NATIONAL NUCLEAR REGULATOR

For the protection of persons, property and the environment against nuclear damage

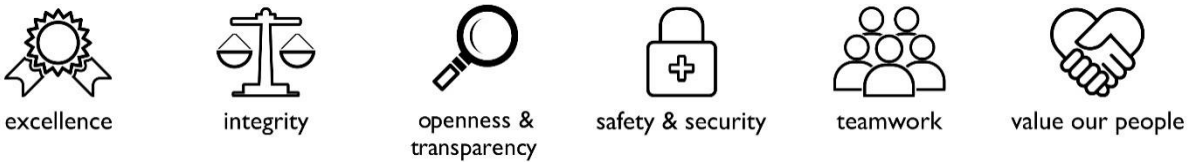
INTERIM REGULATORY GUIDE

AGEING MANAGEMENT AND LONG TERM OPERATIONS OF NUCLEAR POWER PLANTS

RG-0027

Rev 0

March 2019



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REVISION HISTORY			
Rev no.	**Supersedes**	**Nature of revision**	**Date approved**
N/A	None	New Document	N/A

DOCUMENT REGISTRATION	
Office or department of owner	Office of the Executive: RITS
Designation of owner	Manager :RSP
NNR file no.	2/1/P

DOCUMENT HIERARCHY AND PROCESS MODEL

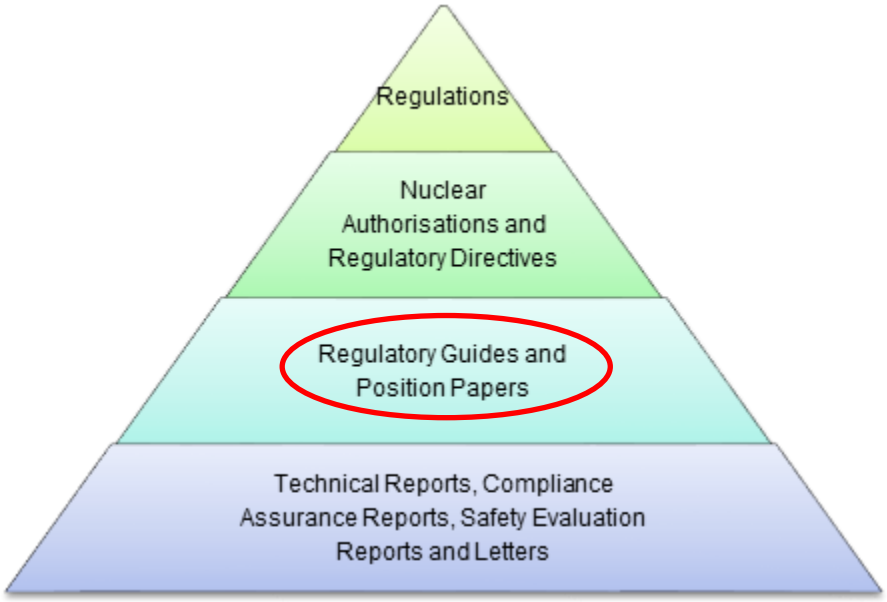

Figure 1: Location of the Regulatory Guide in the NNR Document Hierarchy

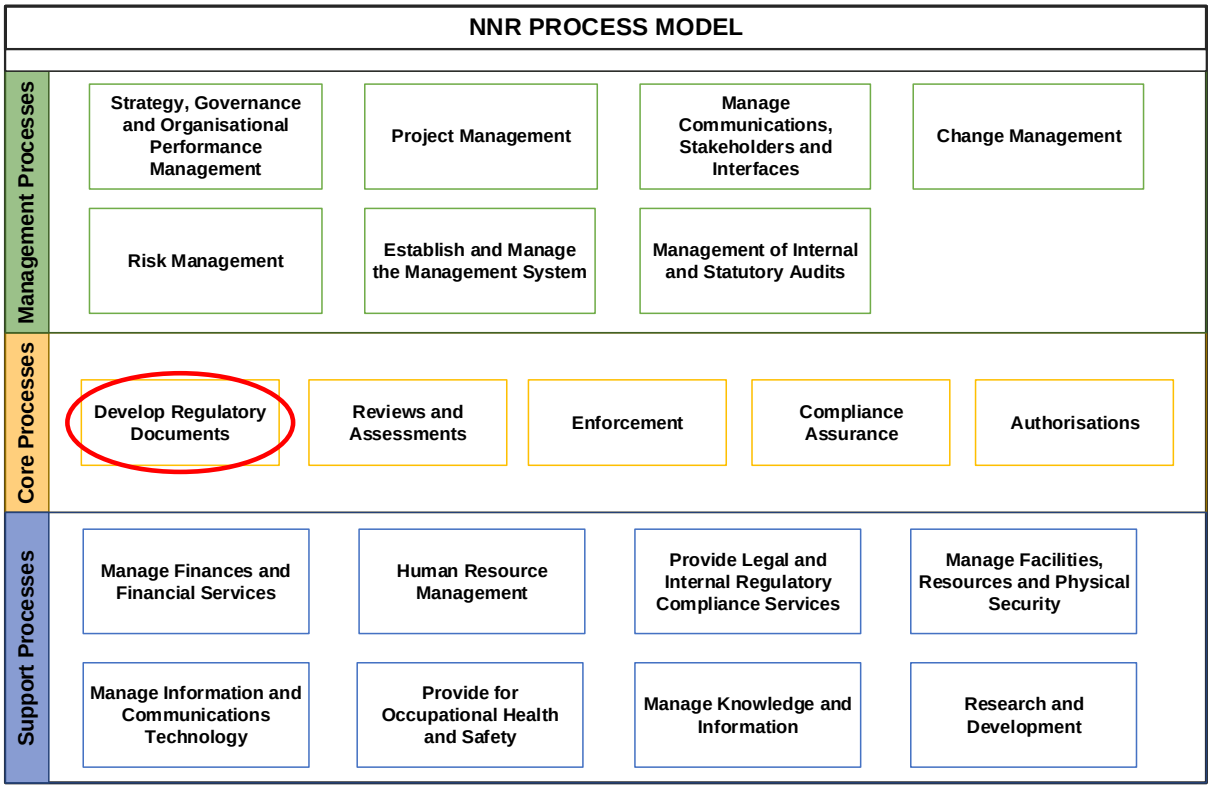

Figure 2: Location of the Regulatory Guide in the Process Model

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FOREWORD

The legal framework applicable to regulation of nuclear industry in South Africa is comprised of law and supporting regulatory documents. Law includes legally enforceable instruments such as Acts, Regulations and Conditions of licences. Regulatory documents comprise of policies, standards, guides, notices, procedures and information documents which support and provide further information on the legally enforceable instruments. Both law and regulatory documents form the framework for regulation of the nuclear industry in South Africa.

Regulatory Guidance documents provide guidance to the licensees and applicants on how to meet requirements of the legally enforceable instruments. This Regulatory Guidance document provides more information about approaches used by National Nuclear Regulator for the Ageing Management and Long Term Operation for Nuclear Power Plants.

1 INTRODUCTION

The National Nuclear Regulator Act, 1999 (Act No. 47 of 1999, hereafter referred to as the NNR Act) establishes the National Nuclear Regulator (NNR) as an independent Regulator and the competent authority for nuclear regulation in South Africa to provide for the protection of persons (the public and workers), property and the environment against nuclear damage.

Section 5 of the NNR Act provides for the objects of the Regulator. In pursuit of these objects, the NNR has established safety standards and regulatory practices that have been documented as regulations and guidance documents. Regulations are mandatory and set specific requirements to be fulfilled by the authorisation holder or an applicant for a nuclear authorisation. Guidance documents are developed to assist authorisation holders and/or applicants for authorisations in meeting the regulatory requirements.

The NNR ensures that its regulatory standards and practices are in line with best international standards and practices that are applied by nuclear regulatory authorities. Therefore, this guideline is developed in line with international requirements and best practices and is based on the International Atomic Energy Agency (IAEA) safety standards.

2 PURPOSE

To provide guidance on the Ageing Management and Long Term Operation (LTO) for Nuclear Power Plants (NPPs).

3 SCOPE

This guide is applicable to Ageing Management and Long Term Operation of NPP's, and include provisions for maintaining the safety of NPP's during LTO.

4 DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Ageing: General process in which characteristics of a structure, system or component (SSC) gradually change with time or use. This term is most commonly used with a connotation of

changes that may diminish the performance of SSCs and may be detrimental to protection and safety (i.e. as a synonym of ageing degradation) of persons, property and environment.

Ageing degradation: Ageing effects that could impair the ability of a SSC to function within its acceptance criteria.

Ageing management: Engineering, operations and maintenance actions to control within acceptable limits the ageing degradation of SSC's.

Authorisation holder: A holder of a nuclear authorisation as defined in the NNR Act.

Configuration management: The process of identifying and documenting the characteristics of a facility's SSC's (including computer systems and software), and of ensuring that changes to these characteristics are properly developed, assessed, approved, issued, implemented, verified, recorded and incorporated into the facility documentation.

Current licensing basis: The safety case applicable at any time during operation of the plant, comprising applicable regulations and Regulator guidelines and all licence-binding documentation, including project management documentation, safety analysis report, operational limits and conditions, and other safety related programmes applicable during a licensing stage applicable during licensing stages (including modifications), which shall be retained as records.

Design basis: The range of conditions and events taken explicitly into account in the design of a facility, according to established criteria, such that the facility can withstand them without exceeding authorised limits by the planned operation of safety systems.

Design life: The period of time during which a facility or component is expected to perform according to the technical specifications to which it was produced.

In-service inspection: Inspection of SSC's undertaken over the operating lifetime by or on behalf of the operating organisation for the purpose of identifying age related degradation or conditions that, if not addressed, might lead to the failure of structures, systems or components.

Lifetime management - Integration of ageing management with economic planning:

- To optimise the operation, maintenance and service life of SSCs;
- To maintain an acceptable level of performance and safety; and
- To maximise the return on investment over the service life of the facility.

Long Term Operation: Operation of the plant beyond an established time frame set forth by, for example, licence term, design, standards, licence and/or regulations, which has been justified by safety assessment, with consideration given to life limiting processes and features of SSCs.

Maintenance: The organised activity, both administrative and technical, of keeping SSC's in good operating condition, including both preventive and corrective (or repair) aspects.

Non-physical ageing: The process of becoming out of date (i.e. obsolete) owing to the evolution of knowledge and technology and associated changes in codes and standards.

Operating lifetime: The period during which an authorised facility is used for its intended purpose, until decommissioning or closure.

Periodic safety review: A systematic reassessment of the safety of an existing facility (or activity) carried out at regular intervals to deal with the cumulative effects of ageing, modifications, operating experience, technical developments and siting aspects, and aimed at ensuring a high level of safety throughout the service life of the facility (or activity).

Physical ageing: Ageing of SSC's due to physical, chemical and/or biological processes (ageing mechanisms).

Safety Aspects of Long Term Operation: The IAEA peer reviewed safety assessment focused on the safety aspects of long term operation for nuclear power plants planning on extending plant life into long term operation.

Safety Related Programmes: Means collectively all nuclear safety related activities conducted during the operational phase of the facility and may also be applicable during interim authorisation stages.

Surveillance:

(1): observation or measurement of condition or functional indicators to verify that an SSC currently can function within acceptance criteria.

(2): continuous monitoring of plant conditions during operation or shut down.

Technological obsolescence: The lack of spare parts, technical support, suppliers and / or industrial capabilities.

4.2 Abbreviations

AM	Ageing Management
AMP	Ageing Management Review
CLB	Current Licensing Basis
EXCO	Executive Committee
IAEA	International Atomic Energy Agency
IGALL	International Generic Ageing Lessons Learned
LTO	Long Term Operation
NNR	National Nuclear Regulator
NPP	Nuclear Power Plant
PSR	Periodic Safety Review
SALTO	Safety Aspects of Long Term Operation
SAR	Safety Analysis Report
SC	Structures and components
SSC	Systems, structures and components
SSRP	Regulation on Safety Standards and Regulatory Practices
TLAA	Time limited ageing analyses

5 REGULATORY FRAMEWORK

5.1 NNR Act

1) The legal basis for the NNR relating to the operation of nuclear facilities is derived from the NNR Act, specifically sections 5(b), 20(1), 21(1) and 23.

2) Section 5(b) of the Act grants the NNR the power to exercise regulatory control over the safety of siting, design, construction, operation, manufacture of component parts, and decontamination, decommissioning and closure of nuclear installations through the issuing of nuclear authorisations.

3) Section 20(1) of the Act states that: “No person may site, construct, operate, decontaminate or decommission a nuclear facility, except under the authority of a nuclear installation licence”. In terms of the provisions of this section, the siting, construction, operation, decontamination or decommissioning of any nuclear facility as defined in section 1(xviii) of the Act must be authorised by way of a nuclear licence granted by the NNR.

4) Section 21(1) requires that any person wishing to site, construct, operate, decontaminate or decommission a nuclear facility may apply in the prescribed format to the Chief Executive Officer of the NNR for a nuclear licence and must furnish such information as the NNR board of directors requires.

5) In terms of Section 23 of the Act, the Chief Executive Officer may impose and amend conditions of authorisation that are necessary to ensure the protection of persons, property and the environment against nuclear damage, or to provide for rehabilitation of the site.

5.2 SSRP - Regulatory Standards

Regulation on Safety Standards and Regulatory Practices (SSRP), promulgated in terms of section 36 of the NNR Act, includes the following requirements relevant to Ageing Management and Long Term Operation that must be complied with:

a) Requirement 4.1.1: Operational safety assessments must be made and submitted to the Regulator at intervals specified in the nuclear authorisation and which must be commensurate with the nature of the operation and the radiation risks involved.

b) Requirement 4.1.2: Operational safety assessments must be of sufficient scope and must be conducted and maintained in order to demonstrate continuing compliance with dose, risk limits and other relevant conditions of the nuclear authorisation.

c) Requirement 4.1.3: The operational safety assessment must establish the basis for all operational safety-related programmes, limitations and design requirements.

d) Requirement 4.3.1: An appropriate maintenance and inspection programme must be established.

e) Requirement 4.3.2: The maintenance and inspection programme must be implemented to ensure that the reliability and integrity of installations, equipment and plant having an impact on radiation and nuclear safety are commensurate with the dose limits and risk limits in Annexure 2 and 3.

5.3 Nuclear Authorisation

1) The Nuclear installation licences issued in terms of the NNR Act should specify various conditions that as a collective defines the current licensing basis for the specific nuclear facility.

2) Operation of a nuclear facility beyond an established timeframe defined in the current licensing basis or relevant standards should be supported by a safety case to demonstrate continued safe operation of the nuclear facility.

3) Operation of a nuclear facility beyond an established timeframe defined in the nuclear installation licence is subject to:

   a) An application for variation of the respective nuclear installation licence supported by a safety case to demonstrate continued safe operation of the nuclear facility.

   b) The application should be done in accordance with Government Notice GN1219: Format for the application for a Nuclear Installation Licence or a Certificate of Registration or a Certificate of Exemption.

5.3.1 Safety case and submissions to NNR for Long Term Operation

1) The Periodic Safety Review (PSR) should be used to as an input to the safety case justify LTO.

2) To ensure the safe LTO of nuclear facilities, the authorisation holder should demonstrate to the NNR that:

   a) The safety of the nuclear facility will be maintained throughout the proposed period of LTO in accordance with current safety standards as far as reasonably practical; and

b) Sufficient resources and technical support will be available for the intended period of LTO, including cessation of operation, decommissioning to the termination of period of responsibility.

3) The safety case should:

a) Demonstrate compliance with relevant regulatory safety criteria and requirements;

b) Be synchronised where practical with a Periodic Safety Review (PSR);

c) Provide an overall assessment of the safety of the nuclear facility and justification for continued safe operation for the intended period of Long Term Operation;

d) Determine the:

i) extent to which the existing current licensing basis remains valid;

ii) extent to which the nuclear facility conforms to modern current national and/or international safety standards and operating practices and considers operational experience;

iii) adequacy and effectiveness of the safety related programmes and the SSCs in place to ensure plant safety until the end of commercial operation;

iv) improvements to be implemented to resolve any gaps identified in the review and timelines for their implementation.

e) Include:

i) A description of the reassessment of the design basis of the facility;

ii) Ageing Management and Long Term Operation programmes, supporting documentation such as scoping document and time limited ageing analyses and all other relevant safety related programmes;

iii) Results of ageing management review and trends of expected ageing effects during the period of Long Term Operation based on past studies;

iv) Description of environmental qualification of equipment;

v) Summary of the verified safety analyses;

vi) Summary of the of the operational experience feedback, research activities and plant improvements;

vii) Summary of the PSR and the action plan for improving; and

viii) An updated Safety Analysis Report.

ix) The update to the safety analysis report should also include documentation of the revalidation of the time limited ageing analyses for the period of Long Term Operation.

4) The submissions to the NNR should justify that:

a) The intended safety functions of SCs will be maintained with sufficient safety margins for the whole period of LTO;

b) The implementation of plant activities for LTO is properly documented in an updated safety analysis report or other licensing documents, together with an integrated implementation plan that includes results of the engineering process and constitutes the basis documents for application for and approval of LTO; and

c) The implementation plan identifies the corrective actions and/or safety improvements required to be implemented for safe LTO, and includes formal commitments from the operating organisation to implement these within a reasonable schedule.

5) Key requirements regarding documents that should be submitted to the NNR in support for LTO are outlined in Section 7.9. Additional requirements may be established depending on the project and relevant regulatory requirements.

5.3.2 Licensing schedule and timelines

1) Typical timelines for review and approval for LTO applications should include the following considerations:

a. Preparation;

b. Engagement with stakeholders as appropriate;

c. Review schedule;

d. Approval processes

2) The NNR should be formally notified as soon as practical but no later than 48 months in advance of the expiration of the existing licence or current licensing basis of an authorisation holder intention to pursue LTO.

3) This should be followed 42 months in advance for a formal application for a variation of the nuclear installation licence or an update of the current licensing basis to allow

for adequate time for regulatory reviews, resolution of comments, engagement with stakeholders as required and regulatory governance processes.

4) The application or notification referred to above should be accompanied by a Project Management Manual defining amongst others the project organisation, roles and responsibilities, licensing interfaces and schedule, resources and deliverables.

6 AGEING MANAGEMENT

6.1 General Considerations

1) The authorisation holder should describe ageing management as part of the management system for the NPP.
2) The authorisation holder should develop, implement and maintain an ageing management programme comprising the functions, duties and responsibilities for assuring the operability and technological conformance of SSCs important to nuclear safety throughout operating life of the facility.
3) The ageing management programme should determine the consequences of ageing and the activities necessary to maintain the operability and reliability of SSCs.
4) The ageing management programme should be coordinated with, and be consistent with, other relevant safety related programmes, including the programme for periodic safety review.
5) The authorisation holder should develop a systematic approach for the continuous improvement of ageing management programmes by identifying both foreseen and new ageing and degradation mechanisms of SSCs. This should be implemented through the entire lifetime of the plant, (i.e. design, construction, commissioning, operation, Long Term Operation, suspended operation and decommissioning.)
6) Long term effects arising from operational and environmental conditions (i.e. temperature conditions, radiation conditions, corrosion effects or other degradations in the plant that may affect the long term reliability of plant equipment or structures) should be evaluated, assessed and monitored as part of the ageing management programme.
7) The designated personnel responsible for ageing management of the nuclear facility should possess the necessary competence, skills and experience to discover such solutions that the adverse effects of ageing mechanisms on the operability of SSC may be prevented.
8) The authorisation holder should have documented procedures in place for ensuring that any information and knowledge necessary for discharging the duties is not lost in the event of personnel changes.
9) The authorisation holder should make use of research data, operating experience feedback from other nuclear facilities as well as the feedback received from the authorisation holder’s in-house operating and maintenance organisation to identify ageing mechanisms.

10) The authorisation holder should assess the effectiveness of the ageing management system on a regular basis and make necessary improvements and corrective actions whenever there is increase in the failure of SSCs.
11) The authorisation holder should keep abreast with new developments in design, manufacturing techniques, condition monitoring and maintenance methods for the purpose of improving the ageing management of SSCs.
12) The authorisation holder should keep up-to-date record of the reference information necessary for the ageing management of SSCs.
13) The authorisation holder should establish a specific equipment qualification programme, including consideration of ageing of SSCs.

6.2 Management of ageing throughout the lifetime of the facility

6.2.1 Design

1) During the design stage of the NPP, the authorisation holder/ applicant should demonstrate that ageing has been adequately taken into account both in the provision of design margins and the provisions for monitoring, testing, sampling, and inspection to assess ageing mechanisms, verify predictions, and identify unanticipated behaviours or degradation.
2) Appropriate measures should be taken and design features should be introduced in the design stage to facilitate effective aging management throughout the lifetime of the NPP.
3) Ageing management should also be considered in the design of modifications to existing operating plants and for design changes related to modifications and repairs or replacements of individual SSCs.
4) The authorisation holder should ensure that ageing effects under design basis conditions, including transient conditions and postulated initiating event conditions, in the specifications for equipment qualification programmes, (e.g., environmental qualification and seismic qualification programs) are considered.
5) All potential ageing effects and degradation mechanisms for SSCs that will perform passive and active functions should be identified, evaluated in the design stage.
6) The authorisation holder / applicant should identify the effects and interactions between mechanical, thermal, chemical, electrical, physical, biological and radiation stressors on materials properties, materials ageing and degradation processes.
7) The authorisation holder / applicant should demonstrate how past relevant generic ageing issues, relevant ageing management experience and research results are addressed in the design.

8) The authorisation holder / applicant should ensure that suitable materials with adequate ageing resistant properties are used. Materials testing programmes should be in place for periodic monitoring of ageing effects during operation of the plant, taking into account the need for accessibility of the SCs.
9) Provisions for in-service inspections as well as on-line monitoring should be in place, to ensure to proactive monitoring and early detection of degradation leading to failure of SSCs and where the consequences of failure could be important to safety.
10) The authorisation holder should ensure inspections and maintenance activities for SSC are in place over the lifetime of the nuclear facility.
11) The authorisation holder should ensure provisions for relevant preventive and/or mitigatory measures (e.g. appropriate chemistry programmes) are considered.
12) The safe working life of SSCs that are important to safety should be evaluated and defined at the design stage. Particular attention should be given to the evaluation of those components that are judged to be difficult or impracticable to replace. There should be an adequate margin between the intended operational life and the predicted safe working life of such structures, systems and components.

6.2.2 Manufacturing and Construction

1) The authorisation holder / applicant should ensure that suppliers adequately address factors affecting ageing management and that sufficient information on manufacturing are provided to the authorisation holder.
2) The authorisation holder should consider supplier's manufacturing information when developing ageing management programmes, including operating and maintenance procedures.
3) The authorisation holder / applicant should ensure that:
   a) Current knowledge about relevant potential ageing effects and degradation mechanisms as well as possible preventive and/or mitigatory measures are taken into account in the fabrication and construction of in-scope SSCs by manufacturers;
   b) The transport and storage conditions of manufactured equipment are appropriate to avoid premature ageing effects and/or conditions that can promote subsequent ageing;
   c) All relevant reference (baseline) data are collected and documented (e.g. information and data on material chemistry and material properties);
   d) Sufficient surveillance specimens for specific ageing monitoring programmes (to cover possible periods of Long Term Operation) are made available and can be obtained in accordance with design specifications;

e) Equipment qualification tests carried out by the manufacturer are in compliance with the applicable equipment qualification programme;

f) Where material properties could change with time and affect safety, provision should be made for periodic measurement of these properties.

4) If a delayed construction period has occurred at the plant, the authorisation holder / applicant should identify and document the environmental conditions that could affect the physical condition of SSCs and their long term ageing behaviour, and should make any necessary modifications to the ageing management programme for the SSCs.

6.2.3 Commissioning

1) The authorisation holder should establish a programme for measuring and recording baseline data relevant to ageing management for all in-scope SSCs. This should include mapping the actual environmental conditions in each critical location of the plant to ensure that they are in compliance with the design.
2) The authorisation holder should verify that the actual environmental conditions are consistent with those considered in the design of SSCs. Special attention should be paid to the identification of 'hot spots' in terms of temperature and levels of radiation, and to measurement of vibration levels. All parameters that can influence degradation mechanisms should be identified as early as possible, monitored if possible and tracked throughout the operation of the plant.
3) The authorisation holder should collect baseline data and should also confirm that critical service conditions (as used in equipment qualification) are in compliance with the design.
4) The authorisation holder should ensure that SSCs are not subjected to unnecessary stresses by tests performed during commissioning that are not accounted for in the design or that could cause premature ageing.
5) The authorisation holder should document the testing and record the test results properly during commissioning, in order to allow investigation of possible cases of subsequent premature ageing that may have been caused by improper execution of some testing.

6.2.4 Operation

1) A systematic approach should be applied to manage ageing and obsolescence of SSCs, to ensure that required intended functions are maintained at all times during the operation stage of the lifetime of the NPP.
2) The authorisation holder should ensure that programmes and documentation relevant to the management of ageing and technological obsolescence are implemented during the operation stage.

3) The authorisation holder should ensure that specific operational procedures for the water chemistry programme or other environmental control programmes and other preventive or mitigatory actions with respect to ageing are followed.
4) Specific parameters of concern should be monitored and recorded during plant operations to demonstrate compliance with critical service conditions, operational limits and conditions, and any other parameters that were identified as affecting ageing assumptions used in safety analyses or equipment qualification.
5) The authorisation holder should ensure the timely detection and characterisation of significant ageing effects through the inspection and monitoring of in-scope structures or components, and the assessment of observed ageing effects to determine the type and timing of any actions required.
6) The authorisation holder, in cooperation with design organisations, should ensure that corrective actions are followed or taken to prevent or mitigate ageing effects of structures or components through the appropriate maintenance, repair and replacement or modification of a structure or component, and/or through appropriate changes to relevant plant operations, programmes and documentation.
7) In the event of operational changes or modifications to SSCs, the authorisation holder should ensure that a review is performed of possible changes in environmental or process conditions that could affect ageing or lead to the failure of SSCs. If necessary, an ageing management review should be completed for the affected SSCs.
8) The availability of spare parts or replacement parts and the shelf life of spare parts or consumables should be systematically monitored and controlled.
9) Where spare parts or consumables could be vulnerable to degradation mechanisms owing to their storage environment, measures should be taken to ensure that they are stored in an appropriately controlled environment.
10) For major SSCs important to nuclear safety, the authorisation holder should consider preparing contingency plans or exceptional maintenance plans to deal with their potential ageing effects or their failure caused by potential ageing effects and degradation mechanisms.
11) Evaluation of relevant operating experience and research and development programmes should be continuously performed to support better understanding of degradation mechanisms and their ageing effects and to improve the ageing management programmes.
12) If a new ageing effect or degradation mechanism is discovered (e.g. through feedback of operating experience or research and development), the authorisation holder should

perform an appropriate ageing management review and should implement additional ageing management as necessary.

6.2.5 **Long Term Operation** (LTO)

1) If LTO is contemplated, the authorisation holder should establish policy documents, dedicated organisational structures and action plans to perform evaluations for Long Term Operation well before the plant enters into Long Term Operation.
2) The authorisation holder should assess the current physical status of relevant SSCs during the preparation phase for Long Term Operation.
3) The authorisation holder should justify that the physical status of SSC's will be managed consistent with the current licensing basis for the planned period of LTO.
4) Concerning ageing management, the authorisation holder should review and validate the existing programmes and processes (or elements thereof) relevant to ageing for all in-scope structures or components.
5) For in-scope SSC's, the authorisation holder should identify all time limited ageing analyses (TLAAs) and should demonstrate either that all these analyses will remain valid for the planned period of LTO, or that the structures or components will be replaced, or that further operation maintenance or ageing management actions will be implemented.
6) Decisions concerning Ageing Management and Long Term Operation should take due account of the potential implications for the subsequent decommissioning stage.
7) Since LTO is operation beyond the originally established timeframe and evaluations for LTO are based on assumptions, the authorisation holder should periodically perform the following activities to validate or correct the ageing related assumptions so that plant safety during LTO is ensured and improved:
   a) Evaluation of operating experience at the plant or at other nuclear power plants after entering LTO;
   b) Analysis of trends in ageing effects;
   c) Review of the effectiveness of the ageing management programmes and existing safety related programmes for LTO;
   d) Incorporation of relevant research and development results;
   e) Evaluation of the need for new research and development.

6.2.6 **Long Term Shutdown**

1) The authorisation holder should review and, where necessary, revise the ageing management programmes to ensure that relevant factors affecting ageing are taken into

account for SSCs that are temporarily placed in lay-up or safe-storage states during suspended operation.

2) Authorisation holder should establish clear defined process for provisions for ageing management of SSCs in lay-up, including requirements for any condition assessments to be completed prior to the return to service of the plant following a period of suspended operation.
3) The provisions for ageing management, including the scope of condition assessments, should be reassessed if the duration of the shutdown is greatly extended beyond what was originally anticipated due to unforeseen issues or delays in the return to service.

6.2.7 Decommissioning

1) The authorisation holder should ensure that ageing management arrangements are in place during the transition period between permanent shutdown of operations and implementation of the approved final decommissioning plan, to ensure that required SSCs remain available and functional.
2) The authorisation holder should establish and implement ageing management activities in decommissioning plans and procedures for SSCs that are required to remain available and functional during decommissioning to prevent their deterioration and to allow the safe dismantling, handling and transport of components until the completion of decommissioning.
3) Authorisation holder should ensure monitoring of SSCs to ensure the integrity of the containment and to ensure that there are no significant radioactive releases during the transition period until completion of decommissioning.

6.3 Relevant Plant Documentation and Programmes

6.3.1 Safety analysis report and other current licensing basis documents

1) The description of ageing management in the safety analysis report should include general information on the following topics:
   a) The strategy for ageing management and prerequisites for its implementation;
   b) Identification of all SSCs of the plant that could be affected by ageing and are in the scope of the ageing management;
   c) Proposals for appropriate materials monitoring and sampling programmes in cases where it is found that ageing effects may occur that may affect the capability of SSCs to perform their intended function throughout the lifetime of the plant;

d) Ageing management for different types of in-scope SSCs (e.g. concrete structures, mechanical components and equipment, electrical equipment and cables and instrumentation and control equipment and cables) and means to monitor their degradation;

e) Design inputs for equipment qualification of the in-scope SSCs, including required equipment, and equipment functions that need to be qualified for service conditions in normal operation and associated with postulated initiating events;

f) General principles stating how the environment of an SSC is to be maintained within specified service conditions (e.g. by means of proper location of ventilation, insulation of hot SSCs, radiation shielding, damping of vibrations, avoiding submerged conditions and proper selection of cable routes);

g) Appropriate consideration of the analysis of feedback of operating experience with respect to ageing.

2) The policy on ageing management and the justification of LTO should be properly documented in the current licensing basis, in particular in such documents as the safety analysis report, reports of periodic safety reviews (if applicable) or other licensing basis documents.

3) The safety analysis report should be kept updated to reflect the results of the ageing management review.

4) The safety analysis report or other licensing documents should provide descriptions of activities in support of safe LTO to ensure that the authorisation holder maintains the necessary information to reflect the current status of the plant and addresses new issues as they arise.

5) The authorisation holder should conduct a comprehensive periodic safety review.

6.3.2 Configuration and modification management programmes including design basis documentation

1) The authorisation holder should follow a configuration management programme or modification management programme that reflects the evolving status of the plant.

2) All modifications of SSCs, releases of process software, operational limits and conditions, set-points, instructions and procedures should be properly documented and retained in a retrievable form.

3) For the purpose of a formal process to maintain design integrity, the nuclear facility should establish an organisational entity (e.g. a unit or member of staff) that has overall responsibility for the design process, that approves design changes and that is responsible for ensuring that the knowledge of the design basis is maintained.

4) The management system should contain the processes and activities relating to the configuration management programme and the modification management programme.
5) The design basis documentation, including design basis requirements and supporting design basis information, should be owned by or accessible to the authorisation holder to support appropriate configuration management and modification management and to allow identification of the time limited ageing analyses for the plant.
6) The design basis information and any changes to it should be included in the safety analysis report or separate design basis documentation.
7) If design basis documentation is not complete or is obsolete, an appropriate programme for reconstitution of the design basis should be implemented.

6.3.3 Safety related programmes

1) Existing programmes that are credited for ageing management and used in evaluations for LTO should be consistent with the attributes listed in Annexure A.
2) An effectiveness review of all safety related programmes essential to Ageing Management and Long Term Operation should be performed.
3) The following existing safety related programmes are essential to ageing management and evaluations for LTO:
   a) Maintenance programmes
      i) Maintenance programmes should be in place and should be properly implemented for ageing management and evaluations for LTO of applicable in-scope SSCs.
      ii) The maintenance programmes should clearly specify the links with the ageing management programmes, including the frequency of maintenance activities and specific information on the tasks and their evaluation and on the retention of records.
      iii) The plant maintenance programmes should be assessed to ensure that in-scope SSCs are capable of performing their intended functions throughout operation, including the planned period of LTO.
      iv) The results of the assessments should be used to improve the existing maintenance programmes. The documentation of the assessments should cover all maintenance activities and should provide technical references to support findings and conclusions.
   b) Equipment qualification programme
      i) An equipment qualification programme to achieve and maintain the qualified status of in-scope SSCs should be in place.

ii) Environmental qualification should demonstrate that, at the end of its qualified life, the equipment will still be capable of performing its intended function(s) under the full range of specified service conditions.

iii) Environmental qualification should establish the qualified life of equipment within which ageing effects would not prevent satisfactory performance of the equipment if a postulated accident were to occur within the established operating period (possibly including LTO).

iv) Monitoring of actual environmental conditions should be implemented in order to get additional information necessary for the assessment of ageing effects on the equipment in its actual operating environment.

v) The qualified life of equipment should be reassessed during its lifetime, taking into account progress in the knowledge and understanding of degradation mechanisms and the actual operating environment of the equipment. If the qualified life is to be increased, a thorough safety demonstration should be provided by the authorisation holder.

vi) The qualification status of equipment should be properly documented and maintained throughout the plant lifetime. The documentation should include:

(1) A master list of qualified equipment;

(2) Results of temperature monitoring and radiation monitoring in the plant; if applicable

(3) The evaluation report for equipment qualification;

(4) Test reports relating to equipment qualification;

(5) Reports of TLAA's relating to equipment qualification (for evaluation for long-term operation), or reports of another suitable equivalent analysis.

vii) The review of equipment qualification should include an assessment of the effectiveness of the plant's equipment qualification programme. The review should also consider the effects of ageing on equipment during service and the effects of possible changes in environmental conditions during normal operation and postulated accident conditions since the equipment qualification programme was implemented.

c) In - service inspection programmes

i) In-service inspection programmes should be in place and properly implemented for ageing management and evaluations for LTO of applicable in-scope SSCs, including consideration of baseline data.

ii) In-service inspection procedures should be effective in detecting degradation and it should be demonstrated that ageing effects will be adequately detected with the proposed inspection or monitoring technique.

iii) The results of in-service inspection should be documented such that a trending analysis can be carried out using the results obtained from sequential inspections at the same location and should inform revision of inspection frequencies.

iv) In-service inspection results that indicate notable degradation should be evaluated to ensure that the extent of degradation at similar locations is appropriately determined. SSCs in redundant subsystems should be inspected independently to detect possible differences in their ageing behaviour.

v) A list or database should be developed and maintained to document the adequacy of non-destructive examination in detecting, characterising and trending the degradation of structures or components. The database should provide the technical bases to support the findings and the conclusions necessary to support ageing management decisions.

d) Surveillance programmes

i) Surveillance programmes, including functional tests, should be in place and properly implemented for ageing management and evaluations for LTO of applicable in-scope SSCs.

ii) Particular attention should be paid to the following aspects specifically for nuclear power plants:

(1) The integrity of the barriers between radioactive material and the environment (i.e. the primary pressure boundary and the containment);

(2) The availability of safety systems such as the reactor protection system, the safety system actuation systems and the safety system support features;

(3) The availability of items whose failure could adversely affect nuclear or radiation safety;

(4) Functional testing to ensure that the tested SSCs are capable of performing their intended function(s).

iii) The surveillance programmes should confirm the provisions for safe operation that were considered in the design and assessed in construction and commissioning, and which are verified throughout operation.

iv) The surveillance programmes should continue to supply data from monitoring relevant parameters to be used for assessing the service life of SSCs for the

planned period of LTO, for example through existing or additionally installed means for measuring temperature and pressure, or through additional diagnostic systems.

v) The surveillance programmes should verify that the safety margins for LTO are adequate and provide a high tolerance for anticipated operational occurrences, errors and malfunctions.

vi) Surveillance programmes using representative material samples (such as material specimens for surveillance of the reactor pressure vessel, cable samples and corrosion coupons) should be reviewed and extended or supplemented for ageing within the period of LTO, if necessary.

vii) The documentation on the relevant initial conditions of the material samples used for surveillance should be identified, the adequacy of the information should be assessed, and the documentation should be supplemented as necessary.

viii) Appropriate testing procedures and evaluation methods should be considered for defining the set of specimens to be included in the supplementary material surveillance programme for the reactor pressure vessel, if necessary, at least for alternative assessments such as the master curve approach for assessing fracture toughness.

e) Water chemistry programme

i) The programme should ensure that degradation due to stressors in water chemistry does not impact the ability of SSCs to perform their intended functions, in accordance with the assumptions and the intent of the design.

ii) The water chemistry programme should avoid and/or minimise the harmful effects of chemical impurities and corrosion on plant SSCs.

iii) The authorisation holder should ensure that the plant water chemistry programme is effective in maintaining the water quality required by the technical specifications.

iv) The water chemistry programme should specify the scheduling and the analytical methods used to monitor chemistry and the means of verification of the effectiveness of the chemistry programme.

v) The water chemistry programme should also provide the necessary chemical and radiochemical environment to ensure safe LTO and the integrity of structures or components within the scope of ageing management and evaluations for LTO.

6.3.4 Corrective action programmes

The following guidance relating to corrective action programmes is applicable:

1) A corrective action programme should be put in place to ensure that conditions adverse to quality, such as ageing related degradation, are identified and that corrective actions commensurate with the significance of the issue are specified and implemented.
2) The corrective action programme should document occurrences of identified ageing related degradation and the methods used to address the degradation, such as evaluation and acceptance, evaluation and monitoring, repair, or replacement and external operational experience.
3) The corrective action programme should document the modifications to ageing management programmes, system configuration or plant operations that are made to manage the occurrence or the severity of the ageing effect.
4) The corrective action programme and the associated plant specific operating experience as well as operating experience from other facilities should be routinely reviewed by individuals responsible for the relevant ageing management programme. The review should determine whether ageing management programmes need to be enhanced to ensure that the corrective action programme is effective in managing the ageing effects for which it is credited.
5) If it is determined, through the evaluation of the corrective action programme and the associated plant specific operating experience, that the ageing management programmes do not adequately manage the effects of ageing, modifications to the existing ageing management programmes should be specified and implemented, or new ageing management programmes should be developed, as appropriate.

6.4 Management of Ageing

6.4.1 Organisational arrangements

1) The organisational arrangements, such as the organisational structure and the policies of the authorisation holder should meet NNR requirements as provided in RD-0034.
2) In addition to the above general NNR standards, the following guidance is specific organisational arrangements for ageing management:
   a) For the implementation of the programme for ageing management, the policy and objectives of the programme should be established and the necessary resources (human resources, financial resources, tools and equipment, and external resources) should be identified and allocated.
   b) Suitable organisational and functional arrangements should be established in which all necessary plant personnel and external organisations are involved and support ageing management.

c) An organisational entity should be formally assigned responsibilities for ageing management. This ageing management entity should have close relationships with other organisational units within the plant, such as the operations, maintenance, engineering and management system units. Interdisciplinary ageing management teams consisting of members of different units of the plant and external experts may be established if necessary, on a permanent or ad hoc basis.

d) The responsibilities of the ageing management entity should include:
   i) Development of the facility ageing management programme;
   ii) Coordination of existing and new safety related programmes that are relevant to ageing management;
   iii) Systematic monitoring of relevant operating experience and research and development results, and evaluation of their applicability to the nuclear power plant;
   iv) Direction of interdisciplinary ageing management teams for managing complex ageing issues;
   v) Assessment and optimisation of ageing management programmes;
   vi) Dealing with external technical support organisations;
   vii) Evaluation of further training needs;
   viii) Performance of periodic self-assessments;

e) The ageing management entity should have clearly well-defined responsibilities.

f) Responsibilities for the implementation of ageing management programmes and for reporting on the performance of SSCs should be clearly well-defined.

g) Training on the effects of ageing on SSCs should be provided for personnel involved in operations, maintenance and engineering, to enable them to make an informed and effective contribution to ageing management.

h) Relevant plant and industry operating experience should be systematically collected and evaluated and should be used for improving the ageing management programmes.

6.5 Data Collection and Record Keeping

1) A data collection and record keeping system should be in place as a necessary base for the support of ageing management.

2) The data collection and record keeping system should be established in the early stages of the lifetime of the nuclear facility in order to provide information for the following activities:

a) Identification of manufacturing, construction and environmental conditions that could adversely affect the ageing of SSCs, including any periods of delayed construction or suspended operation;
b) Identification of relevant manufacturing records, such as heat treatment history and certified reports on material tests;
c) Identification and evaluation of degradation, failures and malfunctions of components caused by ageing effects;
d) Decisions on the type and timing of maintenance actions, including calibration, repair, refurbishment and replacement;
e) Optimisation of operating conditions and practices that avoid or minimise ageing effects;
f) Identification of all ageing effects before they jeopardise nuclear facility safety or reduce service lives of SSCs;
g) Records of configuration and modification management, maintenance, surveillance and in-service inspection results and chemistry control records.

3) To facilitate obtaining the necessary quality and quantity of ageing related data from plant operation, maintenance and engineering, representatives of the operations, maintenance and engineering units should be involved in the development and maintenance of the data collection and record keeping system.
4) Design documentation, including documentation from suppliers, should be made available as this is essential in supporting effective ageing management.
5) The use of available generic data should be considered until the plant has developed its own data from the construction stage onwards

6.6 Scope Setting for SSC's

1) A systematic scope setting ('scoping') process to identify SSCs subject to ageing management should be developed and implemented.
2) This process should be acceptable to the NNR and:
   a) Be based on relevant international standards and practices; and
   b) Include benchmarking of the in-scope SSC's.
3) A list or database of all SSCs at the NPP should be made available before the scope setting process is commenced.
4) The following SSCs should be included in the scope of ageing management:
   a) SSCs important to nuclear safety that are necessary to fulfil the fundamental safety functions for that nuclear facility.

b) Other SSCs whose failure may prevent SSCs important to nuclear safety from fulfilling their intended functions.

c) Other SSCs that are credited in the safety analyses (deterministic and probabilistic) as performing the function of coping with certain types of events, including design base extension conditions and severe accident management.

5) Structures and components that satisfy both (a) and (b) of the following conditions can be excluded from the scope of ageing management:

a) Structures and components subject to periodic replacement or a scheduled refurbishment plan on the basis of predefined rules (based on a manufacturers recommendation or other basis and not on an assessment of the condition of the structure or component, which would comprise implementation of ageing management for the structure or component) within the period of LTO;

b) Structures and components accepted by the NNR not to be included in the scope. Any adjustment to revise the frequency agreed upon should be submitted to NNR for approval.

6) If an SSC within the scope is directly connected to an SSC out of the scope, clear definitions of the boundaries between them should be established.

7) In addition, nuclear facility walk-downs should be used to check the completeness of the list of SSCs whose failure may prevent SSCs important to nuclear safety from performing their intended functions.

8) Since the subsequent process is carried out at the level of a structure or component (or its subcomponent), all structures or components and their subcomponents within the scope for ageing management should be identified. If the components or structures within a group have similar functions and similar materials and are in a similar environment, that group may be defined as a structure or component ‘commodity group’.

9) All information and conclusions with regard to the scope of ageing management review should be documented, including:

a) A description and justification of the methods used to determine the structures or components that are subject to an ageing management review;

b) An identification and listing of structures or components subject to an ageing management review and their intended function(s);

c) The information sources used to accomplish the above, and any description necessary to clarify their use.

10) After the scope setting process, a clear distinction between SSCs within the scope and those out of the scope should be evident.

6.7 Ageing Management Review

1) An ageing management review for in-scope SSCs should be performed in order to ensure and demonstrate that ageing will be effectively managed.
2) The ageing management review should systematically assess ageing effects and their related degradation mechanisms that have been experienced or anticipated.
3) The assessment should include an evaluation of the impact of the ageing effect on the in-scope SSC's ability to perform their intended function(s), including consideration of the current condition of the SSC.
4) Relevant applicable lessons relating to ageing provide a good reference basis for the ageing management review [7] but should not be used in place of a plant specific ageing management review.
5) A process to identify relevant ageing effects and degradation mechanisms for each structure or component should be established, and the programmes to manage the identified ageing effects and degradation mechanisms should be in place and should cover the following steps:
    (a) Time limited ageing analyses associated with these structures or components should be evaluated to determine the continued validity of the analyses for the intended period of operation. Results of the evaluation of the time limited ageing analyses should be taken into account in the ageing management review.
    (b) All relevant ageing effects and degradation mechanisms should be identified.
    (c) If the ageing of structures or components is managed by existing ageing management programmes, it should be verified that the ageing management programmes are consistent with the nine attributes shown in Annexure A.
    (d) If the ageing of structures or components is managed by other safety related programmes, such as maintenance, it should be verified that these programmes are consistent with the nine attributes shown in Annexure A.
    (e) If the ageing of structures or components is not managed by any existing programme, a new programme should be established or existing programmes should be modified or improved (e.g. by extending the scope of an ageing management programme) or a specific action (e.g. a new time limited ageing analysis, replacement of the structure or component, or further analysis) should be taken.

(f) If the qualified lifetime of equipment important to safety expires, such equipment should be requalified or replaced at the expiration of its present qualification.

6) An ageing management review should be performed for each in-scope structure or component or commodity group of structures or components and should consist of the following essential elements:

(a) Assessment of the current condition of the structure or component;
(b) Identification of ageing effects and degradation mechanisms on the basis of fundamental knowledge for understanding ageing (e.g. the design basis, materials, the environment and stressors);
(c) Identification of the appropriate programme for ageing management;
(d) Reporting of the ageing management review to demonstrate that the ageing effects and degradation mechanisms are being managed effectively.

6.7.1 Identification of relevant ageing effects and degradation mechanisms of structures or components

1) All relevant ageing effects and degradation mechanisms for each in-scope structure or component should be identified on the basis of the understanding of ageing set out in sections 6.7.1(2) and 6.7.1(3).

2) A comprehensive understanding of structures or components and their ageing effects and degradation mechanisms and how these can affect the capability of an SSC to perform its function(s) should be a prerequisite for the systematic ageing management process. This understanding should be based on:

(a) The design, including the SSC's intended function(s) and applicable regulatory requirements, codes and standards, the design basis and design documents, including safety analyses;
(b) The fabrication of the SSC, including material properties, manufacturing conditions that may affect ageing and service conditions;
(c) The operation and maintenance history of the SSC, including commissioning, operational transients and events, power uprating, modifications and replacements;
(d) Stressors on the structure or component (including loads on the structure or component and the environmental conditions inside and outside the structure or component);
(e) Results of in-service inspections and surveillance;

(f) Operating experience, results of research and development, and any post-service examinations;

(g) Results from walkdowns, inspections and condition assessments, if available;

(h) Results of the evaluation of time limited ageing analyses.

3) The identification process should take into account knowledge of the characteristics of the ageing effect (e.g. necessary conditions under which the effect occurs and rates of degradation), the related degradation mechanisms and their impact on the structure or component's intended function(s).

6.7.2 Identification of the appropriate programmes for ageing management

1) Appropriate methods to detect, monitor, prevent and mitigate ageing effects and degradation mechanisms for each structure or component should be specified.
2) Existing ageing management programmes and other safety related programmes should be evaluated for consistency with the nine attributes in Annexure A to determine whether they are effective in detecting, monitoring and preventing or mitigating ageing effects and degradation mechanisms in the structures or components for which the programme is credited.
3) If existing ageing management programmes and other safety related programmes are not sufficiently effective, the existing programme should be improved or modified or a new programme should be developed, consistent with the nine attributes in Annexure A.

6.7.3 Reporting on the ageing management review

1) Once the approach for managing ageing effects and degradation mechanisms has been determined, documentation should be prepared that logically demonstrates that the ageing effects will be adequately managed.
2) All information and conclusions with regard to the scope of ageing management review should be documented, including:

(a) A description and justification of the methods used to determine the structures or components that are subject to an ageing management review;

(b) An identification and listing of structures or components subject to an ageing management review and their intended function(s);

(c) The information sources used to accomplish the above, and any description necessary to clarify their use.

3) The methodology and results of the ageing management review should be documented and should also provide information on the following:
    (a) The current performance and condition of the structure or component, including assessment of any indications of significant ageing effects;
    (b) The ageing effects and degradation mechanisms requiring management;
    (c) Understanding ageing, monitoring of ageing and prevention or mitigation of ageing effects;
    (d) The specific programmes or activities that will manage the ageing effects and degradation mechanisms for each structure, component or commodity grouping subject to an ageing management review, and the need for the development of new programmes;
    (e) How the programmes and activities will manage the ageing effects and degradation mechanisms, considering the current condition of the structure or component;
    (f) The estimated future performance, ageing effects and service life of the structure or component, when feasible;
    (g) How the results of the ageing management review should be applied in plant operation, maintenance and design.
4) If the ageing management review takes into account IGALL [7], then the demonstration should provide a justification that generic references from the nuclear industry are applicable to the plant concerned, based on plant specific features, plant operating and maintenance history, and/or industry developments since the selected references were issued.

6.8 Ageing Management Programmes

1) The identified ageing effects and degradation mechanisms that require ageing management should be managed using existing ageing management programmes or existing safety related programmes (possibly with improvements or modifications), or new programmes should be developed.
2) Each ageing management programme should be consistent with the generic attributes of an effective ageing management programme listed in Annexure A.
3) Safety related programmes or processes used to manage ageing effects and ageing management programmes should include one or more of four types of activities:
    a) Prevention activities, which preclude the ageing effect from occurring;
    b) Mitigation activities, which attempt to slow the ageing effects;

c) Condition monitoring activities, including inspection and examination for the presence and extent of ageing effects, or surveillance using test samples or coupons intended to mimic the performance of the structure or component;
d) Performance monitoring activities, which test the ability of a structure or component to perform its intended functions.

4) If necessary, more than one type of activity should be implemented to ensure that ageing effects are adequately managed and that the intended functions of the structure or component are maintained.
5) If the programme used to manage ageing effects involves inspection by sampling from a specific population of structures or components, the programme should describe and justify the methods used for selecting the samples to be inspected and the sample size, and should demonstrate that the sampling is adequate to provide reasonable assurance that ageing effects on the structure or component will not prevent the performance of its intended functions throughout its lifetime.

6.8.1 Development of ageing management programmes

1) Ageing management programmes specific to ageing effects and degradation mechanisms or specific to structures and components should be developed.
2) The existing safety related programmes should be coordinated and maintained to manage the ageing effects.
3) The development of the ageing management programmes should be based on the results of the ageing management review.
4) All programmes developed should comply with NNR requirements, codes and standards and the ageing management policy of the plant and should be consistent with the attributes of Annexure A. If a programme is of such a nature that doesn't meet all of the attributes, its use should be properly justified and the justification should be documented.
5) Appropriate acceptance criteria for inspection and monitoring of ageing effects should be established for ageing management programmes based on the design basis or the requirements of the structure or component, relevant requirements and codes and standards, so that a corrective action can be implemented sufficiently before loss of the intended function(s) of the structure or component. The need for sufficient margins should be taken into account in these acceptance criteria.
6) Particular attention should be paid in developing ageing management programmes to ensuring that the programme has in place provisions to prevent, detect, evaluate and mitigate ageing effects of anticipated degradation mechanisms, based on the findings from the ageing management review.

7) Information on the current status of in-scope structures or components should be collected for subsequent review of the effectiveness of the ageing management programmes.
8) The structure or component specific or the degradation mechanism specific ageing management programmes should be considered as guidance for the development of ageing management programmes.

6.8.2 Implementation of ageing management programmes

1) The ageing management programmes should be implemented in a timely manner to ensure that the intended functions of structures or components continue to be met.
2) Detailed implementation procedures that describe preventive and mitigatory actions, monitoring or inspection and assessment actions, acceptance criteria and corrective actions should be established and shared among the different units of the nuclear power plant (e.g. the operations, maintenance and engineering units) that are responsible for implementing ageing management programmes.
3) As part of the implementation of the ageing management programmes, appropriate data should be collected and recorded to provide a basis for decisions on the type and timing of ageing management actions.

6.8.3 Review and improvement of ageing management programmes

1) The effectiveness of ageing management programmes should be periodically evaluated in the light of current knowledge and feedback from the programme and the performance indicators, and should be updated and adjusted as appropriate.
2) Ageing management programmes should be part of the management system of the authorisation holder.
3) The authorisation holder should develop performance indicators; among others these should for example, include:
   a) Material condition with respect to acceptance criteria;
   b) Trends of data relating to failure and degradation;
   c) Percentage of recurrent ageing driven failures and instances of degradation;
   d) Status of compliance with inspection programmes;
   e) Newly discovered ageing effects and degradation mechanisms;
   f) Newly developed ageing management programmes.
4) The qualified life of equipment should be reassessed during its lifetime, with account taken of progress in knowledge of degradation mechanisms. If the qualified life of equipment is to be increased, a thorough safety demonstration should be provided by the authorisation holder.

5) The management of the authorisation holder should provide for performance review and improvement of ageing management programmes.
6) Consideration should be given to arranging for peer reviews of ageing management programmes, to obtain an independent assessment in order to establish whether the ageing management programmes are consistent with generally accepted practices and to identify areas for improvement.
7) An in-depth review of ageing management should be performed periodically, for example as part of periodic safety review or as part of the safety review for LTO, in order to assess the effects of ageing on plant safety and to evaluate the effectiveness of safety related programmes and practices used to support ageing management throughout plant operation, including LTO if applicable.
8) The in-depth review should demonstrate that ageing effects will continue to be identified and effectively managed for each structure or component throughout the entire period of operation of the plant, including LTO if applicable. Requirements for modifications of existing safety related programmes or development of any new programmes should be specified and applied. The results of this in-depth review should be documented and the findings, including any corrective actions and areas for improvement, should be addressed in a timely manner.
9) Adequately funded research and development programmes should be put in place to respond to any new ageing issues and to provide for continuous improvement of the understanding and predictability of degradation mechanisms and the causes of ageing, and associated monitoring and mitigation methods or practices. A strategic approach should be taken to promoting relevant long term research and development programmes.

6.9 Time Limited Ageing Analyses (TLAA's)

1) Time limited ageing analyses should meet all six of the following criteria:
   a) TLAA's should involve SSCs within the scope for ageing management.
   b) TLAA's should consider ageing effects. Ageing effects include, but are not limited to: loss of material, changes in dimension, changes in material properties, loss of toughness, loss of pre-stress, settlement, cracking, and loss of dielectric properties.
   c) TLAA's should involve time limited assumptions defined by the current operating term. The specified operating term should be explicit in the analysis. Simple assertion that a component is designed for a particular service life or plant lifetime is not sufficient. Any such assertion should be supported by calculations or other analyses that explicitly include a time limit or a time-based assumption.

d) TLAA's should have been determined to be relevant by the authorisation holder in making a safety determination as required by the NNR. Relevancy is a determination that the authorisation holder makes on the basis of a review of the information available. A calculation or analysis is relevant if it can be shown to have a direct bearing on the action taken as a result of the analysis performed. Analyses are also relevant if they provide the basis for the safety determination for the plant where, in the absence of the analyses, the authorisation holder might have reached a different safety conclusion or taken a different safety action.

e) TLAA's should involve conclusions or provide the basis for conclusions relating to the capability of the SSC to perform its intended function(s).

f) TLAA's should be contained or incorporated by reference in the current licensing basis. The current licensing basis includes the technical specifications as well as design basis information, or commitments of the authorisation holder documented in the plant specific documents contained or incorporated by reference in the current licensing basis including, but not limited to: safety analysis reports, regulatory safety evaluation reports, the fire protection plan or hazard analysis, correspondence with the regulatory body, the documentation of the management system, and topical reports included as references in the safety analysis reports. If a code of record is in the safety analysis report for a particular group of structures or components, reference material should include all calculations called for by that code of record for those structures or components.

2) Safety analyses that meet all criteria except for criterion (f), and which have been developed to demonstrate preparedness for the intended period of operation, should be also considered as TLAA's.

3) TLAA's analyses should be evaluated using a projected value of the time dependent parameter, for example through a calculation of the neutron fluence for a certain operating period. This projected value of the time dependent parameter, for example the projected neutron fluence, should then be used to evaluate certain analysis parameters, such as the adjusted nil-ductility temperature or the fracture toughness.

4) The validity of TLAA's over the intended period of operation should be assessed through demonstrating satisfaction against one of the following criteria:

a) The analysis should remain valid for the intended period of operation. The time dependent parameter value for the intended operating period should not exceed the time dependent parameter value used in the existing analysis.

b) The analysis should have been projected to the end of the intended period of operation. The value of the analysis parameter value should be changed based on the time dependent parameter projected for the intended operating period, and the value of the analysis parameter should continue to meet the regulatory limit or criterion.

c) The effects of ageing on the intended function(s) of the structure or component should be adequately managed for the intended period of operation. The value of the analysis parameter should be managed (using an ageing management programme) to ensure that ageing effects are adequately managed and that the value of the analysis parameter will continue to meet the regulatory limit or criterion throughout the intended period of operation.

5) If the TLAA's cannot be found acceptable using Criterion (a), (b), or (c), then corrective actions should be implemented. Depending on the specific analysis, corrective actions could include:
   a) Refinement of the analysis to remove excess conservatism;
   b) Implementation of further actions in operations, maintenance or the ageing management programme;
   c) Modification, repair or replacement of the structure or component.
6) Results of the evaluation of time limited ageing analyses should be used as an input for ageing management review.

6.10 Documentation of Ageing Management

1) The assumptions, activities, evaluations, assessments and results of the evaluation of the plant programme for ageing management should be documented. The documentation should be developed and retained in an auditable and retrievable form.
2) The documentation should also include the following to demonstrate that ageing effects will be managed during the planned operating period:
   a) A description of safety related programmes and documentation relevant to ageing management;
   b) A list of commitments or plans for improvement or development of safety related programmes and documentation relevant to ageing management.
3) The documentation should include an update of the safety analysis report reflecting the assumptions, activities and results of the plant programme for ageing management.
4) The assumptions, activities, evaluations, assessments and results of the plant programme for ageing management should be also reflected in the reports of periodic safety reviews.

6.11 Management of Technological Obsolescence

1) Technological obsolescence of the SSCs in the plant should be managed through a dedicated plant programme with foresight and anticipation and should be resolved before any associated decrease in reliability and availability occur.
2) A technological obsolescence programme should be prepared and implemented to address all SSCs important to safety and spare parts required to maintain those SSCs.
3) The technological obsolescence programme should involve participation of the engineering, maintenance, operations and work planning units, plant senior management, and supply chain organisations.
4) The technological obsolescence programme should be made available to the NNR for acceptance.
5) The technological obsolescence programme should be consistent with the attributes as stipulated in Annexure A.
6) The technological obsolescence programme should include three basic steps:
   a) The authorisation holder should identify the installed SSCs important to nuclear safety that are technologically obsolete or will become obsolete in the upcoming years;
   b) The identified equipment should be prioritised on the basis of the nuclear safety and criticality significance of the obsolete equipment (i.e. its impact on the plant safety);
   c) The authorisation holder should develop and implement effective replacement solutions in a timely manner.
7) For the identification of obsolete equipment and parts, the following activities should be performed:
   a) Collection of data on structures and components, usually from plant asset management systems (equipment databases with information on manufacturers and parts);
   b) Determination whether the manufacturer still supports (provides) replacement equipment and spare parts.
8) For the prioritisation, suitable criteria should be used such as: safety relevance; plant demand; quantity in stock; safety classification of components; failure history; reliability of structures or components; work order information; stock history; uncertainty (spare parts with insufficient data).
9) Training should be conducted on obsolescence to educate personnel involved in understanding obsolescence management.

10) The authorisation holder should exchange information and should participate in collaboration within the nuclear industry and should make use of industry tools to identify and resolve common occurrences of technological obsolescence.
11) The authorisation holder should periodically assess the effectiveness of the technological obsolescence programme and should continuously seek to improve performance and efficiency. Self-assessments should be performed concerning the obsolescence programme, its implementation and its effectiveness and any lessons learned should be acted on.

6.12 Reporting

1) The authorisation holder should annually submit to NNR the status report for the ageing management of SSCs including the effectiveness of the ageing management programmes.
2) The ageing management status report should cover all the structures and components within the scope of ageing management including the topics such as:
   a) Long-term trends in defects/failures;
   b) Major maintenance performed;
   c) Assessment of operability and safety margins;
   d) Adequacy of maintenance, in-service inspections and monitoring;
   e) Validity of qualifications and time limited ageing analyses;
   f) Summary of spare parts stock and condition.

7 LONG TERM OPERATION

7.1 General Considerations

1) Where applicable, the authorisation holder should establish and implement a comprehensive programme for ensuring the long term safe operation of the plant beyond a time-frame established in the licence conditions, design limits, safety standards and/or regulations.
2) The justification for LTO should be prepared on the basis of the results of a safety assessment, with due consideration of the ageing of SSCs.
3) The justification for LTO should utilise the results of periodic safety review and should be submitted to the NNR, for approval on the basis of an analysis of the ageing management programme, to ensure the safety of the nuclear facility throughout its extended operating lifetime.
4) The comprehensive programme for LTO should address:
   a) Preconditions (including the current licensing basis, safety upgrading and verification, and operational programmes);
   b) Setting the scope for all structures, systems and components important to nuclear safety;
   c) Categorisation of SSC's with regard to degradation and ageing processes;
   d) Revalidation of safety analyses made on the basis of time limited assumptions;
   e) Review of ageing management programmes in accordance with current NNR and/or international safety standards and operating practices; and
   f) The implementation programme for LTO.

7.2 Organisational Arrangements

1) The authorisation holder should adopt a comprehensive project structure or similar organisational arrangements for preparation and implementation of the programme for LTO, which should take into account the arrangements for the management of physical ageing, as described in Section 6.4.
2) The organisational arrangements for the management of physical ageing, including technological obsolescence, should be properly implemented and should be one of the prerequisites for a decision to pursue LTO for the nuclear power plant.
3) In addition to the existing obligations associated with ageing management, the authorisation holder should clearly define the additional responsibilities and authorities for

preparation for and implementation of LTO, after considering all the regulatory requirements relevant to LTO.

4) The authorisation holder should ensure that appropriate resources are available to accomplish the assigned responsibilities and accountabilities regarding preparation for and implementation of LTO.

7.3 Principles of and Approach to Long Term Operation

1) Figure 1 shows major steps in the programme for LTO, and in particular illustration for the ageing management of SSCs necessary to ensure safe LTO.
2) The decision of an operating organisation to pursue LTO should be based on an evaluation (feasibility study) that addresses the following aspects:
    (a) Strategic elements, such as the need for electrical power, an economic assessment and issues concerning diversity in supply, with due consideration that safety takes precedence over electricity production;
    (b) Compliance with current codes, standards and regulations;
    (c) The most recent relevant international standards and guidance;
    (d) A technical assessment of the physical condition of the plant;
    (e) An evaluation of past operating experience at the plant relating to ageing, obsolescence and other safety issues;
    (f) Storage of spent nuclear fuel for LTO;
    (g) Radioactive waste management for LTO;
    (h) An assessment of the environmental impact of LTO;
    (i) An evaluation of the impact of LTO on nuclear emergency plans.
    (j) An evaluation of the impact of LTO on nuclear security plans.
3) A plant policy for LTO should be established and should cover the principles of and concept (strategy) for LTO. When a decision on LTO is connected to a regulatory process, such as licence variation or periodic safety review, the plant policy should take account of the related regulatory process.
4) The LTO programme should be based on the following principles:
    (a) Operational practices should meet NNR requirements, should follow international guidelines, as applicable, and should be adequate to ensure safe operation of the plant.
    (b) The regulatory process should be adequate to ensure that safe operation of the nuclear power plant is maintained and should focus on ageing effects that need to be properly managed for the planned period of LTO.

(c) The current licensing basis should provide an acceptable level of safety and should be carried over to the planned period of LTO in the same manner and to the same extent, with the exception of any changes specific to LTO.

5) The concept (strategy) for LTO should address basic goals and objectives, milestones, activities, organisational roles and responsibilities, interactions with other major projects, and interactions with external organisations.

6) The operating organisation's staff, in particular plant personnel, should be familiar with LTO and should understand its principles and concept.

7) Ageing management review and evaluation of time limited ageing analyses should have been completed previously in accordance with Section 6.7; if not, such review and evaluation should be completed for LTO.

8) Technological obsolescence should have been addressed previously in accordance with Section 6.11; if not, then it should be addressed for LTO.

9) The assessment for LTO should demonstrate, in particular, that ageing effects will be adequately managed so that the intended functions of the SSCs can be maintained consistent with the plant's current licensing basis for the planned period of LTO.

10) The approach to the assessment prior to LTO is outlined in Figure. 1. With regard to ageing, an overview of the major steps of the programme for LTO should involve the following:

(a) Demonstration that ageing effects will continue to be identified and managed for each structure or component in the scope of LTO for the planned period of LTO (including feedback on operating experience and research and development findings).

(b) Review of time limited ageing analyses to ensure that the analyses continue to meet the criteria specified in Section 6.9(4).

11) The approach to an assessment for LTO should also take into account the licensing processes and other licensing related requirements, such as the performance of a periodic safety review. This is to ensure that any safety improvements required for LTO will be addressed as part of the preparation for LTO.

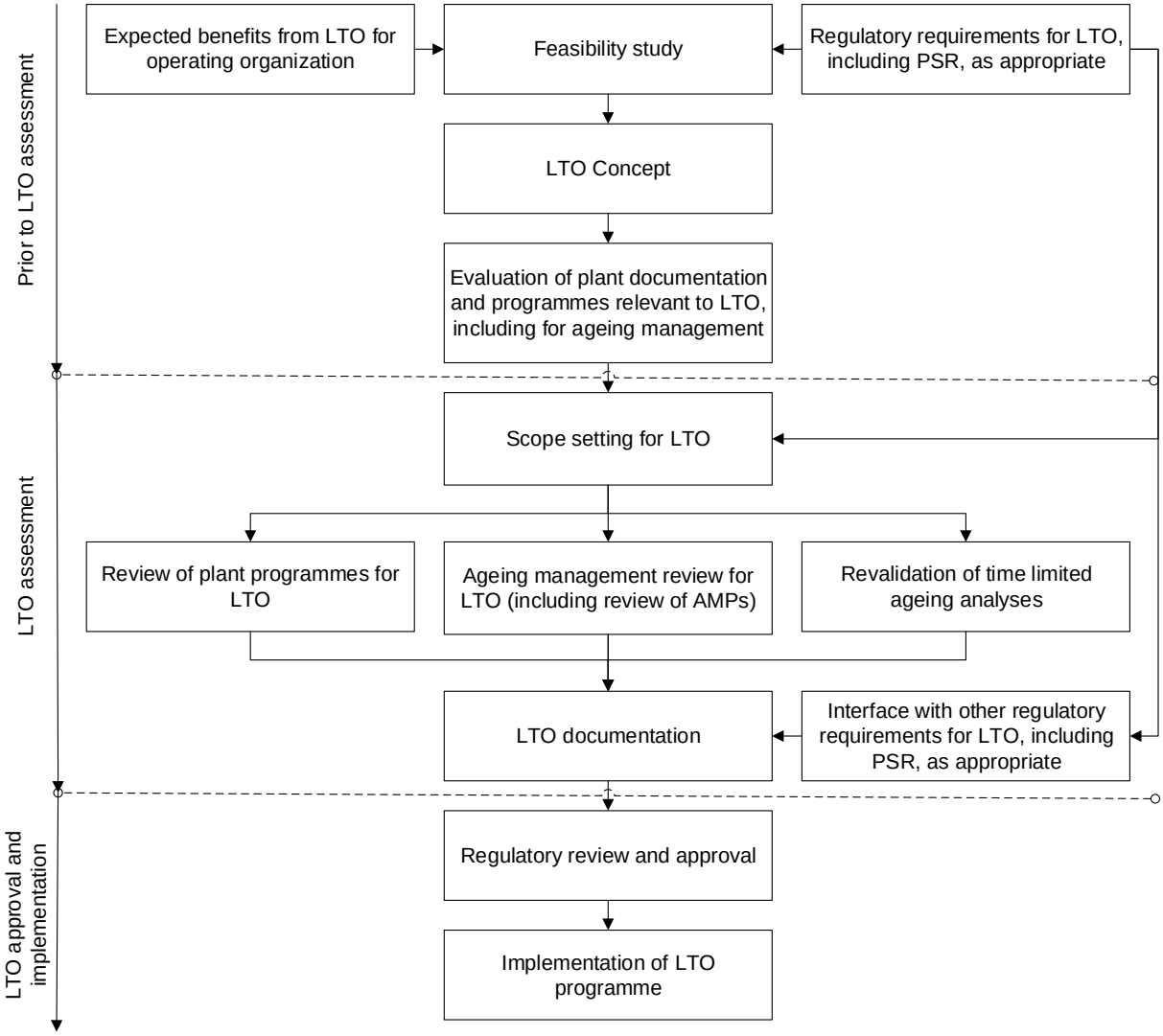

Figure 1: Major steps in a programme for LTO

7.4 Development of a Programme for Long Term Operation

1) Ageing management for the period of LTO should use the approach described in Section 6.4 and should account for the differences that will occur for the period of LTO, for example longer operating times and higher neutron fluence levels. In addition, changes that will occur before the period of LTO should be considered, including changes in regulatory requirements, codes and standards, knowledge and operating experience.
2) Time limited ageing analyses should be re-evaluated for the planned period of LTO, and it should be demonstrated that they meet the criteria in Section 6.9(4).
3) The programme for LTO should include the following activities, evaluations, assessments and results:

(a) The method of scope setting, the results obtained (structures or components within the scope and out of the scope of LTO), and supporting technical justifications.

(b) Demonstration that the programmes credited for LTO support the conclusion that the intended functions of the SSCs and the required safety margins will be maintained. This demonstration should address the following topics:

  (i) A description of the intended functions of the structures or components;

  (ii) Identification of applicable ageing effects and degradation mechanisms based on, for example, the materials used, the environment and operating experience;

  (iii) Specification and description of operational programmes and ageing management programmes that manage the identified ageing effects;

  (iv) Demonstration that these operational programmes and ageing management programmes (including new programmes) are effective.

(c) Demonstration that the review performed for the SSCs within the scope of LTO is consistent with the process outlined in Section 6.7. A technical justification should be provided that:

  (i) Demonstrates that ageing effects will be adequately managed for each structure or component in such a way that the intended function(s) of the structure or component will be maintained throughout the planned period of LTO in a manner that is consistent with the current licensing basis;

  (ii) Ensures that operating experience and research findings are adequately reflected in assessing the ageing effects of structures or components that are in scope for LTO and will continue to be taken into account during the entire period of LTO.

(d) Demonstration that the time limited ageing analyses have been revalidated and that the evaluation includes:

  (i) Identification of time limited ageing analyses in accordance with the definition specified in Section 6.9(1);

  (ii) Revalidation of each identified time limited ageing analysis in accordance with the recommendations provided in Section 7.8 to demonstrate that the intended function(s) of the structure or component

will be maintained throughout the planned period of LTO in a manner that is consistent with the current licensing basis.

(e) The implementation of the programme for LTO, specifying the corrective actions for safe LTO, and the schedule and commitments of the operating organisation relating to LTO.

4) The programme for LTO should address the safety improvements required for safe LTO, the schedule, and the commitments of the operating organisation relating to LTO.

7.5 Scope Setting for Structures, Systems and Components for Long Term Operation

Scope setting for LTO should follow the approach outlined in Section 6.6 and should account for differences in regulatory requirements, codes and standards.

7.6 Ageing Management Review for Long Term Operation

1) The process set out in Section 6.7.1 should be used to identify programmes to manage the ageing of in-scope structures or components.
2) The ageing management review for LTO should focus on the following issues:
   a) Whether any new ageing effect or degradation mechanism is anticipated in the course of the planned period of LTO;
   b) Whether the significance, degradation rate or susceptible sites of degradation mechanisms are expected to change during the planned period of LTO;
   c) Whether current relevant operating experience and research findings have been incorporated into ageing management programmes.
3) If the operating organisation has not performed an ageing management review, the results of an ageing management review for LTO should be used to identify or develop effective ageing management programmes in order to detect and mitigate those ageing effects identified in the ageing management review before the integrity and the functional capability of the SSCs are compromised.
4) The ageing management review should provide a clear demonstration that ageing effects will continue to be identified and managed for each structure or component in the scope of LTO for the planned period of LTO.

7.7 Review of Safety Related Programmes and Ageing Management Programmes for Long Term Operation

1) On the basis of the results of the ageing management review for LTO, the existing safety related programmes used for ageing management and existing ageing management programmes should be reviewed to ensure that they will remain effective in managing the effects identified for the planned period of LTO.
2) This review should identify programme modifications and/or new programmes necessary to ensure that the structures or components will be able to perform their intended functions for the planned period of LTO.
3) Any existing and new safety related programmes for LTO should be reviewed to determine whether they are consistent with the nine attributes set out in Annexure A.
4) In addition, the plant documentation and programmes described in Section 6.3 should also be reviewed with respect to the planned period of LTO.

7.8 Revalidation of Time Limited Ageing Analyses

1) Time limited ageing analyses should be reviewed to determine the continued acceptability of the analysed structure or component for the planned period of LTO, in accordance with Section 6.9(4).
2) The time dependent parameter should be determined from a re-evaluation or analysis of the operating history of the plant (including its projection to the end of the planned period of LTO) to define a value of the parameter that applies to or bounds the expected value of the parameter at the end of the planned period of LTO.
3) The value of the time dependent parameter applicable to the period of LTO should be used to re-evaluate the time limited ageing analyses, as described in Section 6.9(4).

7.9 Documentation in Support of LTO

1) The assumptions, activities, evaluations, assessments and results of the plant programme for LTO should be documented by the operating organisation in accordance with current national and/or international safety standards [9]. The documentation should be developed and retained in an auditable and retrievable form so that it provides a part of the technical basis for approval of LTO.
2) The documentation should provide detailed information on each element outlined in sections 7.4(3) and 7.4(4) and any other information required by other relevant regulatory requirements.

3) With regard to ageing management, the documentation should also include the following to demonstrate that ageing effects will be managed throughout the planned period of LTO:
   a) A description of safety related programmes and documentation relevant to ageing management throughout the planned period of LTO;
   b) A list of commitments for the improvement or development of safety related programmes and documentation relevant to ageing management throughout the period of LTO, and information on the implementation of new ageing management programmes.
4) The methodology used to carry out the ageing management review for LTO should be documented and justified.
5) All information and conclusions with regard to the scope of an ageing management review for LTO should be documented, including:
   a) An identification and listing of SSCs subject to an ageing management review and their intended functions;
   b) A description and justification of the methods used to determine the structures or components that are subject to an ageing management review (i.e. scope setting);
   c) The information sources used to accomplish the above, and any description necessary to clarify their use.
6) The results of the ageing management review for LTO should be documented in an appropriate report. The report should address the understanding of ageing, the monitoring of ageing and the prevention and mitigation of ageing effects. In addition, recommendations should be provided for the application of the results of the ageing management review in plant operation, maintenance and design.
7) Documentation of the demonstration that ageing effects will be adequately managed during LTO should include the following:
   a) Identification of the ageing effects and degradation mechanisms requiring management;
   b) Identification of the specific programmes or activities that will manage the ageing effects and degradation mechanisms for each structure, component or commodity grouping listed;
   c) A description of how the programmes and activities will manage the ageing effects and degradation mechanisms.
8) The documentation should include an update of the safety analysis report and other documents required by the licensing process reflecting the assumptions, activities and results of the plant programme for LTO. The update to the safety analysis report should

also include documentation of the revalidation of the time limited ageing analyses for the period of LTO.

9) The assumptions, activities, evaluations, assessments and results of the plant programme for LTO should also be reflected in the periodic safety review report, if applicable.
10) If the periodic safety review is used as a licensing tool, the safety assessment performed for safety factors 2–5 as defined in SSG-25 [8] should consider the entire planned period of LTO.

7.10 Regulatory Review and Approval

1) Refer to the relevant nuclear authorisation and in **section 5.3** of this regulatory guide regarding requirements and guidance on regulatory approvals.
2) To ensure the safe LTO of a nuclear power plant, the operating organisation should demonstrate that the safety of the nuclear power plant will be maintained throughout the period of LTO in accordance with current NNR and/or international safety standards and operating practices.
3) The demonstration of safety for LTO should be provided to the regulatory body for review and approval at a level of detail, and in a manner, defined by regulatory requirements.
4) The justification should include trends of expected ageing effects during the period of LTO based on past studies, such as studies undertaken in past periodic safety reviews, and, when appropriate, the plant modifications to be implemented to improve safety.

7.11 Implementation of the Programme for LTO

The programme for LTO should be implemented by the authorisation holder in a manner consistent with the requirements of the NNR and relevant national regulations.

8 REFERENCES

The following references were consulted during the compilation of this document:

[1] National Nuclear Regulator Act, 1999 (Act No. 47, 1999)

[2] Regulations on Safety Standards and Regulatory practices (GN R388).

[3] IAEA Specific Safety Guide SSG-48, Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants

[4] IAEA Safety Report Series No.57, Safe Long Term Operation of Nuclear Power Plants

[5] IAEA Safety Report Series No.82, Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)

[6] IAEA Specific Safety Guide SSG-25, Periodic Safety Review for Nuclear Power Plants

[7] IAEA Specific Safety Requirements SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation

[8] STUK Guide YVL A.8, Ageing Management of a Nuclear Facility (20 May 2014)

[9] Nuclear Energy Agency OECD, Glossary of Nuclear Power Plants Ageing,1999.

ANNEXURE A: GENERIC ATTRIBUTES OF AN EFFECTIVE AGEING MANAGEMENT PROGRAMME

Attribute	Description
1. Scope of the ageing management programme based on understanding ageing	• Structures (including structural elements) and components subject to ageing management • Understanding of ageing phenomena (significant degradation mechanisms, susceptible sites): – Structure or component materials, service conditions, stressors, degradation sites, degradation mechanisms and ageing effects – Structure or component condition indicators and acceptance criteria – Quantitative or qualitative predictive models of relevant ageing phenomena
2. Preventive actions to minimise and control ageing effects	• Specification of preventive actions • Determination of service conditions (i.e. environmental conditions and operating conditions) to be maintained and operating practices aimed at precluding potential degradation of the structure or component
3. Detection of ageing effects	• Specification of parameters to be monitored or inspected • Effective technology (inspection, testing and monitoring methods) for detecting ageing effects before failure of the structure or component
4. Mitigating ageing effects	• Operations, maintenance, repair and replacement actions to mitigate detected ageing effects and/or degradation of the structure or component
5.. Monitoring and trending of ageing effects	• Condition indicators and parameters monitored • Data collected to facilitate assessment of structure or component ageing • Assessment methods (including data analysis and trending)
6. Acceptance criteria	• Acceptance criteria against which the need for corrective actions is evaluated
7. Corrective actions	• Corrective actions if a structure or component fails to meet the acceptance criteria

8. Operating experience feedback and feedback of research and development results	• Mechanism that ensures timely feedback of operating experience and research and development results (if applicable), and provides objective evidence that they are taken into account in the ageing management programme
9. Quality management	• Administrative controls that document the implementation of the ageing management programme and actions taken. • Indicators to facilitate evaluation and improvement of the ageing management programme • Confirmation (verification) process for ensuring that preventive actions are adequate and appropriate and that all corrective actions have been completed and are effective • Record keeping practices to be followed