Office for Nuclear Regulation

FILE NOTE – ORIGINALLY APPENDIX 3 OF NS-TAST-GD-009 REV 02 AMMENDED INLINE WITH REV 3 EDITS BUT REMOVED TO REDUCE SIZE OF TAG.

APPENDIX 3: EMIT REQUIREMENTS THROUGHOUT THE LIFETIME OF A NUCLEAR FACILITY

A3.1 Concept to Preliminary Safety Report/Case

As soon as the requirement for a new Nuclear Power Plant (NPP) or any other new nuclear facility is identified, there will be a need for definition of a preliminary functional design specification of the plant. This task is undertaken by a Licensee's Design Authority, or an architect/engineering/manufacturing organisation that becomes an entity formally appointed by the prospective plant owner, the eventual Licensee **(Refs 6 and 4 respectively for INSAG 19 and SSR-2/1). (NS-TAST-GD-079 Licensee Design Authority Capability also refers).**

At project inception, and through at least to inactive commissioning, the Formally Appointed Entity is likely to be a partnership between a licensee, or prospective licensee, and an architect/design organisation or engineering design/project management company, backed by other companies providing design expertise in all of the engineering disciplines that are required by the project.

The design companies have to be able to show that they have used persons who are Suitably Qualified and Experienced in design of nuclear plant and that they have complied with the design safety assurance requirements set down by the Formally Designated Entity. If these companies can be shown to match such requirements, they can become not simply contractors, but "Responsible Designers" appointed by the prospective licensee's Design Authority acting as Intelligent Customer **(NS-TAST-GD-049 – Licensee use of contractors and intelligent customer capability also refers).**

Responsible Designers are contracted to formally maintain their specialised knowledge of design and their competence in the process of detailed design for the plant lifetime, or at least into early active operation. The operating organisation will have applied for a Nuclear Site Licence, and following grant on the Licence will have requested regulatory permissions for commencement of construction, installation, inactive commissioning, active commissioning and operation as appropriate. Hence it may be in a position to show that it can not only be an Intelligent Customer but even take on the role of licensee's own Responsible Designer in many disciplines. Design in this context also includes determining and documenting the needs for EMIT for all parts of plant within the Responsible Designers remit. The plant operating department of the licensee also provides representatives to advise the project grouping on design inputs available from operation of similar plant, and licensee's ways of working in areas of operation, maintenance and testing, and operational experience feedback. **(Licence Conditions 19, 20, and 21 apply here and further guidance may be found in NS-TAST-GD-057 on Design Safety Assurance).**

To understand who is involved in the project, what they are delegated to do, and how the project and its documentation is intended to evolve, a project manual will be drawn up as early as possible in the project's life. This will show that, within the detailed design remit, the Responsible Designers will be required to determine what form the plant detail design will take, and what the needs for EMIT will be for all Structures, systems and components in their plant areas or systems. The manual will also describe the intended process for developing a comprehensive listing of all potential facility EMIT (often termed the Maintenance Catalogue), selecting those items that will be undertaken as routine maintenance and, from the latter, those items important to safety that will be placed on the Plant Maintenance Schedule (or similarly named schedule), as required by **Licence Condition 28(4).**

A preliminary design specification will be prepared to include data on the power output for the NPP or radioactive material throughput for other nuclear facilities. It will also give indicative

requirements for the equipment to support the specified power output or materials throughput, along with the engineering standards and radiological protection requirements against which the areas of the facility are to be designed. There may be a need to redefine this, as later safety analyses may indicate differing engineering needs for redundancy and diversity in plant **(NS-TAST-GD-036 Diversity, redundancy, segregation and layout of mechanical plant also refers)**, and additional barriers to radioactive release **(NS-TAST-GD-020 Containment for Reactor Plant and 021 Containments in Chemical Plant also refer).**
After preparation of the preliminary design specification, there is a need for two intertwining paths for project development – one being the ongoing processes leading to detailed facility design **(NS-TAST-GD-057 Design Safety Assurance)** and the other being that which generates the safety analysis for the facility **(NS-TAST-GD-006 Deterministic Safety Analysis and The Use of Engineering Principles in Safety Assessment , NS-TAST-GD-034 Transient Analysis for DBAs in Nuclear Reactors, and NS-TAST-GD-030Probabilistic Safety Analysis also refer)**. Both paths need to be consolidated in the project manual defined process leading to safety case production **(NS-TAST-GD-051Guidance on the Purpose, Scope and Content of Nuclear Safety Cases)**. The formally Appointed Entity will also implement a further documented process, again defined in the project manual, tabulating sets of project assumptions generated by the ongoing design and safety analyses.

These Project Assumptions are usually collated within databases under headings such as Design Assumptions, Safety Assumptions, Seismic Assumptions, Operating Assumptions and Maintenance Assumptions. Initially the contents of these databases are likely to be generated by structured engineering analysis of the concept design, describing the Safety Functional Categorisation (SFC) requirements of Structures, Systems and Components (SSCs) and applying nuclear safety Engineering Classifications (ECs) to these **(SAP ECS1)**. As the ongoing design is subjected to this process, any additional SSCs that are generated will also be assigned safety functional categories and engineering classification according to their importance to nuclear safety **(SAP ECS2)**. This then becomes the initial version of the Engineering Schedule for the facility, which is then likely to increase in size and change in detail as the project streams - facility design and safety analyses - progress.
The preliminary design specification and tables of assumptions along with the tabulation of SSCs against SFCs and ECs will be the base information used for the initial deterministic safety analysis. This will be followed, as soon as sufficient information is available, by the start of Probabilistic Safety Analysis (PSA) **(NS-TAST-GD-030Probabilistic Safety Analysis).** These complimentary safety analyses are intended, after a number of iterations, to eventually provide:

- Establishment and confirmation of the design bases for all SSCs important to safety;
- Characterisation of Postulated Initiating Events (PIEs) that are appropriate for the design and site of the facility:
- Analysis and evaluation of event sequences that result from PIEs to confirm the engineering qualification requirements;
- Comparison of the results of the analysis with radiological acceptance criteria and design limits; and
- Demonstration that the management of anticipated operational occurrences and design basis accidents is possible by automatic response of safety systems in combination with prescribed actions by the operator.

All of the above should be described in a Preliminary Safety Report.

A3.2 Requirements up to early site work.

As the project progresses to the first major area needing full design definition - commencement of civil engineering works - the civil engineering requirements for site excavation, site blinding, base mat design and building foundations must be available. To satisfy the needs for this, the project will generate "design packages" for discrete civil engineering construction work areas. Nuclear regulatory expectation is that these will be described within a Pre Construction Safety Case. **SAPs ECE 1 to ECE 24 encompassing Civil Engineering** describe that which should be contained within the civil engineering part of the design definition, typically including appropriate codes, inspectability requirements, structural analysis and model testing.

There is also a need for sufficient information at this point to demonstrate that a concept design for the whole facility has been created including preliminary facility layout, indicative conservative plant throughputs / duties / loadings, and any detailed design needed for the through life inspection and maintenance of these early plant areas. Such items may include the ongoing means for examination of key load bearing elements, the provisions for environmental monitoring of leaks to ground, and the means for through life access for inspecting embedded items, such as sampling boreholes and earthing pits for lightening protection (this should make provision for projected changes in radiological conditions for through life access). It is evident that features like these cannot be added, without great difficulty, later in the project. **SAP ELO1** cover this aspect of design, specifically noting the need to make provision for through life examination, inspection, maintenance or testing of the facility, such that radiation dose to EMIT operatives remains as low as reasonably practicable throughout the facility life.

If as built inspections, and leakage to ground monitoring is started as this early stage of the project, then in effect part of the Plant Maintenance Programme has had its baseline defined and has commenced.

Architect/Engineering Design Authorities have developed processes that allow relatively early commencement of the civil engineering stages of major engineering projects and these have been used in the UK nuclear industry. These processes involve significant use of Quality Assurance and independent validation and verification of the civil engineering design packages. Part of the regulatory expectations is that a report, or a series of reports, is produced to justify the civil engineering design (with some licensees such documents are referred to as Civil Engineering Design Justification Reports (DJRs)). Regulatory assessment based on review of the total content of a nuclear facility's project design packages is not a realistic proposition. Hence DJRs, or equivalent documents, are likely to be used throughout the design development for all engineering disciplines or against work areas throughout a new build project or major modification to an existing facility. Typically the earliest Civil Engineering DJR needs to be in place before commencement of any construction work that may have a safety important function. Similarly, other discipline based DJRs relating to facility areas need to be available before installation should commence in those areas.

A3.3 Progress through Development of the Design

As the detailed design progresses in each project area and engineering discipline, it should be possible to observe through the design packages and the assumptions databases how detailed design for nuclear safety is being addressed. Indeed, there should be a constant thread running throughout design, manufacture of equipment, construction, commissioning, operation and decommissioning showing that any SSC in place to provide a nuclear safety function (i.e. confinement of radioactive matter, heat transfer and removal, and criticality control) is effective in achieving this designed safety intent. There is a need to demonstrate that consideration of nuclear safety continues to be achieved and this is to be primarily by passive or engineered means. Throughout all phases of the facility life there should be description of such functions, safety analyses relating to them, and demonstration of the means for continually gaining assurance that the functions remain as initially intended by use of EMIT. The combination of these three may be considered to be the means for demonstrating that the Design Intent continues to be met.

International and National Safety and Environmental Regulatory Requirements, bring in the concept of defence in depth, multiple barriers to radioactive release, and categorisation of structures, systems and components for safety significant facility features, will also need to be shown to be continually addressed within the ongoing work on design packages.

At this stage there will be sufficient information within design packages, assumptions databases and the Engineering Schedule, such that the deterministic and probabilistic safety analyses will start to have significant substance, with the Pre - Construction Safety Case being progressively updated to demonstrate design and safety analyses developments. One of the more important outputs from PSA will come to the fore in this project phase, confirming that the chosen level of redundancy and diversity for frontline safety systems compares favourably with other installations, and/or matches the level of required availability and reliability should quantitative PSA targets be appropriate.

Equally important in the delivery of the safety significant activities will be similar definition of the support systems needed to achieve the requisite levels of reliability. Again PSA is used in this context to show the extent of this need. Dependency matrices generated from the PSA output are one means for showing the interaction between frontline safety systems and their support systems. They are of great value in the development of arguments for the number of safety system trains and safety support equipment trains to give the necessary levels of redundancy and diversity. They are also of use in determining appropriate EMIT strategies, by giving indication of when unavailability of primary safety trains, or support equipment trains, will degrade the safety of the facility, and that the extent of the EMIT activities provides the required level of assurance that design intent continues to be met.

Other considerations that need to be taken into account at the earliest possible stage in generating design information are:

- Site Specific Inputs, that may require changes to the preliminary civil engineering design and its DJRs (such as noted in SAPs ECE 4 and 5)
  - Definition of R&D requirements for novel design features (SAPs Para 281), equipment qualification (SAPs EQU 1 and EMT4) or innovations in inspection techniques, and any changes to the preliminary design that results from such work.
- Design input for long lead items from preceding but similar facilities and any operational experience from these that comes to light during the lengthy design and manufacturing phases.

This demonstrates the need for definition of a change control process within the Project Manual, such that changes within project approved design and safety documentation, resulting from ongoing development work, are formally captured. This is of particular importance for the Design Justification Reports relating to facility areas, as they need to be available before installation should commence in those areas.

Design packages not only provide information on materials chosen, design codes used, and calculations to confirm design code compliance but will also contain details of features included to allow access for EMIT of safety significant components. Such safety significant components often have the longest manufacturing lead times and hence their design packages need to be produced relatively early in the life of the project.

Typical of the EMIT features for these components are the blind nozzles and associated pipework needed to permit insertion of ultrasonic probes for in-service measurement of primary containment process vessel wall thickness. It is often not enough to know that a corrosion allowance has been added to the wall thickness given by a vessel design code calculation, there is also a need for through life demonstration that corrosion mechanisms are as listed in the Design Assumptions produced by the Responsible Designers. Similarly where pipework erosion is considered to be a possibility on, say, primary containment pipework, the design may need to provide for siting of permanently installed inspection devices, such as field signature method arrays. These devices will be used to provide as built measurements of the relevant parameters – the baseline for future comparison of measurements between as built and future in–service measurements.

The discipline based DJRs relating to facility areas need to be available before installation so that the project can permit such work to commence in the relevant areas.

All Design Packages and DJRs should contribute to the Maintenance Assumptions Database, which will form the basis of the Maintenance Catalogue. The comprehensive nature of a project's maintenance catalogue means that it is of limited value on its own in determining what must be examined, inspected, maintained or tested for nuclear safety reasons (i.e. to comply with LC28, and other safety and environmental EMIT requirements).

Again the project manual should define a process whereby a group of Suitably Qualified and Experienced Persons (SQEPs) from the project team, the safety analysts, the responsible engineers and a team representing 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. This process for populating maintenance schedules should also define how the group is to document the reasons for accepting only condition monitoring, or operator surveillance with breakdown maintenance on some plant items. This group or a similarly constituted group should also meet regularly to give endorsement to maintenance instructions generated for all safety significant plant.

A3.4 Manufacture and Works Testing

The information base for manufacture of a plant area is the design package. Such a comprehensive suite of documents holds far too much information for nuclear regulatory Inspectors to examine thoroughly. It is again more appropriate to sample from DJRs, which should by this stage describe plant engineering, its substantiation and safety requirements of the equipment as designed. Any concerns raised by such sampling may often only be cleared by examination of the relevant detailed areas of a design package.

It is during the project phase between concept design and the earliest part of manufacturing that development work on novel systems or components is undertaken. Such work may have significant impact on the EMIT tasks defined within the evolving maintenance schedules. Something very different from that envisaged by equipment designers or operations representatives may be produced by this work.

A typical example of this from the 1970s was work undertaken to prove the adequacy of AGR control rod operations based on principles not used previously. For even a single control rod type approximately 1600 'drop tests' had to be performed to develop the rod drive and trip *operations. This has then provided the basis for EMIT procedures used for this control rod type even to the present time.*

Often for more complex and large plant, such as Reactor Fuelling Machines, Nuclear Safety Significant Cranes and In Cave Handling Equipment, there will be a trial build at the manufacturer's works. The need for any proof testing of items of plant and systems may be included in this. Such testing should be end to end testing of a complete piece of equipment or system – so far as is reasonably practicable, and will be repeated during on facility acceptance tests. This trial build may be sufficiently extensive to allow integrated testing of mechanical, electrical and even control and instrumentation systems. Such testing is usually extended to trial the 'as designed' maintenance instructions. Any changes resulting from this testing are captured via project change control processes.

Satisfactory completion of works trials is likely to generate a project report that allows some form of project hold point to be lifted. This may be used along with the appropriate Safety Report to seek regulatory permission as appropriate to start installation of plant and equipment.

Inspectors will gain valuable insight into the adequacy of works testing and trials by works visits and by discussion with licensee's representatives on the findings generated by the testing plus the extent of modification derived from that work.

A3.5 On Facility Installation, Facility Acceptance Testing and Inactive Commissioning

Even with extensive works build and testing of plant, along with installation, testing, and examination of the civil, structural and mechanical engineering features on site, there will be significant changes to plant and documentation caused by rectification of interfacing problems. This is another example of an area where project change control needs to be robust and Inspectors may wish to examine how the changes are affecting the proposed EMIT procedures. Such changes may result in modification of the content of the Maintenance Schedules, Maintenance Instructions, possible changes to Safety Case Limits and Conditions, and revision to the Safety Report and Design Justification Reports. Also additional to the proof testing performed at works build, there may be repeats of proof tests.

Many areas of a nuclear facility cannot be works tested, typical of this would be civil power reactor core operations, or the nuclear ventilation systems which act along with civil, structural and mechanical engineering features to give nuclear containment **(see NS-TAST-GD-021 for Containment – Chemical Plants and NS-TAST-GD-022 for Nuclear Ventilation)**. In such situations the signed off documentation for facility acceptance testing, including documented changes derived from within any maintenance trialling done at this time, has to become the baseline for demonstrating that the design intent for installation has been met. *Using a nuclear ventilation system as an example, the facility acceptance testing will generate a 'Ventilation Footprint', the benchmark against which all future commissioning, EMIT and through life ventilation audits will be compared.*

Within facility areas that contain more complex equipment, the next phase of testing, Inactive Commissioning, will see a gradual shift of project leadership towards the facility operating organisation's personnel, this being completed before Active Commissioning. This phase of work includes Maintenance Demonstrations, particularly where man access will not be permitted even at the start of active commissioning. For such work the Maintenance Instructions in their "Draft for Maintenance Demonstration" version will be used, with the expectation that these will be revised to accommodate findings and differences in work practices, thus generating the Facility Maintenance Instructions. The merits of coincident versus staggered proving tests should be demonstrated at this time. It is during these demonstrations that any need for appropriate plant and equipment isolations or plant substitutions used during maintenance should be shown to be effective. Part of this demonstration should also prove any return to service procedures as these may differ from plant isolation procedures. This testing phase is also the most appropriate time to perform any human factors assessments of EMIT tasks looking for common cause failure mechanisms created by the procedures or by actions of operatives.

Any proposed changes to Maintenance Schedules, or the tasks within them resulting from this project phase, require consideration and endorsement by the SQEP Group(s) developing the maintenance schedules and instructions. It is important that such changes, particularly those to safety significant SSCs, are documented along with records of the consideration and agreement by all relevant project, safety, and operations disciplines, thus demonstrating comprehensive acceptance.

Inactive Commissioning will also involve the need for proving the interactions between systems important to safety, and demonstrating the proposed in-service test regime for each part of any such system as well as the whole system. This is the means for showing that procedures are available for satisfying **SAPs EMT 5 and 6 (Adoption of test procedures and provision of EMIT commensurate with the reliability required)**. It is also important to note that SAP EMT 7 expects functional testing of the complete system and the safety function of each component. In all cases the associated reliability analysis must reflect the actual testing carried out. It has often been found that licensees fail to carry out end to end proof testing but reliability analyses erroneously assume that the testing is end to end, thereby underestimating the risks from the facility, possibly by significant amounts.

A typical example here would be a radiological access door (Shield Door). Such doors will have proximity switches for position indication, interlock devices to ensure only one door can operate when working as part of the access system for a containment cell, or in association with a radiation alarm. These features will work along with an electrical, hydraulic or pneumatic drive system and mechanical protective devices such as shoot bolts. Proving and reproving such a system, to assure safety, requires very detailed test procedures and documentation to define all interactions. One means for providing this is the use of Combined Configuration Diagrams along with the commissioning work sheets. Only by fully defining all possible interactions, and testing them, can the extent of future EMIT be demonstrated to be adequate for providing continued assurance of the safety function of the whole system.

Where a maintenance activity to satisfy a safety requirement is shown on the appropriate assumptions database, cross references to unique numbers for the test documents, maintenance instruction number and completion sign off for inactive commissioning should be evident. Any EMIT on a structure, system or component to be included on the Plant Maintenance Schedule, as a Safety System or Safety Related Equipment, may be expected to be addressed in this way, but should also cross reference to where its safety role is defined within the nuclear safety case.

Some safety devices can only be fully tested in situ prior to active commissioning, subsequently safety case requirements may preclude comprehensive safety system testing.

Typical for this situation would be the over-speed limiter on a crane whose operating area is over a nuclear containment. Once nuclear materials are in place in the facility the safety case is likely to require that uncontrolled lowering of the crane hook and loads is to be prevented. In this case functional testing during facility operational life may be required to comply with the maintenance schedule. Hence the device will have to be removed, tested on a dynamic test *rig, possibly refurbished and retested on the dynamic rig, then reinstated in the correct orientation. Completion of testing would then require simulation of the device output and checking of the correct operation of the remaining items in the full system (brakes etc.). The Maintenance Instruction for all such work should have detailed sections on each phase of the EMIT but should also detail the means by which correct re-instatement is to be achieved.* **(By proceeding as above SAP EMT 7 requirement "Where complete functional testing is claimed not to be reasonably practicable, an equivalent means of functional proving should be adopted." are satisfied).**

A further example of testing that can only be achieved fully prior to active commissioning is for pneumercators (level or density measuring devices, which sense the pressure difference between air bubbling out of a dip leg into the liquid being measured and also out of a reference leg into cell or vessel air). Once the liquid being measured is active it is only possible to prove the dip leg is not blocked. Checking of the rest of the function requires injection of pressure simulation, where the legs enter the rest of the measuring system. This can then demonstrate that process parameters are correctly displayed and actions derived from them are initiated. Confirmation that dip legs have been re-connected is of great importance here and the Maintenance Instructions must address this.

Items such as those above address the requirement for demonstrating that provisions are being made to satisfy the Licence Condition 28 requirement for EMIT. However, there is an added complication in that other safety legislation also has to be satisfied. Typical of this is the need for complying with the EMIT requirements of Lifting Operations and Lifting Equipment Regulations and Pressure Systems Safety Regulations. At some time after equipment installation there will be proof load and pressure testing against these regulations respectively. After such tests, statutory obligations for EMIT apply to either a periodicity requirement or to a written scheme of examination – in effect the periodicity clock has started to tick or the number of operations/hours in operation are being accumulated against the limit defined in the written scheme. Items such as these are often placed on a Statutory Maintenance Schedule. The need for defining when commencement of working to the Plant Maintenance Schedule, Statutory Maintenance Schedule and Residual Routine Maintenance Schedule is to occur is of great importance. An appropriate time has to be declared and justified by the licensee for when the periodicity or written scheme requirements for each entry is to start.

At the end of Inactive Commissioning, it is important that evidence of successful completion of all testing shown on the Inactive Commissioning Test Schedule is available for review by licensee management and nuclear regulators. This is an essential part in the process for the Licensee requesting the issue of a Licence Instrument for Commencement of Active Commissioning. In order to satisfy this, a Completion of Inactive Commissioning Report is written by the licensee. The report will not only describe what has been tested, but changes that have resulted from construction or installation modifications and inactive test outcomes. These may result in modification of the content of the Maintenance Schedules, Maintenance Instructions, possible changes to Safety Case Limits and Conditions, and revision to the Safety Report and Design Justification Reports.

A3.6 Active Commissioning and Operational Lifetime of the Nuclear Facility

A3.6.1 Active Commissioning

Active Commissioning is the gradual introduction of radioactive substances into the facility, demonstrating that shielding and containment are effective, and for proving of process and process operating procedures, which again includes EMIT.

Before a Licence Instrument for Commencement of Active Commissioning can be issued (as appropriate), ONR expects to have received amongst other documents, a request to commence active commissioning from the representative of the licensee supported by a Completion of Inactive Commissioning Report, a Schedule of Maintenance Activities Important to Safety (the Plant Maintenance Schedule), a Schedule of Tests for the Active Commissioning of the Facility, a Pre-Active Commissioning Safety Report and documentation to show that ownership and management of the facility, soon to contain radioactive materials, resides within the licensee's organisation. Only these documents have been listed here as they can be related directly to EMIT and will be of relevance to the assessments performed by ONR Inspectors against this topic.

The Licensee in applying to commence active commissioning will declare when full implementation of the Plant Maintenance Schedule is to be completed. This is a complicated area to progress as Active Commissioning is a phased process and the tests initially introducing radioactive materials to the facility have to be demonstrably safe. For this reason Active Commissioning Tests are not always repeats of Inactive Tests or a first active run of Maintenance Schedule/Instruction items. When an SSC important to safety successfully comes through its active commissioning tests, then the clock should commence for relevant items on the Plant Maintenance Schedule, if it has not already done so, irrespective of whether or not the rest of the facility area is operationally active.

At the end of the pre agreed Active Commissioning period, an Active Commissioning Report is produced. Amongst items in this report will be discussion of operational experience gained. This experience may well change aspects of the design intent, which if approved through the project/licensee change control process leads to modification of design justification reports. These revised reports incorporating facility operating and EMIT experience are often renamed as Design Assessment Reports and may be revised throughout facility life as Periodic Safety Reviews are conducted.

A3.6.2 EMIT During Operation

Many EMIT tasks are undertaken whilst nuclear facilities are operational. Indeed some of the need for redundancy or diversity of SSCs is generated by the requirement for bringing one of these SSCs off line to perform such tasks, whilst achieving continued functionality of the safety requirement for a specified time period. The EMIT tasks performed during operation are often needed to satisfy safety analysis defined mean time between tests to achieve reliability and availability requirements as set down in the safety case.

The Maintenance Instructions (MIs) followed for these tasks usually only give indication of direct measurements required or require achievement of pre-defined acceptance criteria. To gain assurance of continued acceptability further examination and trending of lifetime data may be needed. Such trending or further examination is usually undertaken by SQEP resource from the Design Authority, whether part of a Systems Health Group or Responsible Engineers/Designers Group. It is most important, when assessing the adequacy of in-operation EMIT, to determine that the Maintenance Instructions are sufficiently comprehensive to give full system testing (i.e. from sensing device to end effector, again showing adherence to SAP EMT 7). As mentioned previously, where this is not feasible, the MIs should define areas of partial testing, and how the results of each part can be linked to demonstrate continuing achievement of design intent for the whole system.

In routine operation another important aspect of EMIT is extracting assurance of continuing safe operation from surveillances performed by operations staff. Examples of these surveillances would be data logged from condition monitoring equipment associated with vibration levels on rotating machinery, in-reactor control rod drop traces, or operating parameter traces for fluidic ejectors. Again there is a need for through-life examination of such data by a SQEP resource to determine if adverse trends are present. Such examinations would not usually be within the remit of operations staff and are likely to be within the remit of the Design Authority, possibly leading to recommendations for the replacement of SSCs before they begin to reach the end of the equipment's useful life. Examination of the means for communicating the results of such trending and recommendations to operations staff is an effective way for Inspectors to see that it is happening, supported by appropriate sampling. In addition to the options discussed above, licensees may choose to implement maintenance arrangements based on operating organisation association recommendations, and these may be acceptable provided they ensure that the facility remains appropriately safe, including performance of required safety functions. Also, arrangements which are based on generic approaches to maintenance may be acceptable, such as:

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

Again, providing these approaches address the safety requirements for nuclear SSCs, they may be acceptable, providing the licensee makes an appropriate safety case.

A3.6.3 EMIT within Outages

In order to perform a significant number of the tasks listed on the Plant Maintenance Schedule there will be a need to shut down a nuclear reactor or cease operation within other nuclear facilities to a planned periodicity. Prior to such pre-planned facility shutdowns (usually termed Outages), a programme of work to be undertaken is devised, such that all safety significant Plant Maintenance Schedule items needing EMIT are covered, along with EMIT of multiple trains of auxiliary SSCs needed to allow the safety significant items to function. The programme of work is described within an Outage Intent Document (OID), which is issued some months before the planned facility shutdown. The OID also defines items of plant requiring exchange with overhauled items and possibly significant pre-planned plant modifications.

The outcome from such EMIT will be assessed by SQEP personnel from the Licensee's Operational and Design Authority Organisations, who will be brought together as an Outage Assessment Panel to determine if the recorded outputs are acceptable.

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, since such a change may be deemed appropriate by one engineering discipline within the regulator, but unacceptable from the perspective of another. The view from each discipline should be considered and a decision on the acceptability of the request can then be made.

A3.6.4 Periodic Safety Reviews

Nuclear Licensees should have processes, which allow for annual review against safety case requirements and for flagging up of failure to comply with Maintenance Schedules' periodicity requirements. Such information is used as input to safety case reviews and to 10 yearly Periodic Safety Reviews (PSRs). An important aspect of PSR Reports is confirmation that a Plant's operational history is demonstrating continued design assurance and integrity. The PSR process is also used to demonstrate the adequacy of EMIT regimes by describing plant failures, anomalies and the means found for rectification. It should also provide, where appropriate, confirmation that the reliability claims made within the safety case are continuing to be met, or exceeded. **For further guidance on PSRs refer to NS-TAST-GD-050 Periodic Safety Reviews.**

A3.6.5 End of Routine Operations and into Post Operational CleanOut/Decommissioning

At the end of routine operation of a nuclear facility, there will still be a need to continue with many of the EMIT tasks during say reactor defueling or post operational clean out. Additionally whilst nuclear materials, whether irradiated or activated, are present on the facility at least some EMIT requirements will exist. The extent of the reduced EMIT requirements will be defined by a revised safety case that describes these phases of the facility life. The means for implementing such a revised safety case will be covered within the Licensee's Corporate Modifications Procedures. **For further guidance on Decommissioning refer to NS-TAST-GD-026 – Decommissioning.**