 6a – Secure area for dedicated tool storage cabinets.

Photograph 6b Good use of storage for specialist tooling



A4.2.5.10 Component shelf life should be carefully monitored so that perished components or consumables are not inadvertently used and manufacturers may specify specific storage conditions. Quality assurance arrangements for through life management of such components require a heightened level of management attention to ensure suitable controls are in place and effective.

A4.2.5.11 The storage of used parts or part used consumables should be avoided if possible as they can lead to quality issues and can become a source of foreign material. Parts that can safely be re-used must be adequately labelled and appropriately stored with a traceable history to verify their quality. Bulk storage of new spares should be avoided to assist with foreign material exclusion. Any unwanted removed parts should be discarded through an appropriate waste route. The use of dedicated spares kits with the correct amount of parts for a particular task, as mentioned above, helps reduce parts inventory. This is particularly applicable for small items such as fasteners, washers, etc. Effective use of a central stores facility should be adopted providing it is well controlled.

A4.2.5.12 Larger items of equipment required to undertake certain tasks should be stored with care in a designated ‘set down’ area as shown in photograph 7. This set down area ensures that only those tools necessary for the task are out on the workshop floor.

Photograph 7 – Typical example of designated storage area for larger items of maintenance equipment.

A4.2.5.13 Workshop consumables (nuts, bolts, washers, seals, adhesives, etc.) may be used in routine maintenance tasks which are not safety critical, but are often stored and available in the same facilities used to maintain safety critical equipment. In such cases, management control is necessary to prevent inadvertent deployment to safety critical applications.

A4.2.6 FOREIGN MATERIAL - IDENTIFICATION, ASSESSMENT & MITIGATION

A4.2.6.1 Whenever maintenance activity involves opening a system or component, Foreign Material Exclusion (FME) becomes a consideration. Foreign Material (FM) includes any rogue material that is not intended to be inside the equipment and is particularly significant where it can threaten reliability. Insufficient covering of open equipment can lead to inadvertent FM entering the item such as metal shavings, rags, grinding dust, etc although inadvertently installing the wrong component or fastener can also be considered as FM. The sections above provide examples of good practice for cleanliness and storage to improve FME but handling and transportation of items prior to installation can also improve FME.

A4.2.6.2 The cleanliness standards expected when undertaking maintenance is commensurate with the safety significance of the equipment being worked on. Good practice includes the deployment of temporary clean surfaces in working areas and covering of dirty workshop surfaces. Such covering can also assist in controlling the potential spread of contamination.

A4.2.6.3 HSE Guide HSG129 – Health and Safety in Engineering Workshops; provides guidance for small individual workshops. Expectations for the oversight applied by duty holders undertaking maintenance tasks are provided in Nuclear Energy Agency, Nuclear Regulation NEA/CNRA/R [2011]4 – The Nuclear Regulator's Role in Assessing Licensee Oversight of Vendor and Other Contracted Services.

A4.2.6.4 FM needs to be minimised and any requirements need to be defined and included in the work package. Consideration should also be given as to whether there is a risk that other systems or plant, voids, ponds or personnel may be affected by the FM. Table 1 sets out some of FME considerations and solutions to be considered.

Table 1 – FME considerations and solutions

FME Consideration	FME Possible Solutions
Should the area surrounding the work be in an exclusion zone? If yes, define the work area.	• Warning Signs • Barriers • Controlled access • Access/egress arrangements including those used in emergencies • Protecting of other areas
Can parts, tools or other items that could be dropped into open systems be retrieved? Consideration should be given to implement the following:	• Appointment of personnel (Guardians) to control and monitor anything taken into or removed from the exclusion area. • Securing items such as tools, security passes, film badges, dosimeters, spectacles, etc, using lanyards to ensure items are retrievable if dropped. • Removing non-essential items or materials from the area. • Ensuring tools are in good condition and do not have loose or missing parts (record missing parts to avoid confusion later). • Use the correct tool and materials, fail safe tools if required • Comply with material control as required. • Account for all tools, equipment & materials prior to system/component closure.
Is there any dirt and debris in the area adjacent to the work area that could be introduced into the open system? If yes then the following should be taken into account;	• Cleaning of adjacent area prior to starting the work activity. • Removing non-essential materials from the work area. • Cleaning overhead areas and gratings. • Install temporary covers when work is not in progress • Maintain appropriate/effective housekeeping conditions. • Ensure removal of harmful contaminants. • Using only approved cleaning materials, solvents and chemicals. • Minimize re-contamination of cleaned surfaces and minimise the cleaning required after installation, repair or modification. • Stopping work and notifying Team Leader/task Supervisor if FME control is lost.
Is the system or component difficult to clean once the activities are complete? If yes, then consideration should be given to the following:	• Clean enclosures, vacuum cleaning systems, special clothing or any other method to reduce the possibility of FM intrusion into a system or component. These considerations are particularly important during maintenance activities that create dust and swarf. • Verify system cleanliness requirements at specified stages of the task and following the maintenance activity. • Control other unrelated work activities in in the area that could introduce dirt and debris into the system or component, such as the removal of floor plugs that connect two different work areas?
Could the system or component be safely left open and unattended for extended periods?	• Install temporary covers when work is not in progress?

A4.2.6.5 Where it is deemed necessary to use temporary covers for FME, the covers should satisfy certain requirements as follows:

- Non brittle, non-splitting, non-tearing, non-melting.
- Thick enough to avoid damage to underlying surfaces.
- Made from cheap/compatible but non porous materials.
- Unable to damage system or component.
- Will not deteriorate or decompose over time
- Will not cause any chemical reaction
- Easily detectable and retrievable
- Each cover should carry an identifier that is clearly visible. For example a caution notice and/or be coloured to contrast the plant (e.g. fluorescent colours if appropriate).

A4.2.6.6 Temporary covers should not be used for extended periods. Once work is complete, then verification of system cleanliness may be required. Verifications may range from simple visual inspection to system flushes with rigid acceptance criteria and independent verification by appointed personnel.

A4.2.6.7 FME requirements, when identified, should be included into maintenance instructions. Reference should also be made within the job history section when completing maintenance history. FME requirements and FME control logs if used should be retained and included in the work package for future work planning.

A4.2.6.8 In the unfortunate event that FM ingress has occurred and cannot be safely and easily retrieved, the task should be stopped and the job made safe. A team that includes SQEP's should then consider the situation before any further action is taken which could possibly make the situation worse. Although it is best if foreign matter is retrieved it is inevitable that in some cases the foreign matter will be located in such a way as to prevent retrieval. In these cases design authority assistance may be necessary to determine the effects of leaving the FM inside the system and to consider alternative retrieval methods.

A4.2.6.9 In all cases when foreign matter has been allowed to ingress into a system or component even if it was retrieved, an effective corrective action process, possibly including root cause analysis, should be performed to prevent recurrence.

A4.3. CHECKLIST

Inspectors may find the following checklist helpful as a brief summary of the guidance contained in this appendix.

Checklist	✓
Maintenance professionals actively involved in continual reviewing of performance, reinforcing and sharing relevant good practice and correcting deficiencies	
Arrangements in place for staff at all levels to offer suggested improvements	
Planning arrangements appropriate to implement maintenance tasks.	
Essential maintenance appropriately staggered to retain redundancy.	
Arrangements in place to protect technicians from conflicting commercial pressures.	
Arrangements in place for independent functional checking.	
Arrangements in place for independent teams of technicians employed on duplicate plant.	
Adequate procedures to identify safety critical tasks.	
Readily available manuals, drawings and other necessary information sheets in a convenient location for those undertaking the work. Availability of key maintenance documents for emergency situations.	
Evidence that training adequately addresses safety critical tasks and the possible consequences if technicians fail to follow procedures.	
Evidence that training reflects feedback from those with appropriate maintenance experience and, where appropriate involves subject matter experts.	
Procedures to ensure that workplace check sheets are accurately copied across into final records.	
Arrangements in place for introducing alternative procedures when a deviation from standard procedure is necessary. Submission of any amended (red lined/penned) maintenance documentation through official review process.	
Job cards should accurately identify the appropriate maintenance manual or other key documentation.	
Arrangements in place for safety critical maintenance tasks to be inspected by supervisors and independently verified at completion.	
Arrangements in place to prevent technicians from working on two (or more) similar systems at once.	
Arrangements in place to achieve appropriate standards in temporary maintenance facilities.	
Appropriate storage, control and identification of tooling and specialist equipment.	
Evidence that redundant items are disposed of, especially old parts, consumables, and items that do not belong in the facility.	
Arrangements in place for ensuring that parts are adequately labelled, stored and documented. Unwanted components discarded through appropriate waste route.	
Maintenance facility building or area is in a condition that is appropriate for maintaining nuclear safety critical plant.	
Housekeeping standards are appropriate.	

Equipment is safely and appropriately stored in a designated storage location.	
The facility is equipped with appropriate storage locations, shelving, containers, cabinets, etc.	
Hand tools are adequately controlled and maintained.	
Evidence that storage of consumables and spares is appropriately controlled to minimise inventory.	
Evidence that shelf life of spare parts and consumables is adequately controlled.	
Adequate lay down areas are provided for work in progress particularly large plant items and large specialist tools, jigs frames etc.	
Adequate consideration of FME and its potential effects on the plant.	
Adequate exclusion zones if necessary to control FM.	
Use of personnel to control and account for materials	
Adequate control of tooling and personal belongings to control FM, use of lanyards if applicable.	
Cleanliness, sterile working conditions during maintenance.	
Appropriate FME covers provided and in use.	
Are FME requirements included into maintenance instructions	
Procedures in place for dealing with FM if found inside a plant item.	