Regulatory Practices on Ageing Management and Long Term Operation of Nuclear Power Plants in the Ibero-American Region

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Foro Iberoamericano de Organismos Reguladores Radiológicos y Nucleares

IAEA
International Atomic Energy Agency

REGULATORY PRACTICES ON AGEING MANAGEMENT AND LONG TERM OPERATION OF NUCLEAR POWER PLANTS IN THE IBERO-AMERICAN REGION

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REGULATORY PRACTICES ON AGEING MANAGEMENT AND LONG TERM OPERATION OF NUCLEAR POWER PLANTS IN THE IBERO-AMERICAN REGION

RESULTS OF THE FORO/IAEA PROGRAMME ON NUCLEAR AND RADIATION SAFETY IN IBERO-AMERICA

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FOREWORD

Although the operating lifetime of a nuclear power plant was originally anticipated to be in the range of 30–40 years, 200 of the 434 currently in operation are over 30 years old. In this context, Member States have assigned high priority to continuing the operation of nuclear power plants beyond the lifetime initially planned — while also maintaining the highest safety conditions possible. It is thus essential to encourage international cooperative efforts in the development of safety regulatory practices on ageing management and long term operation.

Established in 1997, the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO) aims to strengthen its members' radiological and nuclear safety regulatory organizations. Through a regional network of radiological and nuclear safety regulators, States in the Ibero-American region have worked together to strengthen radiation protection for patients, to improve safety at radiation installations, to tighten controls on radioactive sources used in medicine, agriculture and industry, and to improve safety and security at nuclear power plants. Since FORO's creation, it has cooperated with the IAEA in areas of mutual interest, and a technical programme administrated by the IAEA was established in 2003 and formalized in Practical Arrangements signed in 2010.

This publication presents the results of the 2009–2010 FORO/IAEA project on regulatory practices on ageing management and safety considerations for extending the operating lifetime of nuclear power plants. The purpose of the project was to provide nuclear regulators in the region with guidance on regulatory criteria, assessment, regulatory inspection and periodic safety reviews relating to ageing management and long term operation of nuclear power plants. The results are presented in a set of four reports, with guidelines for FORO members and a summary report of the project. These reports contain valuable information for the development of future international guidance in the field.

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1. INTRODUCTION

1.1. THE FORO/IAEA COOPERATION

The Ibero-American Forum of Radiological and Nuclear Regulatory Bodies (FORO) aims at strengthening the regulatory organizations in its members through the exchange of information and experience, and by offering technical programmes in key areas of nuclear safety and radiological protection for its members and the region.

FORO is now composed of nuclear regulatory bodies of eight countries: Argentina, Brazil, Chile, Cuba, Mexico, Peru, Spain and Uruguay.

Created in 1997, this initiative is comparable to other international nuclear regulatory organizations such as the International Nuclear Regulators Association (INRA) and the Western European Nuclear Regulators Association (WENRA), but with an important difference: a common language.

Since its foundation in 1997, the FORO and the IAEA have cooperated in areas of mutual interest aiming at achieving a high level of radiation and nuclear safety and security in a sustainable manner. This cooperation has its roots in their respective Statutes. One of the major Agency functions is "to establish standards of safety for the protection of health and minimization of danger to life and property […] and to provide for the application of these standards […]". FORO statutory objective is to "promote a high level of safety in its member countries in the Ibero-American region".

Since 2003, a crucial instrument for the purpose of FORO has been its technical programme in priority safety areas, which is carried out through an IAEA extrabudgetary programme (EBP), funded by voluntary contributions from FORO members. This cooperation was formalized by means of practical arrangements signed in 2010 and 2011 in English and Spanish, respectively.

The FORO/IAEA cooperation also includes participation in FORO projects and facilitating the dissemination of results to other countries in Latin America and other regions. The results are joint technical reports, networking and information exchange. Six innovative projects have been completed within the scope of an extensive technical programme: (i) prevention of accidental exposures in radiation therapy through the application of probabilistic risk assessment and the development of a radiotherapy risk assessment tool (named SEVRRA); (ii) collaborative approaches between regulatory and health authorities for regulatory control of medical exposures; (iii) regulatory assessment and inspection of nuclear power plant (NPP) ageing management and long term operation; (iv) control of inadvertent radioactive material in scrap metal and recycling industries; and (v) assessment of stress tests performed to NPPs in the FORO member countries. Three joint FORO/IAEA publications have already been issued by the IAEA. The IAEA Director General, Yukiya Amano, has described FORO as an initiative that "has undoubtedly helped to improve nuclear safety and security in the countries concerned".

The activities developed under the EBP programme are initially evaluated by the FORO technical steering committee and then submitted for endorsement to the FORO plenary. The technical steering committee is composed of senior experts and/or managers of the eight regulatory bodies' members of FORO and of the IAEA. The FORO plenary is composed of the heads of the regulatory bodies.

Recently, four new projects have been launched on: (i) capacity building for regulatory staff concerning the safety of nuclear reactors; (ii) emergency preparedness and response; (iii) licensing of cyclotrons for producing radionuclides for positron emission tomography in medical applications; and (iv) guidelines to promote and develop safety culture on practices involving the use of ionizing radiation.
One major topic of collaborative work between FORO and the IAEA focused on safety considerations on ageing management and long term operation of nuclear power plants (NPPs).

1.2.DEVELOPMENTS OF THE FORO PROJECT IN THE IBERO-AMERICAN REGION

The FORO/IAEA project on regulatory practices on ageing management and life extension (hereinafter referred to as the FORO/IAEA project or 'the project') was initiated at the end of 2007 and launched in mid-2008. The initial phase consisted of summarizing the situation in the countries of the Ibero-American region with NPPs in operation.

At that time, the Spanish regulatory body (Consejo de Seguridad Nuclear, CSN) was immersed in the assessment of the long term operation request for a period of 10 additional years for the Santa María de Garoña nuclear power plant (the first process of this kind in Spain), which was finally informed favourably by the CSN in June, 2009. It was considered that this circumstance could remarkably enrich the results of the FORO/IAEA project as it would allow studying an on-going process, which could be taken as a reference case.

At the end of the 1990s, the Argentinian regulatory body (Autoridad Regulatoria Nuclear, ARN) required Nucleoeléctrica Argentina S.A. (NA-SA), the entity responsible for the nuclear power plants operation, to implement an ageing management programme (AMP) for each NPP in operation. The programme, which specified factors to be considered in the AMP, was submitted within 4 months after such requirement issuance and, in compliance with it, NA-SA has submitted quarterly progress reports on its application. AMP became part of the mandatory documentation included within the operation license (OL) of both Atucha I and Embalse NPPs.

In the initial phase of the FORO/IAEA Project, the Brazilian regulatory body (Comissão Nacional de Energia Nuclear, CNEN) expressed its accordance with the objectives of the project as they aligned with the interests of Brazil, taking into consideration that it would probably have to asses a long term operation (LTO) request of the Almirante Álvaro Alberto CNA-AA-1 (Angra-1) NPP in an early future.

The Mexican regulatory body (Comisión Nacional de Seguridad Nuclear y Salvaguardias, CNSNS), at that time, had not officially received any LTO request for the two units of the Laguna Verde NPP. However, several conversations were held with the licensee (Comisión Federal de Electricidad, CFE), who manifested its intention to submit, in 2013, the documentation for the LTO request based on ageing management to the CNSNS. Due to this fact, the organization showed great interest in participating in the FORO/IAEA project in order to acquire experience from the FORO member countries and to improve its assessment and inspection activities.

Chile and Cuba also expressed their interest and joined the project team as from the beginning. Section 2 provides more details on the situation of each country at the beginning of the project and the reasons for joining it.

1.3. OBJECTIVE OF THE PROJECT

The FORO/IAEA project on regulatory practices on ageing and life extension, which took place between 2009-2010, aimed at providing regulatory bodies of the Ibero-American region with guidance in this field.

It developed a joint approach on several key items in relation to ageing management and long term operation of nuclear power plants, namely, regulatory criteria, assessment, regulatory inspection and periodic safety reviews.

The results have been presented in a set comprising four technical reports for regulators and a technical report of the project which has been used to produce this publication. These reports contain valuable information for the development of future international guidance in the field. They provide guidelines to FORO members on general regulatory criteria, assessment, regulatory inspection in relation to ageing management and LTO of NPPs as well as on ageing management issues in the periodic safety reviews of NPPs. These reports were issued in Spanish and English and made available in the FORO web page at www.foriberam.org.

1.4. SCOPE OF THE PROJECT

The FORO/IAEA project and the guidelines reports were developed for nuclear power plants with PWR, BWR, CANDU and PHWR type nuclear power reactors. The requirements established in the guidelines are applicable to all operation conditions of this type of NPPs.
Although the guidelines prepared within the scope of this project were elaborated for use in the Ibero-American region by FORO members, they also constitute a valuable input to future work on an international scale.

1.5. ORGANIZATION OF THIS REPORT

This report presents a summary of the development of the FORO/IAEA project. It includes information on the FORO/IAEA cooperation, scope and objective of the project (Section 1), an overview of the situation of the participating countries (Section 2), the development of the project (Section 3) and conclusions and findings of the project (Section 4).

The guidelines produced by FORO for its members on general regulatory criteria, assessment, regulatory inspection in relation to ageing management and LTO of NPPs as well as on ageing management issues in the periodic safety reviews of NPPs are presented in the annexes to this report.

2. SITUATION OF THE PARTICIPANT COUNTRIES AT THE BEGINNING OF THE PROJECT AND DURING ITS DEVELOPMENT

2.1. ARGENTINA

At the end of the 90s, an ageing management programme (AMP) was submitted by the NPP operator to the Argentinian regulatory body for each NPP in operation and was completed by quarterly progress reports on its application. This programme became a mandatory part of the operation license.
In 2002, NA-SA, the NPP operator, implemented a plant life management plan for its NPPs, which broadened the AMP scope and considered the corresponding economic aspects. Such programme began with the study of a particular case (steam generators) in each NPP.

The regulatory activity during this period has been specially focused on the review of the quarterly reports, the performance of regulatory inspections as well as on the regulatory requirements issuance, when necessary.
NA-SA has reported the plans and actions it has performed as part of the Embalse NPP Plant Life Extension (PLEX) project, which was preliminary scheduled for initiating its implementation phase in 2011.

2.2. BRAZIL

The beginning of the Brazilian nuclear programme goes back to the 1950s and the construction of the Brazilian nuclear power reactors, to the 1970-1990s. Besides, the development of the plant life management (PLiM) programme started at the Admiral Álvaro Alberto CNA-AA-1 (Angra-1) NPP at the end of the 1990s. The activities of the Brazilian regulatory body are based on a national regulation, sometimes complemented, if necessary, by internationally recognized guides of other countries or organizations.

The regulatory activities of control and inspection developed by the CNEN for the plant life management and long term operation of Angra-1 NPP and then for Angra-2, did not integrally follow a system based on national reports or guides, but on IAEA safety standards and on the American philosophy and practices.

In the context of a possible long term operation request for Angra-1 the regulatory body considered the FORO/IAEA project to be of great use.

2.3. CHILE

As noted previously, Chile does not have a nuclear power programme but possesses two research reactors: RECH-1and RECH-2. RECH-1 is operational since 1974. RECH-2 started its operation in 1977, went through several modifications and finally was shut down in 1987. The proximity of RECH-1 to its 40 years of operation as well as the inactivity situation of RECH-2 have motivated CCHEN to develop ageing management activities associated with both reactors. CCHEN took great interest in the development of the project.

2.4. CUBA

At the beginning of the 1970s, Cuba designed a nuclear power programme, which included the construction of a nuclear power plant of WWER-440 type reactor in Juraguá, Cienfuegos province. However, on 2 September 1992, the construction of the first Juraguá unit was stopped, putting an end to the construction work (75 per cent completed), mechanical assembly (20 per cent completed) and electrical work (17 per cent completed).

Nevertheless, to ensure the conservation of the provided components and structures, a regulatory process was established to control the conservation process and ageing management of components and structures. From that angle Cuba contributed and benefited from the development of the FORO/IAEA project on regulatory practices on ageing management and life extension.

2.5. SPAIN

The PLiM plans were implemented in the Spanish nuclear power plants during 1990s and since then, CSN performs systematic assessment and control activities (review of the annual

reports on lifetime management) and inspections (development of an inspections programme of biennial frequency).

The work on regulation development performed by Spain in the framework of WENRA (the Western European Nuclear Regulators Association, an association that groups most regulatory bodies of the nuclear European countries) for the harmonization of regulatory requirements and practices, consisting in the analysis and implementation of a set of reference levels, should be highlighted. These are requirements jointly established with the purpose of constituting a 'highest common denominator' of the demandable requirements in the European environment and are based on the IAEA Safety Standards. The ageing management, including the LTO, has been one of the 18 matters addressed in the WENRA programme. This reference level was developed by the CSN.

As a consequence of the regulation process, CSN edited in 2008 the revision 1 of the regulatory guide GS-1.10 'Periodic Safety Reviews (PSR)', and during 2009, developed the instruction IS-22 'Safety Requirements for Ageing Management and Long Term Operation of Nuclear Power Plants', as well as detailed versions of the internal procedures applicable to the inspection and assessment of the ageing management of SSC of the NPPs, including the LTO phase.

The experience of Spain in the field of regulatory practices on ageing management and life extension, throughout its domestic experience and also through its involvement in WENRA activities, allowed Spain to make a significant contribution to the development of the project.

2.6. MEXICO

As mentioned earlier in this report the licensee and operator of Mexican nuclear power plants (CFE) has not requested an authorization for the long term operation of the two Laguna Verde NPPs. The operating licenses (OLs) expire on 24 July 2020 for unit 1 and on 15 April 2025 for unit 2. However, as it was foreseeable that the CFE would request an authorization for the NPP LTO at half term, the Mexican Regulatory Body (CNSNS) was very interested in establishing the regulatory bases of the ageing management of the structures, systems and components (SSC) of both CNLV units.

Regarding the ageing issue of the NPP SSCs, the CNSNS has started modifying the scope of the inspections in the mechanical maintenance, electrical maintenance, instrumentation and control maintenance and in service and pre-service inspections areas, based on the IAEA Safety Standards recommendations and the regulations published about this issue by architect design's country of the NPPs (United States of America). Initially, inspections in these areas were focused on the monitoring, mainly, of the reliability of these SSCs by means of the verification of their operation and maintenance records, which is the reason why it has been feasible to start the monitoring of the ageing process of mechanical components through the following up of the erosion-corrosion programmes in piping and welding and of the intergranular stress corrosion cracking, as degradation mechanisms in the reactor internals.

For the scope of the assessment, the applicable regulations of the reactor origin country and relevant IAEA recommendations have been reviewed. The first exchanges with the licensee are ongoing and the licensee was told that it is a priority to begin with the licensing process and to formalize the activities it is performing on ageing management.

Due to all these facts, current Mexican activities will obtain a regulatory framework in accordance with international practices, to improve the assessment and inspection practices applying to issues already in progress and to obtain experience on those areas in which the application on such framework has not started.

3. DEVELOPMENT OF THE FORO/IAEA PROJECT 2009-2010

3.1. IDENTIFICATION OF SPECIFIC OBJECTIVES OF THE PROJECT

In the first initial stages of the FORO/IAEA Project, four specific objectives were identified:

- Development of guidelines for the elaboration of general regulatory criteria and regulations applicable to ageing management and long term operation;
- Development of a report on good practices regarding the assessment of topics related to ageing management and long term operation;
- Development of a report on good practices regarding the regulatory inspection related to ageing management and long term operation programmes and projects;
- Development of guidelines for regulators on aspects related to ageing management and long term operation in the periodic safety review framework (PSR).

The project had to deal with the double scope of the plant life management (PLiM) plans and LTO licensing processes of NPPs both matters are supported by the same scientific and technological grounds.

In relation to the regulatory actions, the project had to deal with the applicable regulatory and licensing framework, and with the practices employed in the regulatory processes (basically, assessment and inspection). In both cases, the attempt was to standardize the elements used in each country and contrast them with the existent international standards. The IAEA Safety Standards were taken as fundamental reference.

Finally, regarding the geographic scope, the project would be developed in the Ibero-American region; firstly in countries with nuclear power plants and then the scope would be extended to the ones with research reactors.

3.2. METHODOLOGY

As a result of the analysis of the situation in these countries, different levels of progress and necessities to achieve the harmonization of regulatory activities in the regulatory and licensing framework were identified, applicable as practices to be used in the regulatory processes (basically, in assessment and inspection). In accordance with the aforementioned, a strategy was approved, whose main elements were:

- Development of technical workshops for: comparison, contrast and standardization of the individual analyses, coordination of the project documentation elaboration, monitoring of the regulatory activities in the meeting host country, technical visits, etc.;
- Development of technical reports;
- Monitoring of some assessment or inspection activities on the PLiM plan or associated with an LTO licensing process;
- Review of the process followed in any particular LTO licensing case.

The reference terms of the project were included in the project request, which were approved by the FORO technical steering committee and the FORO plenary in 2008. The format of such report demands the pre-establishment of all the important attributes of the project (objective, scope, intermediate goals, activities, necessary resources, schedule and costs). As a general criterion and maximum priority, the intent was to rigorously follow the reference terms reflected in this document.

The project team did not work as a closed group, but, on the contrary, promoted the communication and participation in their activities of other experts, both from the participant regulatory bodies and from licensees of the visited NPPs.

Work procedures were established, which helped the planned objectives achievement with higher frequency and efficiency, such as:

- Distribution of individual tasks, even though the results were always subject to comments of the entire team;
- Establishment and monitoring of work plans and schedules among subsequent workshops or meetings;
- Documentation of each workshop or meeting, by means of specific reports;
- Constant communication between workshops and meetings, maintaining the competent FORO authorities informed (by means of frequent electronic mails and progress reports to the nuclear safety area coordinator);
- Usage of the work environment area as files and documents bank applicable to the project (although potential improvements in the capacities of such work environment were identified).

3.3. IMPLEMENTATION OF THE FORO/IAEA PROJECT 2009-2010

The activities foreseen for the project are hereinafter described, in accordance with the work plan designed in the project request. Even though all these activities were performed (and also some additional ones), the activities sequence described herein, workshop by workshop, were not rigorously followed in the practice. It is also necessary to clarify that the closure meeting was not initially planned.

The first workshop took place on 19-23 January 2009 in Brazil. This kick-off meeting allowed participants to initiate exchange of experience in relation to ageing management and long term operation. Meeting participants discussed details about the methodology, activities and schedule. The preparatory tasks were also distributed, especially to anticipate the preparation of the second workshop, focused on the regulatory and licensing framework.

The second workshop was organized between 30 March and 8 April 2009 in Spain. Dedicated to the regulatory and licensing framework, the meeting developed over eight days and allowed a number of tasks to be carried out. The participants analysed the example cases of the LTO licensing process of the Santa María de Garoña NPP and the first draft of the guide for the elaboration of general regulatory criteria and regulations applicable to ageing management and long term operation had been presented and discussed thoroughly. The progress made set up the bases for the development of the three remaining project reports.

Argentina hosted the third workshop on 21-25 September 2009. The objective of this meeting, focusing on inspection related aspects, was mainly to share knowledge on the matter and to analyse example cases. The participants successfully discussed the three reports prepared under the project on periodic safety reviews, as well as good practices regarding assessment and inspection.

The fourth workshop took place on 29 March-2 April 2010 in Mexico. Its purpose was to facilitate a final discussion on the whole set of developed reports. The technical report of the project was also presented and discussed.

The last meeting of the project was held in Spain between 18 and 22 October 2010. It allowed participants to reach a consensus in order to approve the final version of the developed reports. They were also able to make several proposals for future actions in the area of nuclear safety and ageing management and long term operation of NPPs in the Ibero-American region.

3.4. PERFORMED ACTIVITIES

The activities were developed in two aspects:

- Progress in the basic objectives and tasks of the project (development of technical reports applicable to the regulatory activities in the ageing management and LTO in NPPs);
- Performance of practical activities related to the project.

Apart from the workshop or meeting reports, the status of progress of the project was periodically reported to the coordinator of the nuclear safety area at the technical steering committee of FORO.

The essential aspects of the different performed activities are hereinafter summarized, beginning with the development of the technical reports to be used as guides by the regulators, which was a fundamental task of the project.

3.4.1. Development of technical reports for regulatory activities

As part of the main objective of the project, four technical reports were elaborated for the development and improvement of regulations and regulatory practices regarding ageing management and LTO at NPPs, applicable to the countries of the region.

The technical reports respond to the convenience to establish, with general but not binding character, the criteria to be applied by the regulatory bodies (RBs) of the FORO member countries to require, assess and supervise an ageing management system of structures, systems and components (SSCs), including the case of LTO (licensing process and subsequent operation), of the NPPs.

The technical reports are presented in the annexes, as follow:

- Annex I: FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation of Nuclear Power Plants;
- Annex II: FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants;

— Annex III: FORO Guide for Regulatory Inspection of Ageing Management and Long Term Operation of Nuclear Power Plants;
— Annex IV: FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants.

The main tasks of the workshops were developed in the headquarters of the regulatory body of each participating country. In this environment, the development of these guides advanced and this technical report was elaborated, in which the project progress throughout the work period is described.

3.4.2. Practical tasks carried out throughout the project

Among its support activities, the project included technical visits to the facilities, in which the LTO and PLEX (specific for CANDU reactors) projects of the visited NPPs were discussed. Technical sessions focused on the resident inspection practices were also held.
The main practical activities related to the project were:

(a) Visit to the facilities of the Angra site and the Mambucaba facilities (Brazil)

At the Angra NPP site, the main activity related to the project was the performance of a presentation on activities regarding ageing management, as well as on the LTO project for Angra-1, on behalf of Electronuclear.

The visit to Angra was completed with a presentation about the NPP in the information centre and a walkthrough at the facility, including the site of the future Angra-3 unit, the trial facilities for the performance of the Angra-1steam generators replacement activities (issue about which a great amount of information was required and provided), Angra-2 unit control room (where several aspects about the NPP safe operation were discussed) and the storage facility for high and low radioactive wastes.

Additionally, at the Mambucaba facilities, a visit to the training centre was performed at first, in which the control room simulator was shown, replica of the Angra-2 one, and a discussion about the simulator itself and the training and licensing programmes of operation personnel was held. Finally, the facilities of the environmental laboratories were visited.

(b) Technical visit to the Santa Maria de Garoña Nuclear Power Plant and to its information centre (Spain)

The visit, performed during a refuelling shutdown, included a walkthrough of different facilities of the NPP, as well as of the information centre. Additionally, a technical meeting with the licensee (NUCLENOR) was held and a monitoring of the inspection activities associated with the project issues was performed.

The meeting focused on two presentations: one of general scope on the organization of the licensee, and the other regarding the PLiM Plan and the LTO project of the NPP.
At the same time, CSN inspectors performed an inspection associated with the LTO request of the Santa Maria de Garoña NPP, in relation to which the project team performed the following activities:

— Assistance to the introductory meeting for the licensing inspection;
— Discussion about the licensing inspection results.

(c) Technical visit to the Embalse NPP (Argentina)

It included the visit to the control room, the fuel storage facilities and the facility where the Cobalt-60 sources that this NPP produces were stored. This visit was assisted by technical and directive personnel of the facility, as well as by ARN resident inspectors.

A meeting with representatives of the licensee (NA-SA) was held, which focused on several presentations related to the NPP renewal and LTO project. Among the addressed issues, the following stand out: support missions and experience exchange with IAEA and WANO; organization, phases and methodologies of the project development; safety and licensing aspects; and the most important associated specific projects (replacement of steam generators, fuel channels and of the process computer, power increase, and others.)

(d) Technical visit to the Laguna Verde Nuclear Power Plant, CNLV (Mexico)

The technical visit to Unit 2 included the control room, the technical support centre (in emergencies) and associated facilities, and the refuelling plant, inside the secondary containment. Furthermore, the information centre, the replica simulator and the education and training facilities were visited.

Finally, a meeting with the representatives of the licensee (CFE) was held, which focused on the activities related to ageing management and LTO foresights at CNLV.

(e) Presentation on IAEA activities

In the project framework, technical presentations were made by the IAEA representative. They focused on structure, activities, policies and work methods of the IAEA, as well about new standards, programmes and services of the organism, both of generic and specific character, of interest to the FORO/IAEA project.

3.4.3. Proposals for future activities in the field of ageing management and long term operation

In the fourth workshop held in Mexico, a proposal of future FORO activities was developed within the project subject matters, taking into consideration discussions held throughout the project development.

Afterwards, based on feedback received from FORO´s executive technical committee, some proposed actuations were modified or highlighted at the project closure meeting.

3.4.4. Dissemination of FORO/IAEA project results

Throughout the development of the project, several activities were undertaken to promote the project's activities (not products, as they were not concluded yet). These promotional activities aimed also to increase awareness on the implementation of the project in the countries, within the FORO itself and more specifically, in the nuclear safety area. These activities included presentations in the following events:

— Celebration of the 30th anniversary of CNSNC, jointly performed with the 20th annual meeting of the Mexican nuclear society (Sociedad Nuclear Mexicana), the SNM (Puerto Vallarta, Mexico, July 2009);
— Management committee of the Spanish technological platform CEIDEN (investigation on nuclear fission energy), celebrated in the CSN headquarters (Madrid, November 2009);
— Regional workshop organized by IAEA on the regulatory structures development in emergent countries (Santiago de Chile, Chile, January 2010).

Afterwards, other activities have been proposed and performed, or are planned for the promotion of the results and products of the project. More information in this regard is provided in the closure report of the project.

4. CONCLUSIONS AND FINDINGS FROM THE FORO/IAEA PROJECT

The technical reports providing guidance to FORO members constitute the main output of the Project and are attached in the annexes for reference. In addition, some of the most important points of interest highlighted during the development of the project are hereinafter mentioned:

4.1. GENERAL CONCLUSIONS

All the objectives and all the reference terms established for the project in the request approved by the FORO were entirely complied with, in what refers to the scope, intermediate goals, activities and human resources.

It is important to highlight that in the project request, the participation of CCHEN was not included, as when the request of Chile was developed it was not a FORO member. However, CCHEN participated in the project from the beginning as reflected in all the documentation of the project.

Regarding the schedule established in this report, the duration of some workshops was extended and a closure meeting was added. The actual workload devoted to the project tasks was significantly superior to the foreseen amount, especially regarding coordination tasks. As a lesson learned, before beginning a project of these characteristics, the associated workload must be evaluated with realism, and it must be assured with the participant organisms that each expert they provide has the necessary time to develop the work successfully.

The set of developed technical reports constitute indicative guidance for FORO members' actuation regarding the definition of regulatory, assessment and inspection criteria in the ageing management of the NPPs SSCs, including management in the LTO case.

4.2. TECHNICAL ASPECTS

In the extended operation period, the activities necessary for the ageing management of an NPP structures, systems and components (SSC) must be performed, by means of the corresponding ageing management programmes (AMPs). The AMPs are identified during the ageing management review process, in order to assure the surveillance, control and mitigation of the ageing mechanisms of the SSC that affect safety, both the mechanisms identified in the LTO authorization process and the new ones that could arise. A formal procedure for the identification and implementation of incorporated improvement proposals (IPs) must be followed to control the effects of the new identified mechanisms or to optimize the

management of the already existent ones, including the conclusions of such periodic review to the corresponding documentation.

The safety assessment supporting the NPP extended operation must include, together with the ageing management review for the new period, the review of the safety analysis with a design life hypothesis equal or longer than the NPP design life, in which it is assessed if the conclusions of these analyses are valid considering the extended operation period.

The periodic safety reviews might be considered as a basic tool for the LTO authorization granting. The renewal process of operation licenses (OL) after the performance of a periodic safety review, in which the behaviour of the facility in the previous years is analysed as a reasonable guarantee that safety conditions shall be maintained in the following period, seems also adequate to be applied if an extended operation is required.

To the analyses and studies required in the periodic safety reviews prior to the extended operation, the ones necessary to demonstrate the safe NPP LTO must be added. These are:

— A supplement of the safety analysis report (SAR), in which the studies and analyses that justify the NPP operation in the extended operation period are included;
— A review of the technical specifications, in which the changes necessary to maintain the safe operation conditions in the foreseen period are included;
— An integrated plant assessment (IPA) based in the ageing management review and the time limited ageing analyses (TLAA) necessary for the review of the analyses performed with defined design life hypothesis, which al lows, with a reasonable guarantee, the functionality of the SSC that belong to their scope;
— An update of the analyses of environmental radiological impact to cover the new operation period, considering the foresight of effluents release to the environment, the modifications in the environmental circumstances and the aspects that, due to accumulative nature, can lead to a radiological impact increase;
— A review of the facility radioactive wastes management plan which shows the capacity of management of wastes generated in the required operations for the new operation period.

The presentation of the hereinbefore mentioned documentation, relative to the analyses for the extended operation, should be performed approximately three years before proceeding to the OL renewal.

4.3. ORGANIZATIONAL ASPECTS

Work criteria and methods were followed which allowed an appropriate development of the project.

Some lessons were obtained about the organization and management of this kind of projects, which can be applied to future projects in the nuclear safety are or other areas of the FORO.

Due to the activities development itself, the project involved regulatory experts and licensees, which contributed to the enrichment of the project results; this also allowed spreading its objectives and technical characteristics within its scope.

4.4. OTHER ASPECTS

Besides the activities in the ageing management and LTO scope, the development of the project allowed the project team, to perform a series of complementary activities considered of high interest and enriching in the nuclear safety area context:

- Programming technical visits to the NPPs and other facilities of interest in each workshop or meeting in the host country;
- Technical sessions with the resident inspectors of the regulatory bodies at the NPPs;
- Development of forward looking proposals in the ageing management scope;
- Development of forward looking proposals in the nuclear safety area;
- Development of nuclear safety taxonomy.

4.4.1. Recommendations for the post-project phase

FORO/IAEA project participants made several recommendations with regard to the follow-up of the project:

a) Ageing management and long term operation aspects:

- To extend the applicability of the project to other facilities different from the nuclear power reactors (research reactors or fuel cycle facilities); this aspect arises from the scope established for the project, but its future development was considered of to be high interest;
- To perform a monitoring of the project products application in the countries of the region and to assess the results obtained from such application, and to perform a periodic update of the project products;
- The maintenance of some kind of monitoring meeting, subsequent to the closure meeting, in order to cover, among others, the objectives of the hereinbefore mentioned recommendations.

Finally, it was also highlighted the importance for FORO member countries to actively participate in the IAEA IGALL.

Most recommendations were communicated to the FORO technical steering committee by the FORO nuclear safety area coordinator at the meeting, held in July 2010 (Rio de Janeiro, Brazil).

b) Other aspects in the nuclear safety area

FORO/IAEA project participants advise to perform a new project request in the nuclear safety area. Ideas in this regard were discussed in the first workshops; in the fourth one (Mexico), a subject matter ('Training of Nuclear Safety Regulatory Bodies') was screened; and in the closure meeting the request to submit a draft in the following technical steering committee's meeting was discussed.

They recommend performing technical seminars on nuclear safety matters of similar scope and content to the one held at the CSN Headquarter in November 2007 and improving the capacities and functionalities of the work on environment. These last recommendations were

also presented to the technical steering committee of the FORO by the coordinator of the nuclear safety area at the meeting, held in July 2010 (Rio de Janeiro, Brazil).

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DEFINITION OF TERMS

Within the framework of the FORO/IAEA project, the following definitions have been established for the use of the present publication as well as for the technical reports in the annexes:

— **Time limited ageing analysis (TLAA):** Analyses and calculations carried out by the nuclear power plant Licensee, which meet the following criteria:

- They are related to the SSCs considered within the ageing management scope.
- They take the effects of time and long term operation (LTO) into consideration.
- They maintain hypotheses of limited design life.
- They prove the existence or the lack of capability of SSCs to continue operating according to their specific functions after exceeding the hypotheses of limited design life.
- The calculation or analysis was considered relevant in a safety assessment.
- The calculation or analysis is part of the current Licensing Terms of the plant.

— **Ageing degradation**: Process by which the physical characteristics of the SSCs of nuclear power plants are modified, leading to a change in their behaviour due to phenomena such as radiation exposure, high temperature cyclic transients, pressure or corrosion attacks, among others. [IAEA definition: ageing effects that could impair the ability of a structure, system or component to function within its acceptance criteria.].

— **Ageing effects:** Net changes in the characteristics of a SSC, over age or wear, due to ageing mechanisms.

— **Ageing**: Set of processes (or mechanisms) by which SSCs characteristics progressively degrade over age or wear. It may appear either as *physical ageing* or as *obsolescence*.

— **Technical specifications (TS):** Mandatory data which comprehends the requirements under which the Nuclear Power Plant operation shall be carried out, and which establishes the limits, terms and monitoring for its safe operation.

— **Structures systems and components (SSC):** Generic term which comprises all the elements of a nuclear power plant.

- *Structures* are the passive elements that support or host other elements: buildings, civil works, shielding, etc.
- A S*ystem* comprises several components or structures assembled in such a way as to perform a specific function.
- A *Component* is a combination of pieces and parts which comprises a simple and distinguishable functional unit that performs a specific task in a system. Examples of components are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, pumps, vessels, heat exchangers, deposits and valves.

— **Ageing management:** Engineering, operations and maintenance actions to control within acceptable limits the ageing degradation of SSC. Examples of engineering actions include design, qualification and failure analysis. Examples of operations actions include surveillance, carrying out operating procedures and performing

environmental measurements.

— **Safety analysis report (SAR):** Official report of the facility which comprises the necessary and sufficient information so that the Regulatory Body is able to perform an independent review of a nuclear power plant on nuclear safety and radiological protection, as well as an analysis and assessment of the risks derived from the operation of the facility, both in normal and accident conditions. The technical reports also includes detailed descriptions of safety functions of all the safety systems and SSCs related to safety, of their design bases and functioning in all operational condition, including shutdown and accident conditions. It also identifies the regulations, codes and standards applicable to the nuclear power plant. It is usually referred to as SAR or FSAR, (Final) safety analysis report.

— **Long term operation (LTO):** Continued operation of the nuclear power plant maintaining an acceptable safety level, beyond its design life, after performing a safety assessment which assures that safety requirements applicable to its SSCs are met, by implementing the necessary improvements. It is also referred to as life extension. The safety assessment supporting the LTO of the nuclear power plant shall include, along with the ageing management review for the new period, the safety analysis review considering a lifetime longer than the design life of the nuclear power plant. In such review, whether the conclusions of these analyses are valid taking into consideration the longer operation period shall be assessed.

— **Plant life management (PLiM) plan:** An action programme whose aim is to achieve the original design life without safety deterioration and to keep the possibility of the nuclear power plant license renewal open, for its LTO. In recent times, this concept applies to CANDU technology reactors; but in the past, it was referred to as ageing management plan (AMP), with a similar methodology. A PLiM plan must integrate and, if necessary, complement all the activities related to the assessment and control of the ageing mechanisms affecting passive and long term SSCs relevant to safety.

— **Integrated plant assessment (IPA)** [Programa Integrado de Evaluación y Gestión de Envejecimiento (PIEGE), in Spanish]**:** Set of ageing management analyses which comprise three classical stages: scoping and screening of SSCs, identification of ageing effects and degradation mechanisms, and definition of ageing management programmes. It also includes the time limited ageing analyses (TLAA) which are necessary for the review of the analyses performed with a defined design life hypothesis.

— **Ageing management programmes (AMP):** Structured set of activities oriented to the surveillance, control and mitigation of ageing effects which affect the SSCs comprised in the ageing management process scope. Management programmes are based on different predictive, preventive and corrective maintenance practices, environmental qualification programmes, periodic testing and surveillance of technical specifications (TS), in service inspection programmes, erosion-corrosion programmes, etc., as well as any other specific activity which might be performed at the nuclear power plant with the same purposes.

— **Improvement proposal (IP):** Specific improvement needs associated with a particular ageing management programme, and which have become evident in the

comparison of such programme with a standard reference programme (for instance, those from the NUREG-1801, GALL report of the US NRC), or in the assessment performed in a generic manner by means of the analysis of their attributes. Sometimes, improvements can be related only to the scope of the programme ('*scope improvements*'), which usually arise when different ageing management studies are performed or when a particular ageing management programme has to be applied to a new group of components or structures, implying the widening of its scope.

— **Plant life extension (PLEX):** The extension of the safe operating life of a nuclear power plant beyond its design life. This involves either the replacement or refurbishment of main components or substantial modifications, or both.

— **Periodic safety review (PSR):** Systematic safety reassessment of a nuclear power plant performed at regular intervals (usually every 10 years), to determine the impact of the accumulative effects of ageing, modifications, operative experience, technical developments and site aspects on the facility, and whose aim is to guarantee a high safety level throughout the operating life of the facility.

— **Design life:** The period of time during which a nuclear power plant or component is expected to behave according to the technical specifications to which it was built or manufactured. In most western design nuclear power plants, part of the studies which support the plant safety assessment have been performed with a 30 to 40 years design life hypothesis; for example, those components which cannot be replaced, such as the reactor vessel or the containment building, are the reason why a nuclear power plant's design life is usually considered to be of 30 to 40 years.

— **Lifetime:** Period of time from initial operation to final withdrawal from service of a structure, system or component. It may also be referred to as service life. Lifetime may be longer than design life, provided that actual operating conditions have been less severe than the supposed design ones. The remaining life margin of a SSC can be determined by the comparison between the design conditions with the actual operating conditions.

ABBREVIATIONS

AMP:	Ageing Management Programme
BWR:	Boiling Water Reactor
CANDU:	Canadian Deuterium Uranium Reactor
IGALL:	International Generic Ageing Lessons Learned
IP:	Improvement Proposal
IPA:	Integrated Plant Assessment [Programa Integrado de Evaluación y Gestión de Envejecimiento (PIEGE in Spanish),]
MR:	Maintenance Rule
NPP	Nuclear Power Plant
OL:	Operation License
PHWR:	Pressurized Heavy Water Reactor
PWR:	Pressurized Water Reactor
PLEX:	Plant Life Extension
PLiM Plan:	Plant Life Management Plan
PREEV:	Regulatory Practices on Ageing and Life Extension [Prácticas Reguladoras en Envejecimiento y Extensión de Vida]
RB:	Regulatory Body
SALEM:	CSN Emergency Room [Sala de Emergencias del CSN]
SAR:	Safety Analysis Report
SSC:	Structures, Systems and Components
TLAA:	Time Limited Ageing Analysis
WWER:	Water-Water Energetic Reactor (Soviet designed Pressurized Water Reactor)

LIST OF INSTITUTES

ARN: Nuclear Regulatory Authority from Argentina [Autoridad Regulatoria Nuclear]

CCHEN: Nuclear Energy Commission from Chile [Comisión Chilena de Energía Nuclear]

CEIDEN: Nuclear Fission Energy Technology Platform from Spain [Plataforma Tecnológica de Investigación en Energía Nuclear de Fisión]

CFE: Federal Electricity Commission from Mexico [Comisión Federal de Electricidad]

CNAAA: Admiral Álvaro Alberto Nuclear Power Plant in Angra, Brazil [Central Nuclear Almirante Álvaro Alberto]

CNE: Embalse Nuclear Power Plant from Argentina [Central Nuclear Embalse]

CNEN: National Nuclear Energy Commission from Brazil [Comissão Nacional de Energia Nuclear]

CNLV: Laguna Verde Nuclear Power Plant from Mexico [Central Nuclear Laguna Verde]

CNSN: National Center on Nuclear Safety from Cuba [Centro Nacional de Seguridad Nuclear]

CNSNS: National Commission on Nuclear Safety and Safeguards from Mexico [Comisión Nacional de Seguridad Nuclear y Salvaguardias]

CSN: Nuclear Safety Council from Spain [Consejo de Seguridad Nuclear]

CTE: FORO´s Executive Technical Committee [Comité Técnico Ejecutivo]

FORO: Iberoamerican Forum of Radiological and Nuclear Regulatory Bodies [Foro Iberoamericano de Organismos Reguladores, Radiológicos y Nucleares]

IAEA: International Atomic Energy Agency

NA-SA: Nucleoeléctrica Argentina

SNM: Mexican Nuclear Society [Sociedad Nuclear Mexicana]

WANO: World Association of Nuclear Operators

WENRA: Western European Nuclear Regulators' Association

ANNEX I. FORO GUIDE FOR REGULATORY CRITERIA ON AGEING MANAGEMENT AND LONG TERM OPERATION OF NPPS

I-1. OBJECTIVES

The aim of this guide is to establish regulatory criteria for the ageing management of NPPs components, including LTO management.

I-2. SCOPE OF THE GUIDE

This document is applicable to all NPPs containing PWR, BWR, CANDU and PHWR type nuclear power reactors. The requirements established in the guide are applicable to all operation conditions of the NPP.

I-3. SCOPE OF PHYSICAL AGEING AND OBSOLESCENCE MANAGEMENT

The scope of the ageing and obsolescence management programme, specified in Section I-4, must be established as from the following criteria:

— Include those elements which must keep functioning during and after any design basis event that may arise, to guarantee the following functions:

- Integrity of the reactor coolant system pressure boundary;
- Capability to shut down the reactor and maintain it in a safe shutdown condition;
- Capability to prevent or mitigate accident effects in order to maintain radiation exposure out of the site below the established limits.

— Include those elements whose failure could prevent the satisfactory fulfilment of any of the functions identified in the previous paragraph.
— Include those elements available in the nuclear power plant's safety analysis, and which are related to the requirements for fire safety, environmental qualification, pressurized thermal shock, anticipated transients without automatic reactor shutdown, and complete loss of electric power supply.

I-4. CRITERIA FOR SURVEILLANCE OF PHYSICAL AGEING AND OBSOLESCENCE MANAGEMENT, INCLUDING LONG TERM OPERATION MANAGEMENT

I-4.1. Physical ageing management

I-4.1.1. Management during the nuclear power plant's design life

During the design life of the NPP, the holder of the operation license (OL) or Licensee must perform the actions necessary for the ageing management of structures, systems, and components (SSCs) of the NPP. These activities must include measures for surveillance, control and mitigation of the physical ageing mechanisms of SSCs within the scope defined in the core part of the document, by taking into consideration their condition, and which also identify the improvement proposals (IPs) – new inspection activities, testing, surveillance, maintenance, etc. – incorporated to detect such mechanisms and to control their effects, including the conclusions of these activities in the plant life management (PliM) plan.

I-4.1.2. Management to request long term operation

The request for the NPP OL renewal to operate beyond the design life must include, among other documents, an integrated plant assessment (IPA) [or Programa Integrado de Evaluación y Gestión del Envejecimiento (PIEGE), in Spanish], comprised by the ageing management analyses, which allow to reasonably assure the functionality of SSCs within the scope defined in Chapter I-3, considering the new operation period.

I-4.1.3. Management during the long term operation period

During the LTO period, the OL holder or licensee must schedule and perform the ageing management activities of the SSCs included in the scope defined in Section I-3, by means of ageing management programmes (AMPs) identified during the ageing management review process, in order to assure the surveillance, control and mitigation of ageing and degradation mechanisms of such SSCs, considering the mechanisms identified in the IPA, and others that may arise. A formal procedure shall have to be initiated for the identification and implementation of IPs (new inspection activities, testing, surveillance and maintenance) incorporated to control the effects of new identified mechanisms or to optimize the management of the existing ones, comprising the conclusions of these activities to a long term plant life management (LT-PliM) plan.

I-4.2. Obsolescence management

The obsolescence management programme to be applied at the three stages identified in Section I-4.1 (Sub-sections I-4.1.1 to I-4.1.3) shall be established by following the criteria:

- The responsibility for the programme implementation must be clearly assigned within the licensee's organization;
- The programme tasks must be performed by professional and specifically focused personnel, with wide experience in engineering, maintenance and operation of NPPs;
- The activities of the program shall have to be implemented by means of a multidisciplinary organization, with the NPPs' personnel participation in engineering, technical support, maintenance and procurement topics.

The activities of the programme shall have to be performed by means of procedures oriented to a systematic assessment of obsolescence and to the maintenance of a continued improvement process to solve it if detected.

I-4.3. Requirements for PLiM plan, IPA, and LT-PLiM plan

I-4.3.1. Screening criteria

The PLiM plan, IPA and the LT-PLiM plan apply to those SSCs within the scope defined in Section I-3, and which additionally comply with the following:

(a) They are passive components. These SSCs:

- Include among others: fuel channels, feeders, the calandria, the reactor vessel, the reactor coolant system pressure boundary, steam generators, the pressurizer, piping,

pump casings, valve bodies, the core barrel, component supports, pressure- retaining barriers, heat exchangers, fan casings, ventilation ducts, the containment, the containment cladding, electrical and mechanical penetrations, equipment airlocks, seismic Category 1 structures, wires and electrical connections, cable trays, and electrical cabinets;

— Exclude among others: pumps (except their casing), valves (except their body), motors, diesel generators, air compressors, snubbers, the control rods drive, ventilation gates, pressure transmitters, pressure indicators, level indicators, switchgears, fans (except their casing), batteries, switches, relays, power inverters, circuit boards, battery chargers, and electrical power sources.

The active components could be excluded or not, according to the use of risk based methods, such as predictive risk analyses (e.g. FMEA, HAZOP) or probabilistic safety analyses (PSA), to prioritize the ageing management of those components.

They are not included in any replacement programme based on qualified life maintenance or any other replacement programme.

I-4.3.2. Identification of ageing mechanisms

For each component included within the scope defined in Sub-section I-4.3 (a), their potential ageing mechanisms shall be analysed, as well as their possible causes and consequences.

Once the structures and components with passive and long life functions are identified, in accordance with the previous section, it shall be possible to analyse them individually or by component groups *('commodities')*, considering the similarity in their design or functions.

Particularly, the ageing management of the reactor pressure vessel and its welding shall consider all relevant factors, including embrittlement, thermal ageing and fatigue, in order to compare its behaviour when facing the predictions of the analyses throughout the component's lifetime.

As a consequence of the previous analyses, those ageing effects and mechanisms which require the implementation of a surveillance, control and mitigation activity shall be defined to ensure that the SSC functionality shall not be adversely affected during its service life.

I-4.3.3. Assessment of maintenance practices and AMPs

The aim of these activities shall be to evaluate whether the causes and consequences of ageing (significant ageing mechanisms and their effects) are under appropriate surveillance, control and mitigation by the maintenance practices or AMPs, by taking into consideration that they do not only include activities proper to predictive and preventive maintenance, but also inspection and testing activities, verifications, operational parameter control, etc.

Maintenance practices or AMPs consisting in inspections and tests demanded in the operation license terms shall be valid for ageing management of the considered SSCs, in regard to the ageing mechanisms and effects affecting them.

The assessment of maintenance practices or AMPs shall consist of a comparison between: a) surveillance and mitigation activities applicable to each significant ageing mechanism and

effect for each SSC, and b) the real content of the maintenance practices or AMPs performed on such SSC. The results of the assessment shall include the improvements of the maintenance practices or AMPs necessary to establish an appropriate ageing management, and where necessary, the implementation of new others.

I-4.3.4. Time limited ageing analysis

In the case of ageing management for the long term operation period, all the analyses and calculations performed by the licensee which comply with the definition of the time limited ageing analysis (TLAA) shall be identified and assessed for those SSCs to which the following criteria apply:

(a) The results of analyses affect the design basis which guarantee the safety function of a SSC within the scope of the IPA and which are affected by significant ageing mechanisms;
(b) The lifetime hypothesis defined in the original analysis is shorter than the lifetime which would correspond to it with the new requested operation license.

The assessment of such TLAA shall be performed through one of the following methods:

— Verify that the existing analyses are still valid for the new proposed operation period, and that therefore, a new analysis is not necessary. For this, it shall be demonstrated that the hypotheses and conditions of the analysis already consider the ageing effects within the long term operation period and that acceptance criteria provide a reasonable margin to assure the fulfilment of the function during such period;
— Reassess or perform again the analysis for the new requested lifetime period and verify that the established acceptance criteria are met.

Demonstrate that ageing effects can be properly managed during the new requested operation period.

I-4.3.5. Obsolescence management

The licensee shall define and execute an obsolescence management programme which includes:

— A systematic obsolescence assessment;
— The strategy to be followed once the obsolescence issue has been detected for a type component;
— Its periodic reviews for continual improvement;
— The effectiveness of the implemented programmes, insofar as they provide:

- Sufficient background to support the definition of necessary maintenance actions (acquisition of replacements; analysis, approval and execution of replacements; etc.);
- The necessary technical support performed by duly qualified internal or external personnel.

I-5. DOCUMENTATION

The OL holders or licensees of nuclear power plants shall have to prepare reports containing the activities performed in compliance with Sections I-3 and I-4. Those reports shall have to be submitted to the Regulatory Body (RB) with the content and according to the hereinafter mentioned schedule.

I-5.1. Ageing management periodic reports, during the nuclear power plant's design life

The licensee shall submit to the RB, with the frequency required by it, a report containing the activities of the PLiM plan of the NPP, which must include the surveillance, control and mitigation of ageing mechanisms as well as the degradation of SSCs included in the life management scope as defined in Section I-3. It must also include the aspects regarding obsolescence, and the improvement proposals incorporated to detect such mechanisms and to control that their effects are identified (new inspection and testing activities, surveillances, and maintenance).

Also, within the scope, contents and terms to submit the documentation related to the periodic safety review (PSR) of the NPP, a review of the PLiM plan shall be included in order to confirm that, within the period considered for such PSR:

- The ageing and degradation mechanisms of the SSCs included within the life management scope as defined in Section I-3 have been taken into consideration;
- The unexpected ageing mechanisms and effects, as well as the effects of obsolescence, have been considered;
- New relevant information produced and other arising aspects have been incorporated to the PLiM plan;
- The most suitable methods and tools available for ageing and obsolescence management have been implemented;
- The effectiveness of the ageing management, in accordance with the results of the practices performed at the NPP, has been assessed.

I-5.2. Ageing management report to request authorization for long term operation

The licensee shall submit an IPA report to the RB containing the ageing management analyses (scoping, screening, identification of ageing mechanisms, assessment of maintenance practices or of AMPs and IPs) and the TLAAs necessary for the assessment of the analyses performed with definite design life hypothesis which allow reasonably guarantee the functionality of the SSCs within the scope.

A supplement of the safety analysis report (SAR) shall be attached to the IPA report which shall include the studies and analyses that justify the ageing management for the SSCs of the NPP in the long term operation period, and a review of the technical specifications including the necessary changes to maintain safe operation conditions during this period.

The minimum anticipation time with which the documentation in regard to the IPA report shall be submitted will be of 2 years prior to the OL renewal date. Additionally, an update of those documents including the modifications incorporated to the NPP shall be submitted one year before the OL renewal date.

I-5.3. Ageing management periodic reports during the nuclear power plant's long term operation period

The licensee shall submit to the RB, with the frequency required by it, a report containing the activities of the LT-PLiM plan of the NPP, which includes the surveillance, control and mitigation of the ageing and degradation mechanisms of SSCs, those identified in the IPA, and the new ones that may arise; and in which the IPs (new inspection activities, testing, surveillance, maintenance, etc.), incorporated to control the effects of such mechanisms, are identified.

REFERENCES FOR ANNEX I

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ANNEX II. FORO GUIDE FOR ASSESSMENT OF AGEING MANAGEMENT AND LONG TERM OPERATION OF NUCLEAR POWER PLANTS

II-1. OBJECTIVES

The aim of this guide is to provide guidelines to assess the safety aspects relative to the ageing management of nuclear power plants, in order to assure they shall operate safely until the end of their lifetime.

This document deals, generically, with topics related to ageing management assessment, life extension projects and long term ageing management. Some singularities considered by the countries that participated in the development of this guide are mentioned.
Most differences when dealing with these topics are due to the technological differences and the different methodologies developed in the designing and manufacturing countries of the nuclear power plants.

The assessments to be performed at the different phases of a nuclear power plant's lifetime, together with the regulatory inspections described in the **Annex III FORO Guide for Regulatory Inspection of Ageing Management and Long Term Operation of Nuclear Power Plants** shall aim to verify the following factors:

- If the nuclear power plant can reach the original design life, without safety deterioration, avoiding the unforeseen degradation of structures, systems and components (SSCs) of the nuclear power plant, framed within the scope of the hereinafter defined ageing management process;
- If an ageing surveillance, control and mitigation programme has been established during the original design life, which allows reaching the technical-economic life defined by the Licensee for the nuclear power plant;
- If the planning and systematization of the ageing management established for long term operation (LTO) provides reasonable guarantee on the functionality of the SSCs framed within the scope of the ageing management process;
- If during the long term operation period (Life Extension), the necessary ageing management activities are performed so as to reasonably guarantee the surveillance, control and mitigation of ageing mechanisms of the SSCs framed within the scope the ageing management process, avoiding their unforeseen degradation and therefore, a deterioration of safety.

Furthermore, this guide defines the assessments to be performed by the Regulatory Body (RB) to license the Long Term Operation of nuclear power plants.

II-2. SCOPE OF THE GUIDE

This guide deals with:

- The assessment of all the stages of the plant life management (PLiM) plan during the design life of the SSCs framed within the scope of the ageing management process;
- The key elements to be considered and which shall be assessed when establishing the scope, planning and execution of a plant life extension (PLEX) project, (typical of CANDU nuclear power plants) or during the operation license renewal process if the nuclear power plant's design life is exceeded. This programme is known as integrated

plant assessment (IPA) [Programa Integrado de Evaluación y Gestión de Envejecimiento (PIEGE), in Spanish], in the case of American design nuclear power plants;
— The assessment of LT-PliM plans which include diverse AMPs in force during the LTO period.

Such assessments comprise the following items:

— The scope, requirements, methodologies and results of ageing assessments;
— The acceptance of the refurbishment tasks and safety improvements' scope proposed by the Licensee;
— The verification of the appropriate planning for the tasks to be performed to implement improvements, taking aspects related to radiological and nuclear safety into consideration;
— The verification of a proper execution of the improvement related works;
— The verification of the mandatory documentation update, taking the extended operation period into consideration.

The guidelines regarding these items are also provided in the guide applicable to periodic safety reviews (PSRs) **(Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants)**.

If the nuclear power plant design required an extended refurbishment shutdown, two fundamental factors related to the replacement of components affecting safety shall be considered due to their ageing. The first factor is related to SSCs that could be contaminated (fuel channels, feeders, steam generators, etc.) and the second one is related to the restart, especially if new components have been introduced in the reactor, which implies it shall be done with a fresh core. Therefore, the following items shall be added to the aforementioned ones:

— Verification of an appropriate management of radioactive waste generated in the refurbishment tasks of the nuclear power plant;
— Verification of the application of an appropriate Radiological Protection system during the refurbishment shutdown;
— Verification of the compliance with technical conditions to initiate the restart process of the nuclear power plant;
— Verification of the necessary conditions checking during the commissioning process for the safe restart of the nuclear power plant.

This guide only deals with those factors related to nuclear and radiological safety. Even though the assessments related to physical safety and safeguards exceed the scope of this guide, these shall be established within the long term operation licensing framework. The same applies to assessments related to the Safety and Hygiene of the nuclear power plants, for those countries in which the RB is responsible for the control of such factors.

II-3. ASSESSMENT OF AGEING MANAGEMENT

II-3.1. Overview

Nuclear power plants (NPPs), like other conventional facilities, are subject to ageing.
The aim of a NPP ageing management is to reach the design life guaranteeing the safe and economically feasible operation of the plant and to create the bases for a possible long term operation.

Ageing is manageable if:

- Symptoms are recognizable;
- The ageing mechanism is known and can be monitored;
- Suitable and timely measures for its mitigation are taken.

The PLiM plan allows a cost-benefit optimization for capital investment, replacement and modernization of equipment (obsolescence management), systems, and general operation and maintenance tasks. On the other hand, this plan provides evidence of:

- Lifetime of the NPP SSCs;
- Cost of their maintenance;
- Cost of their replacement;
- Change management.

A PliM plan provides a systematic analysis for early detection of the ageing effects of critical SSCs (CSSC). The performed tasks are the precursor of refurbishment and modernization activities for a possible long term operation.

Furthermore, ageing management allows the control, improvement and update of the operation, maintenance (predictive, preventive and corrective), modification, chemistry monitoring and in-service inspection programmes, among others, for them to be more effective.

There are several methodologies for the development of PliM plans in the international practice. Some FORO member countries have accepted, among others, the analysis methodologies mainly developed by the American RB (USNRC) in the License Renewal Rule, 10CFR54 *Requirements for Renewal of Operating Licenses for NPP* [III-19], or the ones developed by the Canadian RB (CNSC) known as *Ageing and Ageing Management in CANDU Nuclear Power Plants* [III-17] or RD – 360 *Life Extension of NPP* [III-16].

In any case, and regardless of the adopted methodology, a set of basic documents subject to assessment by the RBs must exist, in which licensees will embody the objectives and basic principles of ageing management, as well as the methodology and results of the analyses performed in every stage of the process. These documents subject to assessment, shall be complemented by others which the licensee shall incorporate during the different inspections that the RB shall perform on ageing management during the different phases of the NPPs' lifetime (in accordance with the **Annex III FORO Guide for Regulatory Inspection of Ageing Management and Long Term Operation of Nuclear Power Plants**).

II-3.2. Basic Aspects of a PLiM plan

A PliM plan shall include a basic ageing management strategy of the SSCs by the licensee during the NPP's design life period, and shall at least allow the detection, measurement and control of natural ageing and obsolescence of SSCs, as well as the ageing caused by their operation under severe or adverse conditions.

It is important to observe that the number of stages or phases of a PliM plan depends on the methodology used by the licensee's organization. It is worth mentioning that in most IAEA member countries, a PliM plan is considered a document of mandatory nature. In this case, the RB shall have to establish a definite period of time for the execution of the updates of such plan. These periods normally vary from 1 to 5 years.

The PliM plan shall be complemented by a periodic report in which the licensee shall include the main activities regarding ageing management performed during the previous period, following the criteria and methodology presented in the PliM plan. The **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation** provides guidelines on these aspects.

The basic contents for the development of a PliM plan are hereinafter dealt with.
The first step of a PliM plan is to develop the policy, plans and procedures which shall outline the basic rules to perform its implementation at the NPP, for what it is necessary to have the following documents at disposal:

II-3.2.1. Policy

- Defines the main elements of the plan;
- Defines roles and responsibilities: it may include the specific personnel for the PLiM plan, as well as the structure for the necessary organization.

II-3.2.2. Plan

- Details of the general plan and strategies: specific goals and schedule;
- Identification of necessary training, tools and sources of information.

II-3.2.3. Procedures

Procedures for the analysis of factors such as:

- Plan implementation process;
- SSC prioritization process;
- Implementation procedure of ageing management and measurement of results;
- SSC assessment methodologies (condition assessment, life assessment, maintenance systematic assessment, etc.);
- Analyses monitoring process;
- Quality assurance;
- Plan verification;
- Improvement and feedback processes.

The development of this plan includes the analysis of CSSCs, through the implementation of assessment methodologies, as a basic task.

These tasks are supported by the plant programmes in course and they require an analysis to guarantee that all ageing effects are considered.

Such analyses must be systematic, rigorous, and must adapt to the SSCs complexity.

The PLiM plans are supported by a series of more specific documents, which contain the details of the analyses related to the different phases of ageing management. It is common that PLiM plans refer to specific analyses regarding:

— The scope and screening of components (mechanical and electrical components, instrumentation and control, and structures);
— Analyses of ageing phenomena and degradation mechanisms;
— Specific ageing management programmes (AMP).

II-3.3. Aspects subject to assessment

A series of aspects regarding the PLiM plan shall have to be assessed depending on the phase in which the NPP is in. In some cases, those aspects are coincident for the different phases, while others are characteristic of a particular phase, as in the case of AMPs. Guidelines on the various aspects to be assessed during the design life are hereinafter provided.

II-3.3.1. Organizational and managing aspects

Main aspects to assess:

(a) Licensee's organization related to ageing management

Regarding the organization, group or committee formed at the NPP for the management of the aspects related to ageing management, the assessment shall have to include:

– Composition:

The group or committee shall be integrated, preferably, by internal experts in different disciplines or activities involved in the AMPs.

Some examples of the disciplines or activities which could be involved are hereinafter listed:

- Maintenance (mechanical, electric, I&C, etc.);
- Maintenance rule (MR);
- Design modifications (DM);
- In-service inspection programmes;
- Environmental qualification;
- Periodic tests;
- Operative experience;
- Research and development;
- Operation;

— Functions and activities to be developed by these groups

— Hierarchical relationships
— Frequency of meetings, topics dealt with, and made decisions
— Ensure that in the organization there is a personnel responsible for the practical aspects in regard to the AMPs
— Assurance that the allocated resources are sufficient and adequate
— Assurance that responsibilities are clearly defined at all levels
— Assurance that the personnel involved in ageing management activities has the necessary knowledge in the specific aspects of this field

Information about the previously mentioned aspects shall be incorporated in the PLiM plan, as well as in associated periodic reports. This information shall be complemented by the obtained from the inspections performed by the RB to the NPP, regarding ageing management.

(b) Acquisition and registration of information regarding ageing management

According to Safety Guide NS-G-2.10 of IAEA and the **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants**, the licensee shall have to count on a systematic acquisition and registration system of data to support AMPs.

The evaluator shall perform verifications oriented to assess such system (data, analyses, etc.), by checking its main characteristics and effectiveness.

The establishment of this system at the beginning of the NPP's design life is the most appropriate action to take in order to have a more complete data register. This information is essential to make decisions that prevent the loss of equipment functionality.

The data to be registered shall have to be related to the different phases of the management process. The data obtained as a consequence of tests, inspections and controls regarding the practical application of the AMPs are of special significance. This information shall allow the diagnosis of components and structures, as well as the consequent establishment of a management strategy to preserve their functionality.

Additionally, the documentary quality of methodological aspects and of the analyses results shall have to be assessed. These results must be properly documented and subject to the existing quality system controls at the NPP.

(c) Monitoring of the commitments with the RB

The level of progress or the effective resolution of the commitments adopted by the licensee as a result of previous assessments or inspections shall be evaluated.

Apart from the information contained in the periodic reports, the information obtained during assessments and inspections shall be essential for the evaluation. This acquisition of information shall be included in the inspection schedule.

II-3.3.2. Periodic reports

The aim of the periodic reports of the PLiM plan is to inform the RB about the main activities regarding ageing management performed by the licensee during the previous period. Such

reports are basic documents which allow knowing the progress and evolution of the ageing management activities performed by the licensee. Furthermore, they allow knowing the current condition of components and systems, which shall enable the identification of degradation mechanisms related to ageing.

The **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation** provides general guidelines regarding these reports.

The basic points usually addressed in these reports in a general manner and whose proper development shall be subject to assessment are hereinafter listed:

- Updates of organizational aspects;
- Summary of meetings and performed activities within the specific existing management committee at the NPP for the development of activities and AMPs;
- Basic ageing management activities performed by the licensee during the period (performance of new analyses, or review and update of existing ones), including an updated list of scheduled documents and analyses, with their reviews and conditions;
- Monitoring of commitments with the RB, results of assessments and inspections performed on the ageing management;
- Results related to the application of AMPs (performed activities, condition of components and structures, new IPs, etc.);
- Monitoring of IPs.

Results related to the participation of licensee's representatives in research or work groups, related to the ageing management of SSCs.

II-3.3.3. Scope and screening of SSCs

A great percentage within the wide range of SSCs of a NPP can be replaced during routine operation, but there are other SSCs whose early replacement would involve either a high economic cost or a high dose cost for the personnel. This could question the feasibility of the NPP operation continuance.

In order to avoid these kind of situations, it is important that the licensee, prior to the development of a PLiM plan, performs a study for the identification and screening of CSSCs, by establishing a prioritization scheme to be dealt with by an analysis methodology during the development of the PLiM plan.

In international practices, different methodologies for the screening of SSCs are recognized. The assessment is based on the fact that the licensee will screen the methodology deemed most appropriate to perform the analyses related to the scope and screening of SSCs and shall provide the RB with the basic principles of the screened methodology; the RB shall approve such methodology, applying modifications, limits or conditions to it, if necessary.

The **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation** provides guidelines to establish criteria regarding the SSCs scope in the PLiM plan, from a nuclear safety point of view.

The licensee shall develop the necessary scope and screening analyses by following the guidelines and criteria of such methodology, with the final purpose of concretely define those SSCs within the scope.

The resulting information shall be organized by systems or type of components ('*commodity*' type groups). It is expected that each component or structure within the scope of the PLiM plan is identified with a specific name or code. This shall facilitate the review of present and absent elements on the final list.

The licensee shall send a list of the SSCs within the scope, with mandatory acceptance of the RB, before being included in the PLiM plan. The RB shall reserve the right to require or recommend the inclusion of other SSCs not previously considered by the licensee.

Based on the aforementioned information, the basic aspects to be assessed are:

— The methodology defined by the licensee to determine the scope and screening of the SSCs which shall be subject to the ageing management process;
— The result of the application of such methodology onto different SSCs of the NPP.

The assessment of these aspects shall require, on behalf of the evaluators, the usage of different kinds of technical documentation, especially of those documents related to the licensing terms of the NPP. Some of them are hereinafter mentioned:

— Safety analysis report (SAR), project bases and technical specifications; normal, abnormal and emergency operating procedures, and guides or procedures for severe accident management;
— Reports of equipment with seismic qualification;
— Reports related to natural external events, such as floods, storms, hurricanes, tornadoes, earthquakes, tsunamis, etc., as well as internal events such as fire hazards, internal flood, etc.;
— Probabilistic Safety Analysis (PSA) to identify important SSCs from the hazard point of view;
— Environmental qualification analysis or study of electric and I&C equipment;
— Technical reports, submitted to the RB, dealing with phenomena such as pressurized thermal shock transients, anticipated transients without automatic reactor shutdown, and complete loss of electric power;
— Documentation associated with the enforcement of MRs on equipment, when applicable;
— Plans and diagrams of the systems important to safety.
— Analysis for the enforcement of new regulations.

II-3.3.3.1. Assessment of methodological aspects for the scope and screening of SSCs determination

II-3.3.3.1.1. Scope

The criteria used for the screening of SSCs are very similar among the methodologies used internationally. The applicable criteria shall be in accordance with the criteria in **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation:**

— Include those elements which must keep functioning during and after any design basis event that may arise, to guarantee the following functions:

  - Integrity of the reactor coolant system pressure boundary;
  - Capability to shut down the reactor and maintain it in a safe shutdown condition;
  - Capability to prevent or mitigate accident effects in order to maintain radiation exposure out of the site below the established limits.

— Include those elements whose failure could prevent the satisfactory fulfilment of any of the aforementioned functions.
— Include those elements available in the NPP's safety analysis, and that are related to the requirements for fire protection, environmental qualification, pressurized thermal shock, anticipated transient without automatic reactor shutdown, and total loss of electric power.

The main aspects to be assessed, according to the scope definition methodology, are:

(a) General methodology used for the scope definition of mechanical and electrical components, I&C and structures

It is the purpose of this item to assess the scope and screening general process, meaning, the different phases or stages followed by the licensee in the definition of the SSCs which shall be subject to the ageing management analysis process. Special attention shall be given to the sequential logic followed during the analysis; the documents developed in the process, used computer tools, etc.

It is worth emphasizing that the methodology, despite being common in general terms, could entail certain differences depending on whether it is about mechanical or electrical components, I&Cs or structures. These methodological differences shall be checked by the evaluator in order to verify their effectiveness within the scope definition.

The evaluator shall have to put special emphasis on the sources of information used by the licensee for the identification of structures and components of the plant, as well as of the intended safety functions performed by each one of them (databases, plans, manufacturer catalogues, licensing terms documents, etc.) This aspect shall illustrate the level of comprehensiveness applied in the process.

The component or structure grouping method chosen by the licensee to perform the ageing management analyses shall have to be verified. The aim of this verification is to reasonably ensure that there is no omission of SSCs.

In this context, there are two possibilities:

— *'Commodity'* grouping type, understood as the joint consideration of elements with similar characteristics or properties that justify their consideration grouped in future ageing phenomena analyses;
— System grouping, following the natural organization considered at the NPP.

(b) Identification of intended safety functions at system and complex structure level

The intended safety functions of a system or complex structure are those which justify their inclusion within the scope because of their compliance with one of the criteria established in the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**. Therefore, the limits or 'fractions' of the system or structure which complies with at least one of the criteria shall be defined.

Regarding the assessment, and at methodology level, the usage that the licensee has given to the concept of intended safety function within their scope analysis shall be verified.

(c) Intended safety functions at component level

The identification of intended safety functions at component level performed by the licensee shall be verified, understanding by them as those that contribute to the scope of the intended safety function of the system or structure they belong to.

The elements of the system or complex structure within the scope shall have to:

— Be within the scope limits defined for the system or structure;
— Perform an intended safety function in an individual manner.

The assessment shall have to give special attention to those components or structures that could have several intended safety functions, such as heat exchangers or orifice plates, to ensure that no omission has been made, as the correct identification of intended safety functions shall condition the subsequent identification of degradation phenomena.

(d) Verification of the identification of SSCs whose functions are Safety Related (SR), according to the criteria in I-3, first paragraph or I-3, third paragraph from the Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation

The order followed for the identification of SR SSCs shall be specifically assessed. The SSCs with intended safety functions clearly defined in the documents of the NPP's licensing terms shall be incorporated within the scope. They will typically be the nuclear class SSCs, with their support systems, as found in the SAR, design bases, etc.

The specific documentary sources considered by the licensee for this definition shall be assessed in order to determine whether they are sufficiently complete so as to reasonably assure the correct identification of the involved SSCs.

(e) Verification of the identification of SSCs whose functions are Non Safety-Related (NSR), according to the criterion in I-3, second paragraph from the Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation

The process followed by the licensee for the identification of NSR SSCs whose failure could prevent the compliance with safety-related functions (according to the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**), shall be assessed. The licensee shall have to bear in mind the intended safety function performed by each SSC and the set of existing physical and functional relationships among them.

The following aspects shall be taken into account in the assessment:

- The magnitude of the analysis performed by the licensee shall mainly depend on the used sources of information. Therefore, their extension and adaptation shall have to be verified;
- It shall be ensured that the licensee considered in the analysis those structures or components identified as NSR in the design basis, but whose failure could make safety components fail. The intended safety function of these components is usually identified in this context as NSR.

The components identified as NSR in the License basis, but whose function is to protect SR structures and components in the case of failure or rupture of certain elements with which they have a spatial relationship, shall also be considered:

- It shall be verified that the licensee had proceeded to the identification of NSR elements physically connected to SR components (typically, piping);
- Finally, it shall be verified that the licensee has analysed the case of those NSR components which, without being physically connected to SR components, have a spatial proximity relationship with them in such a way that SR components' failure could prevent their intended safety functions fulfilment. This is equally applied if there is a functional relationship between both types.

The components complying with the aforementioned requirements shall be incorporated within the scope for their NSR function. For the assessment of relationships (spatial and functional) among components, the following aspects shall be considered:

- If the safety element has a qualified design to fulfil its intended safety function, it is understood as prepared to resist the conditions caused by the failure of the NSR component. Therefore, its inclusion within the scope shall not be necessary. This shall be also applied if the safety element was designed following the 'fail-safe' criterion.
- If the NSR component or structure contains air or gas inside, its rupture shall not be regarded as a threat.
- If the relationship between components is spatial, the licensee may include the existing protection elements with mitigation function within the scope, instead of the NSR elements with possibility of failure.
- The non-inclusion within the scope of a NSR element with possibility to affect another SR one shall not be considered as acceptable, based on the fact that there are several redundancies of the SR one.
- NSR equipment improved by appropriate surveillance or monitoring programmes which are used for the maintenance of the design analysis initial hypotheses, shall not be included within the scope. It is considered that the regulating programmes, requirements and restrictions which already exist for them, assure their ageing control.
- The criterion which states that any malfunction of a NSR SSC involving the acting of a SR SSC does not justify its inclusion within the scope shall be applied, as this fact does not allow assuming the loss of intended safety function of the RS SSC.
- For those NSR SSCs which provide support for SSCs qualified as SR, the cascading effect shall be considered up to a relation level similar to the one established in the licensing terms.

That would be the case, for instance, of a coolant pump regarded as a safety component, whose sealing system is cooled by a non-safety pump, which is in turn powered by a non-safety electric system.

(f) Identification of SSCs related to certain regulatory requirements

The process followed by the licensee for the identification of SSC which comply with the criterion in I-3, third paragraph from the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**, related to requirements regarding fire safety, environmental qualification, pressurized thermal shock, anticipated transients without automatic reactor shutdown, and complete loss of electric power, shall be assessed.

For the assessment of this aspect, the specific documentary sources considered by the licensee for this definition shall be assessed in order to verify whether these used documentary sources are sufficiently complete so as to reasonably assure the correct identification of the SSCs involved.

(g) Special associations of elements

An assessment shall be performed on some particular associations made by the licensee of components or structures which are not a priori evident, as they belong to different types of elements. Piping supports or cable trays are examples of elements which could be included within the structure category and not in the mechanical or electrical component category, as it could be a priori expected.

(h) Itemization of complex components in subcomponents

Another aspect to be assessed is the development performed by the licensee of a systematic itemization of complex components in subcomponents with different materials and environments (for example in the case of a heat exchanger, its tubes, casing, bolts, nozzles, distribution plates, support plates, etc. should be distinguished, as the materials and environments shall be different in each case).

(i) Components within the scope by exploitation criterion

Those components and structures that the licensee decides to include within the scope for availability reasons, replacement costs, etc., shall be clearly distinguished from the ones complying with the safety scope criteria from the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**. Therefore, it shall be verified that the information regarding these elements of interest by exploitation criterion is separately submitted.

II-3.3.3.1.2. Screening

Once the methodological aspects related to the scope definition process have been assessed, follows the assessment of the aspects related to the screening process of components and structures.

The screening process is performed on the basis of the components and structures obtained as a result of the scope process.

The SSC screening criteria are very similar among themselves at international level. The following are among them:

— Passive components whose early replacement would involve either a high economic cost or a high dose cost for the personnel. This could question the feasibility of the NPP operation continuance. The active components shall have to be properly controlled by the application of preventive or corrective maintenance during a routine operation. These passive components and structures:
    - include among others: the reactor vessel, the reactor coolant system pressure boundary, steam generators, the pressurizer, piping, pump casings, valve bodies, feeders, fuel channels, the calandria, the core barrel, component supports, pressure- retaining barriers, heat exchangers, fan casings, ventilation ducts, the containment, the containment cladding, electrical and mechanical penetrations, equipment airlocks, seismic Category 1 structures, wires and electrical connections, cable trays, and electrical cabinets.
    - exclude among others: pumps (except their casing), valves (except their body), motors, diesel generators, air compressors, snubbers, the control rods drive, ventilation gates, pressure transmitters, pressure and level indicators, switchgears, fans (except their casing), batteries, switches, relays, power inverters, circuit boards, battery chargers, and electrical power sources.

— Components and structures which are not included in any replacement programme based on the qualified life maintenance or any other replacement programme.

Two examples of SSC scope and screening methodologies, synthesized in schemes, are shown in Figures II-1 and II-2. Prior to the development of the PLiM plan or AMP, and according to the identification and screening criteria of SSC, a prioritization scheme of SSCs of economic relevance or importance to safety is established.

The analysis of the less important SSCs, which only suppose a residual risk, is omitted in Figure II-2.

The RB shall approve such methodology, applying modifications, limits or conditions, if necessary. The licensee, by applying this methodology, shall prepare a list of the resulting SSCs, with mandatory acceptance of the RB, before being included in the PLiM plan. The RB shall reserve the right to require or recommend the inclusion of other SSCs not previously considered by the licensee.

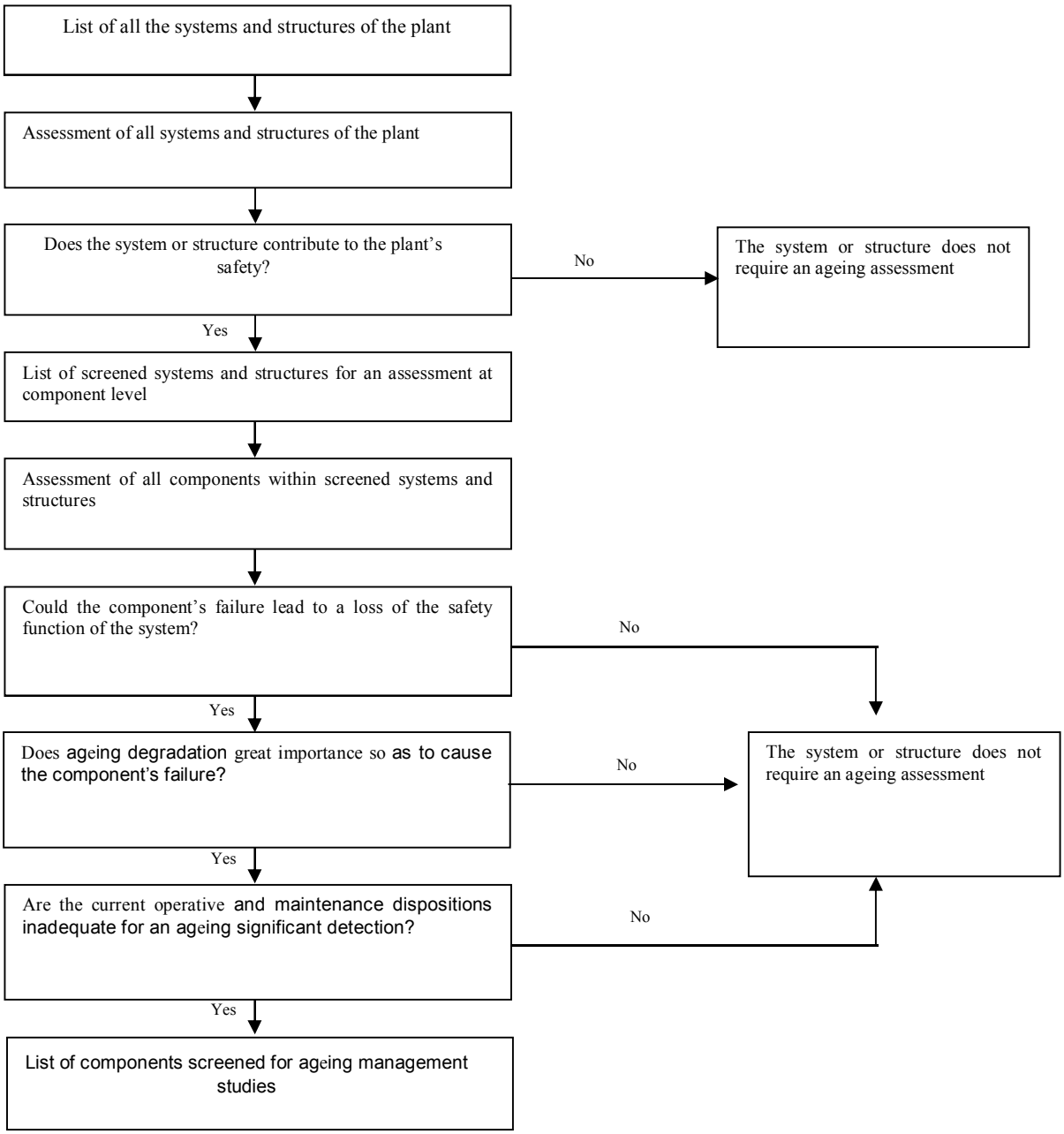

FIG. II-1. Scope and screening scheme of SSCs for a PLiM plan in a PWR, BWR or PHWR nuclear power plant with vessel.

Regarding the methodological approach adopted by the licensee, the practical experience shows that the aspects to be assessed related to the screening methodology are very similar, with some slight exceptions.

The main aspects to be assessed, in regard to the screening methodology, are hereinafter defined:

— Passive components identification process

It shall be verified that the licensee has followed an effective procedure for the identification of those components and structures which are passive within the scope.
The frequent manner to proceed consists in the performance of any kind of selective consulting of a database on components and structures of the NPP. In that case, the

assessment shall focus on verifying the structure of the database, type of the performed consulting, its entire amount of contents, etc.

In those cases in which the aforementioned procedure is not the one followed or in which the licensee has made use of the database and the manual analysis of different documentation of the plant as a complementary method, the assessment shall check these sources and their adaptation for the purpose of the screening process. These verifications shall be mainly based on the information obtained from an inspection of the plant.

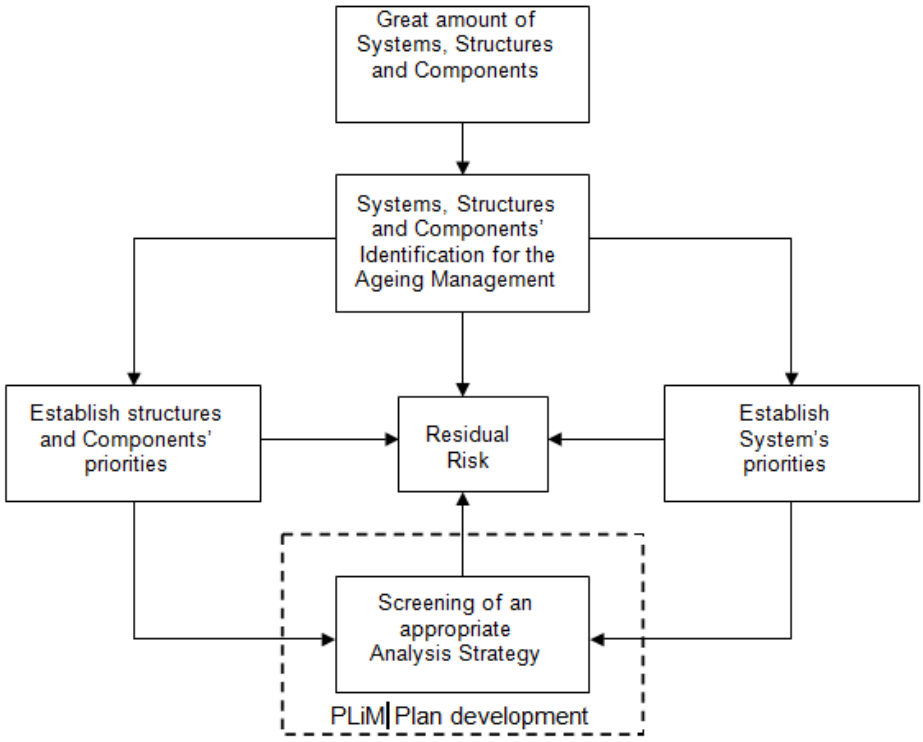

FIG. II-2. Scope and screening scheme of SSCs of economic relevance or importance to safety to be addressed in a CANDU nuclear power plant PLiM plan.

— Identification of passive parts of active components

It shall have to be verified that the methodology followed by the licensee, assures the inclusion of the passive parts of active components, such as pump casings, fans, valves, etc.

— Components experiencing changes in their properties

The assessment shall have to ensure that the employed methodology guarantees the non-screening of those apparently passive components, but which experience a change in their properties, condition, etc., (typically, much instrumentation equipment).

— Identification of long life components

Finally, the process followed by the licensee for the identification of components which, besides being within the scope and being passive, are long life components, meaning that they are not subject to any kind of periodic replacement programme during the NPP's lifetime, shall be assessed.

The sources of information used by the licensee, being typically maintenance procedures, work order records, catalogues and supplier recommendations, etc., shall be verified.

II-3.3.3.2. Assessment of results related to the application of the Scope and Screening Methodology

The purpose of this section is to provide guidelines so that the evaluator verifies whether the scope and screening methodology has been properly applied and if the obtained results are satisfactory.

In this sense, except for particular justified cases, the sampling methodology shall be the one to be followed by the assessment; this means the screening of a finite set of SSCs onto which the assessment criteria shall be applied.

If the results of the initial sample assessment are not satisfactory, then the sample can be broadened. There shall be several criteria for the screening of the samples and they will be adapted to the element subject to assessment, as well as to the phase the NPP is at.

Some general criteria which can be applied for the definition of assessment samples are the ones based on the identification of:

- SSCs especially important to safety;
- SSCs with greater preponderance in the PSA assessments;
- SSCs representative of different categories or types (reactor and internals, safeguards, auxiliary systems, electric systems and I&C, etc.);
- SSCs recommended by internal or external operative experience;
- SSCs with especially critical operating conditions, or especially vulnerable materials and environments;
- SSCs with design attributes not fully demonstrated by testing;
- SSCs with multiple functions in the MR, if applicable, or which support multiple systems;
- SSCs not assessed in the past;
- SSCs that have experienced changes due to design modifications, repairs, etc.

Taking the previous considerations as a base, the main aspects to be assessed are hereinafter defined.

(a) General results at system and complex structure level

- Final list of structures and complex systems contents

It will be verified, from the final list of systems and complex structures resulting from the scope process that other systems and structures clearly expected due to the intended safety functions they perform are not absent.

As a complement of the previous assessment, a system or structure not included in the scope list shall be screened, with the purpose of verifying that indeed, it does not perform any intended safety function.

— Definition process of the systems and structures within the scope

In order to verify the correct implementation of the methodology, several systems and structures included in the final list shall be screened to check the correct identification of their intended safety functions and consequently, the system's fractions within the scope.

(b) General results at mechanical type component level

Classically, these components shall belong to systems within one of the following categories:

— Reactor coolant systems (vessel and internals, pressure boundary, steam generators, etc.);
— Technological safeguard systems (containment dousing system, containment insulation system, high pressure injection system, etc.);
— Auxiliary systems (ventilation systems, cooling systems, etc.);
— Power conversion and steam systems (turbine, main steam system, condensing system, etc.).

For mechanical type components, the assessment shall focus on the performance of the following verifications:

— Identification of mechanical components within the scope and screening

The verification of the correct identification of individual components within the scope shall begin with the previously screened systems based on the intended safety function they perform.

Special attention shall be given to the boundary components among fractions within and out the scope, as well as to the components that the licensee concluded are not within the scope at component level, despite being within the system's scope. In this case, the reasoning endorsing their exclusion shall be verified.

In the case of the components identified within the scope, it shall be verified that they are indeed passive and have a long life.

— Particular case of *'commodity'* type groups

In those cases in which the licensee has chosen to organize the components in 'commodity' type groups, some of them shall be screened to verify that certain significant components of the plant are on the list associated with such group.

Some NSR components within the scope of the criteria in I-3, second paragraph from the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation** will be screened. It shall be verified, by means of the analysis performed by the licensee, that methodological aspects related to this criterion have been properly applied, obtaining satisfactory results.

In the case of the components identified within the scope, it shall be verified they are indeed passive and have a long life.

— Specific verification of the screening criteria

As a complement to previous verifications, several components within the scope (with a defined intended safety function) will be chosen, which have not been finally screened, so as to check that they do not comply with any of the screening criteria (passive and long life) and that their exclusion is well-grounded.

(c) Results at structural component and structure level

Typically, the structures and structural components resulting from the scope and screening process shall be included within one of the following categories:

— Structure of the primary containment;
— Other main structures, such as the structure of the emergency diesel generators' building, the auxiliary building, and the turbine building, etc.;
— Structural components such as: cable trays, piping supports, elastomers to mitigate vibration, equipment supports, ventilation ducts' supports, etc. Non safety structures, but whose failure could prevent the performance of a component or safety structure's safety function, for instance, seismic category II structures with respect to others of seismic category I.

For structures and components of structural type, the assessment shall focus on the performance of the following verifications:

(1) Identification of structures and structural components within the scope

Several complex structures within the scope shall be screened (e.g. the containment building) to verify that the structures and structural components with intended safety function that belong to them have been properly identified (e.g. foundations, slabs, cable trays, piping supports and ventilation ducts' supports, curbs, frames, bellows, containment walls, sheathings or liners, mechanical penetrations, sinks, etc.).

It shall be also verified that the intended safety function is clearly identified in all cases, and that based on that fact, the inclusion within the scope has been justified.

(2) Particular case of *'commodity'* type groups

If the licensee has chosen to organize the analyses in 'commodity' type groups, one of the groups related to complex structures shall be screened to verify that certain structural components, included in the group and which should be within the scope for the intended safety function they perform, are indeed on the list associated with the structural 'commodity'.

(3) Verification of the screening criteria

Most structures and structural components within the scope shall comply with the screening criteria, as they are passive and have a long life. The verification shall focus on the justification provided by the licensee in those cases excluded from the final list due to screening reasons.

(d) Results at electrical type components and I&C level

The typical components in this area will be the wires, phase bars, high-voltage conductors, electrical penetrations, connectors to ground, connectors, insulators, etc.

The assessment shall focus on the following verifications:

- Identification of electrical type components and I&C within the scope and screening

Several electric systems and I&C within the scope shall be screened to verify that individual components have been correctly identified, taking the intended safety function performed by each one of them as a base.

Additionally, it shall be verified that such components are passive and have a long life.

- Particular case of *'commodity'* type groups

In the cases in which the licensee has chosen to organize the components in 'commodity' type groups, some of these groups will be screened to verify that certain significant components, clearly within the scope due to the intended safety function they perform, are in the list of components of such group and that they are passive and long life components.

In NSR components that due to their characteristic intended safety function should be included within the scope of the criteria in I-3, second paragraph from the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**, it shall be verified by means of the analysis related to them whether the methodological aspects related to this criterion have been properly applied by the licensee, obtaining satisfactory results.

- Verifications related to the 'analysis by areas'

The 'analysis by areas' consists in the analysis of a set of components which belong to different electric and I&C systems within the scope, all of them with an intended safety function, located in the same site or area, and which comply with the limit environmental conditions characteristics of such site or area.

In those cases in which the licensee has used the 'analysis by areas' methodology for the definition of the scope, one or some areas within the scope shall be screened to verify that those individual components comprising it have been considered.

Additionally, one or several areas that have not been included within the scope shall be screened so as to verify that there are no components with intended safety functions complying with the inclusion criteria.

- Specific verification of the screening criteria

As a complement to previous verifications, several elements within the scope, but which in the end did not comply with the screening criteria, shall be screened. It shall be verified whether their exclusion is properly justified.

- Environmental qualification

It shall be verified that all electrical and I&C components which are not only passive and have a long life, but are also subject to environmental qualification, have been properly identified. These components shall be analysed in the corresponding time-limited ageing analysis (TLAA).

II-3.3.4. Ageing management review

In this section, the main purpose of the assessment shall be to ensure that the ageing effects in SSCs are properly managed, in such a way that the corresponding intended safety functions are maintained throughout the NPP lifetime.

Prior to dealing with the aspects to be assessed related to this point, it is considered appropriate to develop a synthesis of how is ageing managed according to different approaches. This shall help to understand which aspects are dealt with by the methodology and what elements need to be assessed.

It is important to mention that despite the fact that the methodologies are different, they all tend to properly assure the ageing management of NPPs' SSCs.

In those NPPs that have not used the American ageing management methodology as a basic reference, as in CANDU type NPPs, the implementation of the ageing management is performed throughout a unique life management process which is developed in 3 phases (see Figure II-5).

A synthesis about the application of a PLiM plan and about the aspects it deals with based on the CANDU methodology and in comparison with the American methodology is hereinafter exhibited. Along with the description of the process, some guidelines for the RB's evaluation are presented. Afterwards, general guidelines are provided for the assessment of different aspects associated with the ageing management review.

II-3.3.4.1. Phases and contents of a PLiM plan

II-3.3.4.1.1. PLiM Plan for CANDU nuclear power plants

Phase I

Table II-1 shows the steps contained in Phase I of a PLiM plan for NPPs with CANDU reactors, in accordance with the methodology developed by AECL known as plant life management for CANDU Reactors [III-18]. The first step of such phase is to develop the policy, plans and procedures which shall outline the basic rules to carry out its implementation at the NPP. It is important to mention that this step is similar to the American ageing management methodology.

The development of this phase consists in the analysis of CSSCs, through the implementation of assessment methodologies. Condition assessments, life assessments, and the systematic maintenance assessment are among them. Such methodologies are applicable to CANDU NPPs, and are not considered in the American methodology.

These assessments are supported by the plant programmes in course, and require an analysis to ensure that all the ageing effects are considered. Such analyses are systematic, rigorous, and can be adapted to the complexity of SSCs.

TABLE II-1. SUMMARY OF THE PLIM PLAN PHASES FOR A CANDU NUCLEAR POWER PLANT

PLiM Plan Policy
• Defines the main elements of the programme • Defines the roles and responsibilities: it may include the specific personnel for the PLiM plan as well as the necessary structure of organization
Programme
• Details of the programme in general and strategies: specific goals and schedule • Identification of training, tools, and necessary sources of information
Procedures for Analyses
• Implementation process • Prioritization process • Implementation procedure for life management and effectiveness measurement (performance) • Condition assessment • Life assessment • Systematic maintenance assessment • Process for the monitoring of analyses • Quality assurance • Plan verification
Assessment methodologies
• Condition Assessment • Life Assessment • Systematic assessment of maintenance

Condition Assessment Report

The purpose of a condition assessment report is to establish the current condition of SSCs and to provide a life prognosis for them, both to reach their design life, and their possible Life Extension (long term operation). This is based on a detailed study on degradation mechanisms and the development of models which allow foretelling their behaviour (See Figure II-3 for Phase I).

The results of this stage or Phase I shall be registered in a condition assessment report, which will provide a preliminary assessment on ageing degradation of the screened SSCs (Phase II).

In addition, this condition assessment report shall establish the research and development works to be performed in the next phase (Phase III), for a better understanding of ageing mechanisms, their monitoring, and the necessary mitigation actions.

The condition assessment report, included in the PLiM plan methodology of CANDU reactors, shall have to be permanently updated. These updates shall have to be performed after the scheduled reviews, as they provide important information on the SSCs, or when other events or relevant changes suggest it. After the issuance of the initial condition assessment report or of one of its updates, it shall have to be assessed especially considering the ageing management proposals.

These proposals may include changes in the chemistry in the systems, modification in the operation processes, new monitoring methods, more detailed studies of the degradation mechanisms, SSCs' modification, repair or replacement, etc.

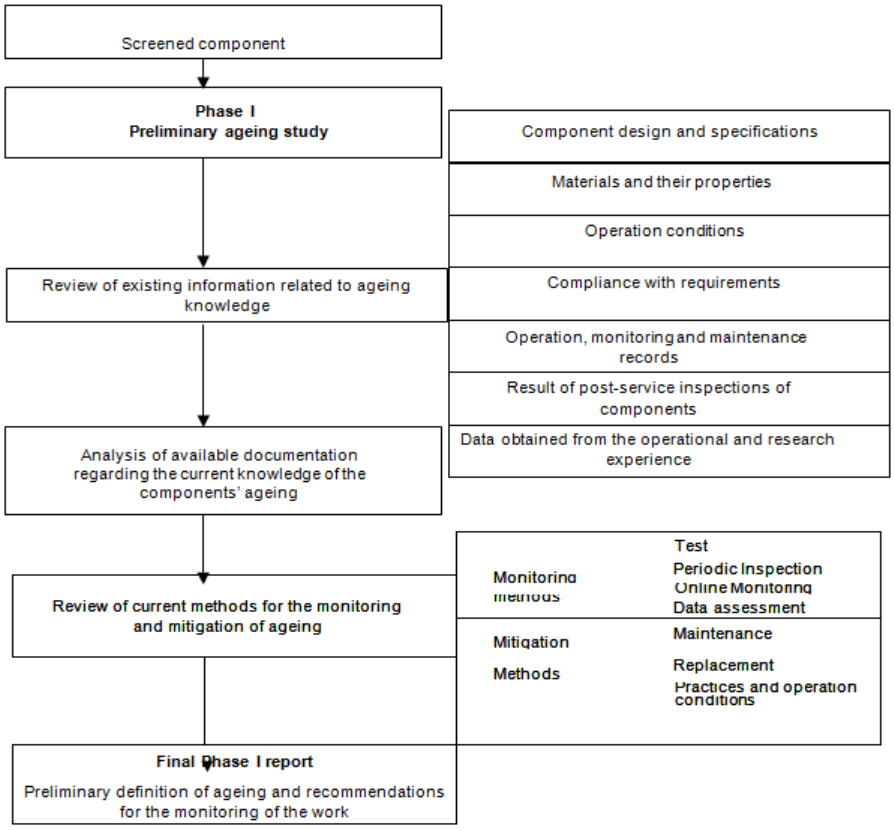

FIG.II-3. Phase I basic scheme of the CANDU-PLiM plan.

The typical contents of a condition assessment report can be observed in Table II-2.
The analysis of possible options to solve the set out problems shall be performed by taking into consideration the acceptability of the solutions proposed by the RB, who shall also:

— Review the condition assessment reports of SR SSCs, by verifying that the assessment methodology is appropriate;
— Ensure that the report is complete and that it reflects the plant's real situation;
— Assess whether the inspection or data gathering techniques are appropriate and if the personnel performing these tasks is qualified and trained as demanded;
— Assess whether the recommendations are sufficient or adequate, and shall identify deviations;
— Determine recommendations critical to safety;
— Control the implementation of recommendations or modifications;
— Be able to require an increase in the frequency and a broadened scope of the inspection to a particular SSC.
—

TABLE II-2. ASPECTS TO CONSIDER IN THE CONDITION ASSESSMENT REPORT OF A SSC

TOPICS	
INTRODUCTION AND OBJECTIVES	MINIMUM CONTENTS
DESCRIPTION AND FUNCTIONS	• Description • Functions • Scope and outlines • Design specifications and codes • Design changes • Environmental qualification • Subcomponent prioritization • Construction/Manufacture, assembly and materials • References • Annexes
OPERATION RECORD	• Chronological record of events • Chemistry controls • References • Annexes

MAINTENANCE AND INSPECTIONS	• Corrective maintenance • Preventive maintenance and inspections • Predictive maintenance • Obsolescence/Manufacturer information • References • Annexes
ASSESSMENT OF DEGRADATION MECHANISMS	Possible degradation mechanisms Assessment of existing degradation mechanisms at the NPP • Degradation mechanisms matrix • References • Annexes
CONCLUSIONS AND RECOMMENDATIONS	• Conclusions • Life prognosis • Recommendations

Permanent monitoring is applied on each SSC, out of the data gathered from the operation, maintenance, the in-service inspection programme, surveillance programmes, operative experience, etc.

From the particular analysis of each condition assessment report, a general assessment of the set of condition assessment reports and the technical-economic assessment reports is performed. The result is registered in an integrated condition assessment report on the NPP's lifetime management, as illustrated in Figure II-4.

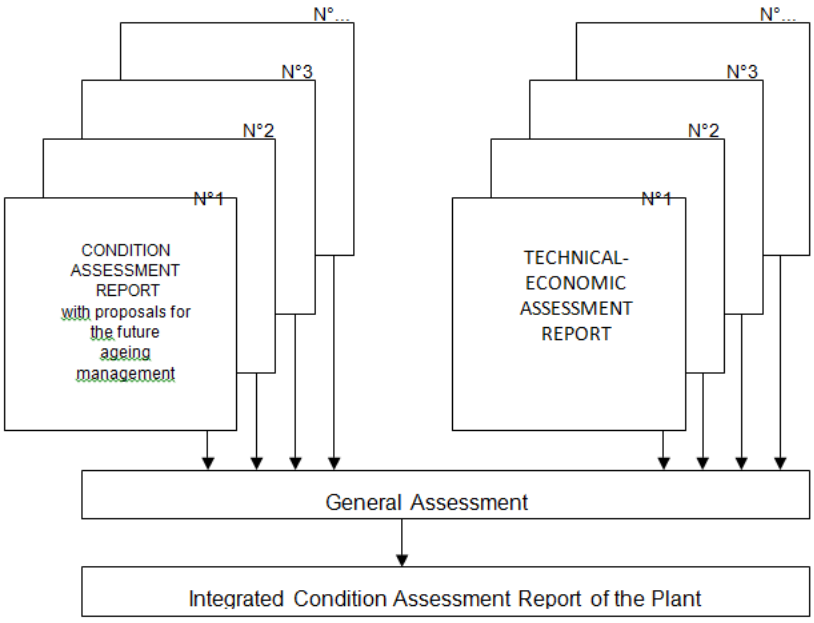

FIG. II-4. Scheme of the integrated condition assessment report of a CANDU nuclear power plant.

Phase II

This stage consists of a detailed study on ageing knowledge, in order to deepen the conclusions obtained at the preliminary studies stage, particularly those weak points related both to technology and to the safety functioning of the SSC during its lifetime.

Main scheduled tasks:

- Research and development studies to improve the current knowledge on significant ageing mechanisms and determine the root causes of the SSCs' ageing degradation;
- Studies on the monitoring of ageing with the purpose of verifying the existing diagnosis and the existing data assessment techniques or developing new ones, capable of detecting the SSC's ageing degradation in a timely manner;
- Studies on ageing mitigation to improve the existing methods or to develop new ones, operation and maintenance practices or new designs, necessary to control the ageing degradation of an SSC;
- Preparation of the report on this stage detailing the conclusions obtained in the previous items.

Phase III

This phase considers the plant life extension (PLEX) project of a CANDU NPP and includes modernization, refurbishment, and long term operation tasks.

If the assessments performed on the SSCs in the previous phases showed that the design life is achieved in good conditions, this would allow the licensee to propose the possibility of facing a PLEX project with view to the long term operation (LTO).

At Phase III, the technical and economic studies supporting such decision are performed, as well as the engineering of the PLEX and the implementation of modernization and refurbishment changes which shall guarantee the LTO of the plant in safe and economic conditions. (see Figure II-5).

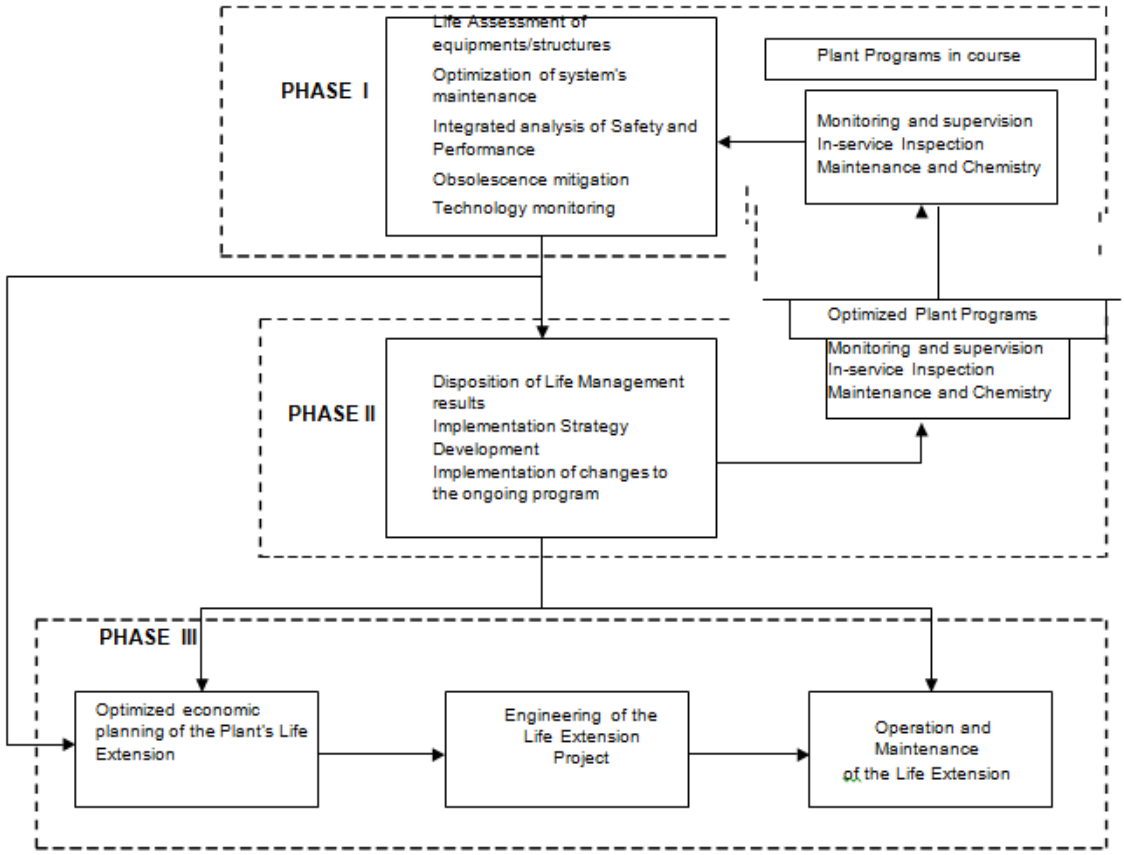

FIG. II-5. Phases of the life management process in a CANDU reactor.

II-3.3.4.1.2. PLiM plan for PWR, BWR and PHWR with vessel

In order to make reference to a PliM plan, the American methodology employs the terminology of the ageing management programmes (AMPs), which are usually several at a NPP.

The AMPs are a structured set of activities oriented to the surveillance, control and mitigation of ageing effects affecting the SSCs important to safety. The AMPs are based on different practices of predictive, preventive and corrective maintenance, environmental qualification programmes, periodic tests and surveillances of the technical specifications, in-service inspection programmes, erosion-corrosion programmes, etc., as well as any other specific activity that could be performed at the NPP with the same purpose.

It is important to highlight that, by following the American methodology, certain systems or sets of 'commodity' type groups are gathered in specific AMPs which have a similar set of maintenance, inspection and control activities.

For the assessment, the starting point is the final list of mechanical, electrical and I&C systems and components, as well as of structures (including structural components) which have complied with the scope and screening phase.

The logical sequence to develop the ageing management analysis supposes, firstly, to determine the materials and environments which correspond to the different elements within the scope and screening. Secondly, and based on these two fundamental parameters, the ageing mechanisms and associated effects are identified. Finally, the appropriate AMPs for the control of the ageing mechanisms and effects previously mentioned are defined.

As well as in the scope and screening phase, the licensee shall have defined a general methodology to perform the associated analyses. As a result of the guidelines application and criteria of such methodology, the licensee shall perform the specific analyses for the identification of ageing mechanisms and phenomena, and shall undertake the definition of the necessary AMPs.

Consequently, an assessment strategy similar to the one in the scope and screening phase is suggested, consistent in the review of the methodological general aspects, which is afterwards applied to verify the results obtained from the application of the suggested methodology.

II-3.3.4.1.3. Assessment of methodological aspects related to the ageing management review

The assessment of methodological aspects shall focus on the following aspects:

— General criteria followed by the licensee for the definition of materials and environments

It shall be verified if the criteria and methodology defined by the licensee allow the acquisition of a set of materials and environments (internal and external), representative of the existing casuistry in the different operative condition to be considered in the analysis.

The support documentation, the support computing tools (databases), etc. used by the licensee, and in general, the analysis order for the identification of materials and environments shall be reviewed.

Furthermore, it shall be verified that the licensee has generated a definition of materials and environments (internal and external) detailed enough to be used in the analyses.

— Operative condition considered in the analyses

It shall be verified if the licensee has considered the different operative conditions with relevance in the ageing management analysis, as they condition the ageing phenomena and environments which affect the SSCs (normal operation, periodic functional tests, refuelling periods, etc.).

— Consideration of the operative experience

The usage of a systematic methodology by the licensee for the consideration of internal and external (national and international) operative experience in the identification of degradation mechanisms and ageing effects, as well as in the definition of the AMPs, shall be verified.

— Documentary references and other sources of information

The specific sources of information used by the licensee for the identification of the degradation mechanisms and phenomena, and for the definition of the AMPs, shall be verified.

Additionally, it shall be verified that the licensee considers the information from research programmes, generic safety issues (GSI), new measurement and trial procedures, etc. in the analyses and programmes.

— Process for the definition of degradation mechanisms and phenomena

The specific procedure followed by the licensee for the assignment of degradation mechanisms and phenomena shall be verified.

It is customary to define characteristic 'material-environment' groups (ageing management review (AMR) groups), described in II-3.3.4.2 of this guide, as these two aspects condition the acting degradation mechanisms. Each AMR group shall be associated with a group of potentially occurring degradation mechanisms and phenomena. The grouping of elements within the scope in accordance with these two variables is concurrently carried out, for then to proceed to the assignment of mechanisms through the matching of the groups of elements with the corresponding AMR groups.

The aforementioned is usually supported by computer tools that facilitate the mentioned grouping and matching processes.

It shall be verified that the licensee considers the detection of certain elements that constitute particular cases derived from specific circumstances in which the SSCs are defined (flow stagnation areas, flow acceleration areas, especially aggressive environments, etc.). In this way, these components may not comply with what was established for their group, or may be subject to additional mechanisms that the licensee shall be able to identify.

It shall be verified that the methodology considers the definition of degradation mechanisms and ageing effects regarding the intended safety function that the component or structure performs in the system. Special attention shall be given to those components or structures with several intended safety functions. In these cases, the specific degradation mechanisms and effects linked to each one of them shall be defined.

For those elements that belong to an AMR group, but that the licensee defines as unaffected by its characteristic ageing effects, it shall be verified that a reasonable explanation supporting the result is provided.

— Definition of ageing management programmes (AMPs)

The methodology followed by the licensee for the definition of AMPs oriented to control the previously identified degradation phenomena shall be reviewed. Such definition shall be materialized in a supporting document with essential information about each programme.

In this context, it shall be verified that the methodology considers the adoption of standard programmes with direct application to the NPP, as well as the definition of specific programmes when required.

It shall be verified that each AMP is subjected to the technical assessment of its characteristic attributes, and if the scheme of AMPs contains, at least:

- A section in which the SSCs within the scope are comprehensively mentioned, indicating the materials, environments, and degradation mechanisms they are associated with;
- A descriptive section of the specific inspection and control programmes on which the AMP is based;
- List of IPs awaiting resolution.

— Identification of IPs

It shall be verified that the licensee considers the systematic identification of the IPs associated with AMPs, and that these are properly defined and registered.

IPs may arise during the conciliation process of the plant AMPs with some standard programmes taken as a reference in the industry.

The ageing management review process itself shall also generate what is known as 'scope improvement proposals', as new components or structures that require the application of a particular AMP, whose scope shall have to be broadened, arise.

II-3.3.4.2. Assessment of results related to the ageing management review

Once the methodological general aspects have been assessed, the results obtained by the licensee from the application of such methodology shall be assessed.

In general, and regarding the screening of the assessment sample, the systems or *'commodity'* type groups already used at the scope and screening phase shall follow. For the verification of certain particular aspects, other SSCs, more appropriate for the pursued objective, may be screened.

The main points to be assessed are:

— Verifications related to the definition of materials

In order to ensure that the set of materials considered in the analyses are in accordance with the actual existing ones at the NPP, several components or structures shall be screened to verify that the identification of materials has been correctly performed, at subcomponent level (this means, with the appropriate dismantlement level).

The basic information needed to perform this verification, shall be normally included in the documentation provided by the manufacturer (catalogues), or in the databases of the components, available at the plant. Therefore, this aspect is capable of becoming part of an inspection schedule on ageing management.

— Verifications related to the definition of environments

In order to equally ensure that the set of internal and external environments considered in the analyses are representative of the actual existing ones, several components or structures in

which more than one operative condition has been identified as significant for the analysis shall be screened, verifying that in each case, both the internal and external environments are correct, and that no omissions are shown.

— Assignment of ageing effects and degradation mechanisms

It is the verification, in practice, of the proper assignment of ageing effects and degradation mechanisms to the components and structures within the scope. For such purpose, the assessment shall focus on the following aspects:

- If the licensee had defined generic 'material-environment' groups [ageing management review (AMR) groups], some of them, applicable to the system or 'commodity' subject to assessment, shall be screened to verify the correction and entirety of the ageing effects and degradation mechanisms assigned to the AMR group.
- As a complement, a combination of 'material-environment' which was not considered and not a priori disposable for being typical of similar facilities shall be screened. It shall be verified that indeed there is no component or structure responding to it.
- Several components and structures of the system or 'commodity' subject to assessment shall be screened in order to verify, individually, that the degradation phenomena and ageing mechanisms identified as applicable are appropriate, and that no omissions are shown.

If the degradation mechanisms had been identified by matching the elements with an AMR group, it shall be verified that indeed, the components or structures subject to assessment belong to such group. If this methodology had not been followed, the phenomena and mechanisms identified by the licensee shall be assessed by using reliable and recognized references.

It shall be equally important to verify, through the screening of a component adapted to that end, that the licensee has detected the particular ageing mechanisms affecting it, besides the general ones that affect the AMR group it belongs to (for instance, the case of a pipe section to which the erosion-corrosion applies because of the particular conditions of its tracing, and which has been shown as a consequence of the internal operative experience).

Special attention shall be given to ensuring that the applicable degradation mechanisms and ageing effects have been defined taking into account the intended safety functions of the component or structure.

Likewise, it shall be ensured that the licensee provides a technical justification for all those ageing phenomena which have not been finally qualified as significant among the list of the a priori applicable ones because of the AMR group they belong to.

— Ageing management programmes (AMP)

This point establishes the verifications which shall be performed in order to ensure that the finally defined set of maintenance practices and activities, are sufficient and appropriate for the effective control of the degradation mechanisms they are associated with.

As mentioned in previous sections, the set of maintenance, inspection and control activities shall be grouped into specific programmes named AMP. This name shall appear in those cases in which the licensee has developed a methodology based on the regulations by the USNRC.

For these aspects' assessment, the systems or 'commodity' type groups screened in earlier stages shall be taken as a reference. Again, for certain concrete matters, a system or 'commodity' type group different from the ones already used could be employed.

In accordance with the aforementioned, several AMPs applicable to particular combinations defined by type of component, material, environment, or degradation mechanism shall be chosen from the screened systems or 'commodity' type groups. The following aspects and considerations shall be considered during the assessment:

— The report NUREG-1801, Rev. 1 generic ageing lessons learned (GALL) from the USNRC shall be used as a basic verification tool. This report provides, by systems, a proposal of AMPs valid for concrete combinations (type of component/ material/ environment/ degradation mechanism).
— By using this reference, it shall be verified that the AMPs proposed by the licensee for the screened combinations are consistent with the ones proposed by the GALL report.
— The AMPs from GALL to be used for comparison, can be easily defined by means of the identification of the GALL line applicable to the concrete combination (type of component/material/environment/degradation mechanism), of the element subject to verification.
— Once the contrast AMP has been identified, each characteristic attribute of the licensee's programme shall be afterwards compared to the equivalent attributes of the standard programme. In this way, the coincidence level between both programmes shall be verified.
— Special attention shall be given to those cases in which the GALL report establishes that the applicable standard AMP must be broadened as an essential requirement to assure its validity. Thus, it shall have to be verified that the AMP defined by the licensee has been effectively improved with respect to the standard programme from GALL (For this purpose, the GALL report itself provides instructions on how to improve programmes).
— In those cases where the licensee has categorized one of their AMPs as consistent with GALL, but with exceptions, it shall be verified that:

    - The exceptions are properly grounded;
    - The alternative proposed by the licensee to those points from GALL that they don't conciliate with, complies (where applicable) with the criteria mentioned in the following point for the assessment of the NPP specific AMPs.

In those cases where the GALL report does not include information regarding the particular combination to be assessed (type of component/material/ environment/degradation mechanism), or in those cases where the GALL report itself indicates that the licensee needs to develop a specific AMP for the NPP, the methodology proposed in the Branch Technical Position RLSB-1, included in Appendix A from the NUREG-1800, Rev. 1 (SRP) [III-20] report by the USNRC, shall be used as an assessment guide.

This reference sets out the assessment of 10 attributes for the validation of any AMP. These attributes are generic, and according to the type of AMP (preventive, mitigation, condition monitoring, or operation monitoring), one of them could be left without content.

For the licensee's assessment of attributes, and in the absence of the support provided by the GALL report, the verification of the NPP's own experience shall be mainly resorted to. This experience shall justify the adaptation and effectiveness of the content of such AMP.

The experience of other NPP with similar technology and with AMPs already assessed by the corresponding RBs could be used as a reference.

As from the recommendations on references [III-20] and [III-22] of the USNRC and of the Nuclear Energy Institute (NEI), the 10 attributes that allow the characterization of any AMP to be used as bases for assessment are hereinafter described.

(1) Scope of the programme

The AMP shall consider, within its scope, the general definition of the type of components, materials, environments, and degradation phenomena it applies to. This information shall be coherent with the result of the ageing management analysis.

Furthermore, the AMP shall include a list with the concrete reference of components and structures within its scope.

(2) Preventive actions

In those cases in which the AMP bases all its strategy, or part of it, on the implementation of preventive measures (for example, a programme of protecting paints), it shall describe the foreseen actions to avoid or minimize the occurrence of the degradation mechanisms it manages. These actions could consist of maintenance activities, inspections, operation optimization, and even design modifications (DMs) to control the degradation of the component or structure.

(3) Monitored or inspected parameters

The AMP shall have to describe the parameters to monitor, along with the testing and inspection activities suitable to monitor and control the degradation phenomena.

(4) Detection of ageing effects

The AMP shall have to consider the necessary methods and techniques to detect ageing phenomena before the component or structure is incapable of performing its intended safety function. To that end, the type and/or methods for testing, inspection, trial, etc., the frequency, the sample size, measurement points and instruments, etc., shall have to be adapted to the previous purpose.

In those cases in which the control strategy is based on sampling, it shall have to be verified that the established criteria in this regard are reasonable to assure the representativeness of the total population.

(5) Trend monitoring and analysis

The AMP shall consider the performance of monitoring activities and trend analysis which allow knowing the ageing phenomena progress rate, and therefore, enable the adoption of additional controlling, corrective, or mitigation measures.

In this sense, the AMP shall have to include a description of the monitoring parameters or indicators, the future projection methodology, and the acceptance criteria applicable for decision making.

(6) Acceptance criteria

The AMP shall have to describe, for each control, the applicable acceptance criteria, under which the need to undertake corrective actions shall be defined.

These criteria shall be sufficiently conservative so as to assure that the component or structure shall not be incapable of performing its intended safety function during the foreseen operation period.

Additionally, the AMP shall have to describe the analysis methodology to determine whether the acceptance criteria are complied with or not.

(7) Corrective actions

In those cases where the acceptance criteria are not complied with, the AMP shall have to describe the corrective actions to be performed (operative changes, repairs, replacements, etc.).

Where required, the need to perform a root cause analysis for the non-compliance analysis shall be specified.

It shall have to be specified, for each defined corrective action, the organizational units and personnel responsible for its implementation, along with the period established in that regard.

(8) Confirmation process

The AMP shall have to include a description of those actions that allow verifying the complete execution and effectiveness of the corrective, preventive, or mitigation actions to be performed.

(9) Administrative controls

The AMP shall have to be within the scope of the existing quality control system at the NPP.

(10) Operative experience

The effectiveness of the AMP shall be justified with base on the accumulated internal and external operative experience, and this aspect shall be properly and periodically reviewed to incorporate new experiences and lessons learned. In this same context, the licensee shall consider the information derived from research projects that could be applicable to the AMP.

II-3.3.5. Results of the application of ageing management programmes (AMPs)

This section deals with the verification that the AMPs defined by the licensee are actually applied at the NPP, and that these are effective for the control of the degradation mechanisms they refer to.

Due to the eminently practical nature of the documentation to be managed, these verifications shall be mainly supported by the information gathered from the inspections performed at the NPP.

For the assessment, several AMPs shall be screened to verify the results obtained during the period deemed convenient, in regard to one or more SSCs within the scope.

Special attention shall be given to those specific plant AMPs, or which present exceptions to GALL, or those newly implemented at the NPP, in order to verify their adaptation and effectiveness for the control of the degradation mechanisms they are aimed at.

Likewise, and due to their specificity, those AMPs defined as a result of a TLAA or of a generic safety issue (GSI) resolution shall be considered for assessment.

In accordance to the aforementioned, and for the screened AMPs, the following aspects shall be verified:

- It shall be verified that the monitored parameters and variables are coherent with the ones specified in the AMP. Likewise, the inspections, trials, tests, etc., executed shall have been performed by following the techniques, frequency criteria, sampling techniques, etc. specified in the AMP, and always in accordance with the procedure guidelines;
- It shall be also ensured that the personnel responsible for the performance of tests, inspections and controls, have the necessary experience and training;
- It shall be verified that the corresponding trend analyses have been performed in those cases required by the AMP;
- It shall be verified that all the analyses of results derived from the application of AMPs are clearly defined in the acceptance criteria, and that the obtained results have been compared to the applicable criteria;
- In those cases where the acceptance criteria have not been complied with, it shall be verified:

    - That the broadening of a sample has been performed, if required by the AMP;
    - That the necessary subsequent analyses have been performed (root cause analyses, loss of functionality forecast, etc.);
    - That when needed, the necessary corrective measures, replacements or DMs, as well as their implementation strategy have been defined.

- Likewise, it shall be verified that the different AMP activities have been performed following the quality assurance requirements established in it.

It shall have to be verified that the licensee, when required and as a consequence of the experience acquired from the AMPs practical application, has defined the IPs necessary to increase the adaptation and effectiveness. In this context, the definition of the effectiveness

indicators related to the results obtained from the application of each AMP shall be of great help.

II-3.3.6. Monitoring of improvement proposals (IPs)

The IPs shall arise as a consequence of the following activities:

- Initial AMP definition process, when evaluating the 10 characteristic attributes;
- Ageing management analysis (initial or reviews to the initial ones), when the broadening of the AMP's scope to include new SSCs is required;
- As a result of the experience acquired from the practical application of AMPs;
- As a consequence of the external operative experience analysis, of research programmes, technical advances, etc. which could be specifically applied to the NPP.

The assessment shall try to verify that the licensee has defined a clear monitoring order of the IPs, and that the results obtained from its application are satisfactory. For that purpose, the following items shall be taken as a base:

- The results obtained from inspections performed on ageing management aspects, in which the performance of verifications related to IP management has been taken as a point of inspection;
- The information provided in the periodic reports submitted by the NPP to the RB.

The gathered information shall serve as reference to assess the general effectiveness of the IP resolution process, by verifying, among other aspects, the number of IPs resolved in the period, expected resolution time against the required real time, definition of effectiveness indicators, indicators' results, etc.

II-3.3.7. Monitoring of design modifications (DMs) and replacement of equipment related to ageing management

As part of the assessment, it is necessary to verify that the licensee deals with the DMs and equipment replacements performed at the NPP appropriately.

In the particular case of power increase projects, the following shall be applied, as they may involve DMs, changes in the operational conditions, equipment replacements, etc. that could affect ageing management. Likewise, any modification in the operation procedures performed at the NPP shall be analysed to determine its consequences in the existing ageing management analyses.

For this purpose, a DM or equipment replacement project shall be screened, verifying:

- That the licensee has explicitly considered the aspects related to ageing management in the general design criteria in the case of DMs, or in the specification of new equipment in the case of replacements. This shall have implications in the screening of materials, protection systems, design margins, sampling systems, monitoring, inspection, testing, etc. to mention some examples;
- That the licensee has analysed the effect that the DM or replacement may indirectly cause in the operative conditions of already existing components or structures at the

NPP, as its variation could entail changes in the environments and possible applicable ageing mechanisms;

— That the new components or structures incorporated into the NPP have been analysed following the general methodology of the ageing management analyses. The results of these analyses shall be assessed according to the previously established criteria. The licensee shall propose a strategy for modifications and replacements based on the accumulated experience, the SSCs condition, as well as on their obsolescence conditions. This plan shall have to be specifically assessed, by analysing the reasons that justify it, along with the proposed measurements adaptation.

II-3.3.8. Monitoring of support documents reviews

These verifications are oriented to the monitoring of the analysis developed at previous stages, and which shall be updated over time for several reasons: incorporation of results obtained from the operative experience analyses, research programmes, new GSI, etc.

Firstly, it shall be verified whether the licensee has a systematic review procedure of the several sources of information that could be of interest for the improvement and update of analyses and programmes (operative experience, research programmes results, etc.).

Taking the updated list of support documentation developed through different stages of the process as a base (scope and screening, identification of ageing mechanisms, degradation mechanisms, AMP definition, etc.), one of the reviewed documents shall be screened in order to verify:

— The causes that led to its review;
— The adaptation and consistency of the incorporated modifications, according to the objective of the support documentation.

Likewise, when applicable, the modified aspects shall be assessed in accordance with the previously described methodology, considering the criteria for scope, screening, ageing management analysis, etc.

Finally, in those cases in which the evaluator has information about operative experience (internal or external), or about results of research programmes that could be reasonably applied to the NPP, it shall be verified if the licensee has assessed the impact, and if so, whether this has generated a new review of the involved analyses. This matter could be addressed with the licensee as an item of an inspection agenda.

II-3.3.9. Assessment of the process for the identification and resolution of GSI applicable to NPP

This point refers to the verification of the licensee's periodical proceeding for the identification of those GSI related to ageing phenomena that apply to SSCs within the scope.

For assessment purposes, the following aspects shall be verified:

— If the licensee has defined a systematic manner to identify GSI with implications in ageing management;

— Based on the list of the GSI identified, one or several GSI not included in the list and which could be included according to the licensee's point of view, will be screened. It shall be verified if the licensee has a reasonable justification regarding their exclusion;
— It shall be also verified, in view of a License renewal process, that the licensee has proceed to the GSI previously identified reassessment, and has detected those that due to their time dependence, constitute a TLAA; the latter shall be addressed as described in Section II-4.4.1 of this guide;
— Likewise, it shall be verified that the licensee has the AMPs for the control of the degradation mechanisms related to those GSI with implications in this area.

II-3.3.10. Obsolescence management

The obsolescence of SSCs important to safety shall be proactively managed, with foresight and anticipation, throughout the NPP lifetime.

The licensee shall have to establish an obsolescence management programme. This includes the disposition of the strategy, objective and organizational agreements, the allocation of suitable resources (human and financial), and the monitoring of the programme to assure the compliance with its objectives [III-1].

In this context, two different kinds of obsolescence can be distinguished:

— Regulatory: characterized by components that do not comply with the regulations, criteria, etc. valid at the current moment (for instance, equipment qualification criteria, separation, diversity, functioning under severe accident conditions, etc.). In the case of control components, this may affect both the software and the hardware;
— Technological: characterized by the difficulty to find spare components or specialized technical support.

If obsolescence is not properly managed, it could entail the loss of functionality of components important to safety. Therefore, the licensee shall have to incorporate a management plan based on anticipation throughout the NPP lifetime.

The obsolescence management programme shall have to be more focused on the technological obsolescence management. Furthermore, the programme shall have to provide a guide for obsolescence management of the standards and regulations by means of a PSR [III-2] and the **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants.**

The licensee's obsolescence management activities shall have to be supervised by the RB throughout the plant lifetime.

Based on the aforementioned, and for assessment purposes, it shall be verified:

— That the licensee has defined and put into practice an obsolescence management programme that clearly establishes the scope, objectives, responsibilities, deadlines, actions, resources, as well as the monitoring to measure its effectiveness. That the obsolescence management programmes include:

  - A systematic and periodic obsolescence assessment;

- The strategy to be followed once the obsolescence issue has been detected for a type component.

That the programmes are effective as they enable the definition of necessary actions and resources, to assure the functionality of components throughout the NPP lifetime (spares purchase, replacements, specialized technical staff availability, etc.).

II-4. AGEING MANAGEMENT APPLICABLE TO THE LONG TERM OPERATION

II-4.1. Introduction

In this chapter the aspects of interest for the assessment are described, both in regard to the long term operation (LTO) itself, and to the licensing process for the long term operation (or License renewal process for the LTO).

At first and to that end, a brief introduction to the two licensing documents basic in these processes (IPA and LT-PLiM plan) is shown. Afterwards, guidelines applicable to the assessment of different important aspects in these processes are provided. Finally, the same is described in Section II-4.6, but in the context of CANDU NPPs; the specificity of the licensing process applied to these NPPs requires a specific section.

Despite the aforementioned, it is understood that the guidelines and criteria directly applicable to the assessment, both in the context of NPPs using methodologies based on the American methodology (Sections II-4.4 and II-4.5) and of plants based on CANDU methodologies (Section II-4.6), could be of general application as they can act as guidance for regulators in their licensing projects and LTO programmes assessment tasks. For instance, the guidelines provided in Section II-4.6 on refurbishment shutdowns and subsequent restart, are in general applicable to any kind of plant.

Finally, it is important to mention that the majority of guidelines provided in II-3, applicable to ageing management during the design life, are also applicable to long term operation.

II-4.2. Long term plant life management plan (LT – PLiM plan)

This document shall include the basic ageing management strategy of the licensee, during the long term operation period of a NPP. It shall be also variable if it is perdurable, depending on the life extension length, which shall be defined by the licensee, but with some permanence tendency.

As in the PliM plan, the LT-PliM plan is complemented by a periodic report in which the licensee states the main activities regarding ageing management, performed during the previous period and following the criteria and methodology proposed in the LT-PliM plan.
Among the basic points addressed by this document are:

— Organizational and management aspects related to the PliM plan implemented at the NPP;
— General aspects related to the implementation of the AMPs (SSC monitoring activities, IP management, etc.);

— Aspects related to the review of different ageing management analyses derived from DM undertaken at the NPP, implementation of IPs, results from the internal and external operative experience, research programmes, etc.;
— Progress in the activities to be developed by the licensee, in accordance with the contents of the operation license granted for the long term operation period.

The LT-PliM plan shall be mainly supported by the hereinafter mentioned IPA as well as by the specific documents of analyses developed during the License renewal process. These analyses shall primarily deal with the already mentioned topics, in regard to the PliM plan.

II-4.3. Integrated Plant Assessment (IPA)

By definition, the IPA is the set of ageing management analyses which comprise three classical stages: scope and screening of SSCs, identification of ageing effects and degradation mechanisms, and definition of ageing management programmes. It also includes the time limited ageing analyses (TLAA) which is necessary for the review of the analyses performed with a defined design life hypothesis.

This plan may make reference to the American regulation contained in the rule 10CFR54 *Requirements for operation license renewal* [III-19] and the documents of the USNRC or the nuclear industry from which it is developed by.
The IPA constitutes the basic document for the SSCs ageing assessment submitted by the licensee when interested in obtaining a new operation license, beyond the design life of the NPP.

II-4.4. Aspects subject to assessment

Table II-3 shows the aspects subject to assessment during the design life, the License renewal process, and the long term operation period. Many of these aspects shall have been applied during the design life, and have already been mentioned and discussed in detail in II-3
For that reason, this table shows the stages at which it is necessary to consider each aspect.

II-4.4.1. Review of the TLAA

The main objective when this aspect assessed, is the effective verification that the licensee:

— Has followed a methodology that reasonably assures the identification of all TLAAs, in accordance with the License terms in force;
— Has proceeded to the analysis, review and resolution of the identified TLAAs, by following the criteria established by the **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation.**

Table II-3. ASPECTS SUBJECT TO ASSESSMENT

Aspects subject to assessment	**Design life**	**License renewal**	**Long Term Operation**
Organizational and management aspects	√	√	√
SSC Scope and screening	√	√	√
Ageing management review analysis	√	√	√

Results of the application of AMPs	√	√	√
Monitoring of IPs	√	√	√
Monitoring of DMs and equipment replacements related to ageing management	√	√	√
Monitoring of supporting document reviews	√	√	√
Process for identification and resolution of GSI applicable to the NPP	√	√	√
Obsolescence management	√	√	√
Review of TLAA	(*)	√	√

√ = applicable topic (*) only definition

II-4.4.1.1. Results of the identification process of TLAA

The TLAA are, by definition, totally dependent on the hypotheses and analysis methodology employed in the documents which constitute the licensing terms in force.

For the performance of the assessment, one or more analyses not identified by the licensee as TLAA, and which could potentially be one from the evaluator's point of view, shall also be screened.

In the screening process of potential TLAA, the following documentary references may be used:

— Documents integrating the licensing terms or mandatory documentation:

- SAR;
- OL and its complementary instructions;
- License related correspondence between the licensee and the RB;
- Design basis documents;
- Technical specifications;
- Others mentioned in the licensing terms such as the fire risk analysis, environmental qualification studies, etc.

— Generic TLAA included in the Standard Review Plan (SRP) (Chapter 2 [III-20]), in the GALL report (Chapter X [III-21]), and in the NEI 95-10 guide (Chapter 3 [III-22]);
— Requests of License renewal and assessments by the USNRC or other RBs taken as reference, corresponding to plants of similar technology.

For the analyses not identified as TLAA, it shall be verified if the licensee has a reasonable justification for their exclusion within the list of TLAAs of the NPP.

II-4.4.1.2. TLAA Resolution process

There are three valid methods for the assessment and resolution of TLAAs. Each method is hereinafter mentioned:

— The licensee may justify, by means of the corresponding analysis, that the TLAA remains valid for the long term operation period;
— Extending the TLAA until the end of the LTO period (considering the additional period starting from the initial analysis);
— Resolving the TLAA through the ageing effects management during all the LTO period (definition of an applicable AMP, or corrective or compensatory actions).

For assessment purposes, and taking the final list of identified TLAAs as a base, some of them shall be screened, giving special attention to the plant specific ones, meaning those non generically identified in the GALL report, SRP, etc.

It shall be verified in each case that they have been resolved by following one of the valid methods, and that the followed procedure, the employed calculation programmes, and obtained conclusions are correct and appropriate to the applicable regulation.

Special emphasis shall be placed on the licensee's consideration of the actual operative conditions to which the TLAA object components have been subjected, which condition the ageing level they have suffered.

If there is any TLAA resolved by means of the 'ageing effect management' option, it shall be verified in these cases that there is an AMP associated whose scope and contents are coherent with the criteria established in the corresponding TLAA (affected structures and components, management strategy, etc.).

If the licensee has opted for the corrective or compensatory actions option, it shall be verified that an implementation programme exists, and that the deadlines associated to it are acceptable. If such deadline implies an implementation before the start of the LTO period, this aspect shall be specifically verified in one of the scheduled inspections.

Finally, it shall be verified if the application of a particular TLAA to the corresponding structures and components is properly reflected in the ageing management analyses. The same verification shall be performed if the TLAA has been resolved through the application of an AMP.

II-4.4.1.3. Process for identification and resolution of exemptions based on TLAA

This section refers to certain exemptions to the Licensing requirements obtained by the licensee, which due to their dependence on the 'time' variable, may constitute a TLAA.

These exemptions must comply with the hereinafter mentioned requirements:

— The exemption shall be still applied during the LTO period;
— The exemption affects the SSCs included within the scope of the ageing management review;
— The exemption is based on a TLAA.

For the assessment, and based on a list with the valid exemptions, one or several exemptions shall be screened from those which could constitute a TLAA from the evaluator's point of

view, but which have not been identified as such by the licensee. In these cases, it shall be verified that the analysis has a justification in that regard.

One of the exemptions which actually constitute a TLAA shall be screened, in order to verify that the licensee has properly resolved it for the long term operation period.

II-4.4.1.4. Reference to the TLAA in the SAR

It shall be verified that the SAR makes reference to the different TLAA defined during the License renewal process, properly collected in the IPA. The licensee shall include such information into the SAR, where a summary of the analyses corresponding to each identified TLAA shall be stated.

II-4.5. Specific assessment aspects related to the license renewal process

In the License renewal process, it shall be verified if the licensee has performed the following actions before the end of the validity of the current OL:

- Satisfactory resolution of all the IPs associated with the AMPs defined for the LTO period;
- Effective implementation of all the AMPs defined for the LTO period, as from the new OL enforcement;
- Performance of all the single inspections defined in the ageing management analysis. Single inspections shall have the corresponding analysis of results and redefinition, if required, of the AMPs applicable to the involved components or structures;
- Verification that the SAR makes reference to the different AMPs defined during the OL renewal process (properly collected in the IPA). To that end, the licensee shall include such information into the SAR, where a summary of the contents corresponding to each of them shall be stated.

These verifications shall be mainly based on the information gathered from a specific inspection to be performed at the NPP.

II-4.6. Assessment of the LTO at CANDU NPPs

II-4.6.1. Initiation of the PLEX project

To start a PLEX project, the licensee shall have to formally notify such intention to the RB, and submit a description of the long term operation project (Life Extension) along with this notification; which shall consider, at least, the following aspects:

- Definition of the project's objective and scope;
- Current design and operation condition of the plant;
- Components and structures (temporary and permanent structures, infrastructure, construction equipment, etc.);
- Scheduled activities of the project (operational phases, timing and schedule of each phase, etc.);
- Site information (location, environmental characteristics, and land usage);
- Waste management;
- Foreseen milestones.

The RB shall have to assess the preliminary project description submitted by the licensee, whose purpose is to determine if there are observations on such project that should be taken into account by the licensee.

II-4.6.2. Assessment of the licensing basis document

The RB must assess and approve a licensing basis document which defines the guidelines to be followed for the different Licensing topics. A standard content could be:

- Introduction/scope/objective;
- Project management/quality assurance;
- Environmental radiological impact;
- Periodic safety review (RPS);
- Compliance with standards and regulatory documents;
- Plant condition assessment;
- Design improvements;
- SAR;
- Deterministic, probabilistic, and risk analysis;
- Waste management;
- Activities during the refurbishment shutdown;
- Agreements with the RB.

II-4.6.3. Assessment of the periodic safety review (PSR)

The PSR of a NPP in operation allows having an overview of the NPP safety level and consequently, to determine whether it is necessary to perform practical and reasonable modifications to achieve and maintain a high safety level, closest to that of the most modern plants.

When it is intended to extend the life of a NPP, an integrated safety review is usually performed, with requirements and philosophy similar to the PSR, but focused on the NPP safety diagnosis in view of long term operation.

The assessments related to ageing management within the PSR are described in the Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants.

II-4.6.4. Assessment of ageing studies

The evaluations related to the SSCs condition assessment for the long term operation are hereinafter briefly described:

- The work procedures shall be reviewed in order to verify that the assessment methodologies are the ones recommended by international practices;
- Safety systems or SR systems reports shall be reviewed, verifying that the assessment methodology is properly applied;
- The condition assessment report shall be verified to check of it reflects the actual situation of SSCs of regulatory interest, and if it is complete;

— The conclusions and recommendations derived from the ageing assessments of SSCs of regulatory interest shall be assessed. Critical safety recommendations shall be determined and deviations shall be identified;
— The control over the implementation of recommendations or modifications derived from the ageing assessments of SSCs of regulatory interest (prioritization, disposition and implementation) shall be performed.

II-4.6.5. Assessment of safety analyses

The safety analyses that must be performed within an NPP long term operation framework are included within the PSR, and the assessments related to them are described in the **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants.**

To summarize, it is necessary to assess the scope, requirements, methodologies, and results of:

— Probabilistic and deterministic analyses;
— Risk analysis;
— Design review according to standards, codes and modern practices;
— Severe accident management programme within PSA safety factor;
— Review of the design improvements incorporated in NPPs of similar design.

II-4.6.6. Assessment of the safety improvement plan (SIP)

The results of the safety and ageing assessments and the PSR must be employed to develop a SIP which shall be submitted to and approved by the RB before its implementation.

The assessments related to a SIP are:

(a) Assessment of the sufficiency of corrective actions, plant modifications, safety improvements, compensatory measures, and improvements of the operation and management programmes derived from the identified weaknesses

To determine the sufficiency of such measures it shall be necessary to assess the justification developed by the licensee for those weaknesses that will not be solved. Such justifications may be based on the cost-benefit analysis, reliability analysis, experts' judgements, etc.

(b) Assessment of the improvement implementation schedule

As improvements may refer to DM, changes in the plant practices or programmes, changes in the maintenance or inspection policies, etc., the licensee shall have to define an implementation schedule, which shall be approved by the RB.

The assessment of such schedule shall respond to an assignment of improvement priorities according to their impact on safety.

(c) Improvement assessment

Depending on the regulations of each country, a category of modifications to the NPP exists, which shall have to be approved by the RB.

In the case of changes in the operation, testing, or maintenance procedures this assessment typically includes:

— Assessment of the safety analysis of such change;
— Assessment of procedures, instructions, or plans;
— Assessment of personnel training plans.

In the case of DM in equipment and components, the assessment usually includes aspects such as:

— Assessment of the safety analysis;
— Assessment of the design concept;
— Assessment of supplier qualification.

Regarding major changes in the programmes and policies of the NPP, the assessments may involve areas such as personnel licensing, operation organizational Table, related mandatory documentation, etc.

In all cases, the assessment of the consideration of human factors in the changes, and the update of the corresponding documentation shall be necessary.

II-4.6.7. Assessment of the environmental radiological impact

The licensee shall have to assess the radiological impact that the LTO shall have on the environment. The RB shall assess a report developed by the licensee containing the result of such assessment. Although it is included in the PSR, the performed assessments may be typically summarized in:

— Limitation of radioactive effluents;
— Changes in land usage;
— Precautions for the radioactive waste management originated in the plant refurbishment and the long term operation;
— Review of the radiological environmental monitoring system.

II-4.6.8. Assessment of the works for the implementation of improvements on systems, equipment and components

In case extended refurbishment shutdowns are required for the replacement of critical components, the following assessments shall have to be performed:

— Assessment of work procedures and plans;
— Assessment of the radiological protection programme;
— Assessment of personnel qualification and training plans;
— Assessment of plans for the SSCs commissioning;
— Assessment of emergency plans for special configurations;
— Assessment of policies, plans and transient operation procedures for shutdown;

— Assessment of plans for heavy water management during shutdown;
— Assessment of facilities licensing for management of radioactive waste generated during shutdown;
— Assessments related to personnel licensing;
— Assessments related to the operation of large components movement.

When required by the improvements incorporated in the NPP, assessments related to major changes in the mandatory documentation, operation limits, and OL requirements may be necessary.

II-4.6.9. Assessments related to the license renewal process

The grant of OL for the extended period involves the following assessments:

— Assessment of the SIP implementation report;
— Assessment of mandatory documentation that has been updated or modified.

In case of an extended refurbishment shutdown, a series of assessments related to the restart are needed.

The restart involves returning the reactor and the nuclear and non-nuclear systems, back to commercial operation. It also implies the demonstration by the licensee that all relevant licensing conditions have been fulfilled and that the associated work has been performed to the satisfaction of the RB.

The assessments related to the restart are:

— Assessment of the commissioning plan, which includes:

  - The description and schedule of activities, including the organization and assignment of responsibilities;
  - The acceptance criteria for each commissioning phase;
  - Definition of the shortcomings by the RA and reports presented by the licensee in each case.

— Assessment of the results of commissioning phases:

  - Phase A (Preliminary tests): In this phase the correct state of new or modified equipment is confirmed, and the service capability of new or existing SSCs at the plant is confirmed, through a testing programme of individual components and integrated systems. This phase must be successfully completed prior to the fuel loading in the reactor;
  - Phase B (Fuel loading): In this phase it must be ensured that the fuel is safely loaded into the reactor, and confirmed that the reactor is in suitable conditions to be started and that all the requirements to allow the reactor to go critical have been met. This phase must be successfully completed prior to removal of the guaranteed shutdown state;
  - Phase C (Criticality): This phase confirms reactor behaviour at the initial criticality stage and subsequent low power tests, and includes activities that cannot be performed during the guaranteed shutdown state;

- Phase D (Power operation): In this phase, the reactor and systems behaviour at high power levels, including activities that cannot be performed at low power levels, is demonstrated.

II-4.6.10. Milestones

The restart is achieved by means of the accomplishment of numerous milestones. Milestones that might be reflected in the restart stage of a PLEX project include:

— Fuel loading;
— Removal of the guaranteed shutdown state;
— Heat transport system operation;
— Turbine operation;
— Synchronization of the turbine to the grid;
— Reactor at full power;
— Specific commissioning tests.

II-4.6.11. Hold points

The process of restart includes the progress to regulatory hold points. These are typically aligned with commissioning phases, and may include the aforementioned milestones. License Terms are established for the administration of the hold points, which are then incorporated by the licensee in the restart plan.

The RB approves the removal of a given hold points depending on the licensee's submission of a completion assurance document. This document presents evidence that all project commitments scheduled for completion prior to removal of the respective hold points have been met. The completion assurance document must be accepted by the RB before authorization to remove the hold point is issued.

II-4.6.12. Return to normal operation

Once all RB approvals have been granted and hold points have been removed, the licensee shall proceed to normal operation.

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ANNEX III. FORO GUIDE FOR REGULATORY INSPECTION OF AGEING MANAGEMENT AND LONG TERM OPERATION OF NUCLEAR POWER PLANTS

III-1. OBJECTIVES AND SCOPE

III-1.1. Objective

The aim of this guide is to provide guidelines to inspect the safety factors relative to the ageing management of nuclear power plants, in order to assure that the operation license (OL) holders or Licensees operate them safely until the end of their lifetime.

This document deals with topics related to the ageing management inspection, life extension projects and long term ageing management. Some singularities considered by the countries that participated in the development of this guide are mentioned.
Most differences when dealing with these topics are due to the technological differences and the different methodologies developed in the designing and manufacturing countries of the nuclear power plants.

The inspections to be performed at the different phases of a nuclear power plant's lifetime, together with the assessments described in the **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants** shall aim to verify the following factors:

- If the nuclear power plant can reach the original design life, without safety deterioration, avoiding the unforeseen degradation of structures, systems and components (SSCs) of the nuclear power plant, framed within the scope of the hereinafter defined ageing management process;
- If an ageing surveillance, control and mitigation programme has been established during the original design life, which allows reaching the technical-economic life defined by the licensee for the nuclear power plant;
- If the planning and systematization of the ageing management established for long term operation (LTO) provides reasonable guarantee on the functionality of the SSCs framed within the scope of the ageing management process;
- If during the long term operation period (life extension), the necessary ageing management activities are performed so as to reasonably guarantee the surveillance, control and mitigation of ageing mechanisms of the SSCs framed within the scope the ageing management process, avoiding their unforeseen degradation and therefore, a deterioration of safety.

Furthermore, this guide defines the inspections to be performed by the Regulatory Body (RB) to license the long term operation of nuclear power plants.

III-1.2. Scope of the guide

This guide deals with:

- The inspection of all the stages of the PLiM plan during the design life of the SSCs framed within the scope of the ageing management process;

— The key elements to be considered and which shall be inspected when establishing the scope, planning and execution of a PLEX project (typical of CANDU nuclear power plants) or during the OL renewal process if the nuclear power plant's design life is exceeded. This programme is known as IPA [Programa Integrado de Evaluación y Gestión de Envejecimiento (PIEGE), in Spanish], in the case of American design nuclear power plants (NPPs);
— The inspection of LT-PliM plans which include diverse AMPs in force during the LTO period.

These inspections comprise the following items:

— The scope, requirements, methodologies and results of ageing assessments;
— The acceptability of the refurbishment tasks and safety improvements' scope proposed by the Licensee;
— The verification of the appropriate planning for the tasks to be performed to implement improvements, taking aspects related to radiological and nuclear safety into consideration;
— The verification of a proper execution of the improvement related works;
— The verification of the mandatory documentation update, taking the extended operation period into consideration.

This guide only deals with those aspects related to nuclear and radiological safety.

III-2. REGULATORY INSPECTIONS

The regulatory inspection activity at all the stages that PLiM plans comprise, during the design life of the SSC framed within the scope of the ageing management process, during the OL renewal process if the NPP's design life is exceeded, and during the LTO period until the end of the lifetime itself, involves the implementation of the hereinafter mentioned types of inspections.

Inspections during the design life:

— Inspections during the PLiM plan implementation (**Type 1 Inspections)**, whose object is to verify the development of the PLiM plan of the NPP;
— Routine or periodic inspections of the PLiM plan (**Type 2 Inspections**), whose object is to verify the implementation, the control update and maintenance of the ageing management programmes (AMPs) that comprise the PLiM plan, and to verify the SSCs condition through sampling and from the AMPs perspective, including the documentary verification and field activities (*'walkthroughs'*).

Inspections during long term operation:

— IPA and PLEX project inspections incorporated to the long term OL renewal **(Type 3 Inspections**), whose basic object is to verify the development and content of the NPP ageing management, for the application during the LTO.
— Routine or periodic inspections of the IPA or PLEX application during the LTO (**Type 4 Inspections**), whose objects are: to verify the application of the update and maintenance of the AMPs established in the IPA or PLEX in accordance with the LTO, as well as the continuance of the SSCs condition verification, through sampling

and from the AMPs perspective, including documentary verification and field activities (*'walkthroughs'*) during the LTO.

The Table on the following page (Table III-1) introduces the items subject to inspection during the design life, the OL renewal process and the LTO.
The specific goals of the process are:

— Definition and establishment of a process for the safety assessment by inspecting the content of the NPP PLiM plan during the OL in force, also considering any possible requests for LTO, in order to verify that:

- The lifetime established in the OL can be reached without unforeseen degradation of the NPP's SSCs;
- There are programmes for the surveillance, control and mitigation of ageing degradation, in order to achieve the terms corresponding to the requested OL for the normal functioning during the design life and to the requested OL for the LTO, defined on the basis of the project and approved by the RB.

— Establishment of inspection requirements to verify the material condition of SSC to be included in the PLiM plan;
— Verification of the availability, traceability, auditability of the information needed for the analysis of the PLiM plan and of its compatibility with the approved programmes and procedures of the licensee.

Table III-1. ASPECTS SUBJECT TO INSPECTION

Aspects subject to inspection	**Design life**		**OL Renewal**	**Long term operation**
	1	**2**	**3**	**4**
Organizational and management aspects.	✓	✓	✓	✓
SSC scope and screening.	✓	✓	✓	✓
SSC scope and screening application results	✓	✓	✓	✓
Ageing management review analysis.	✓	✓	✓	✓
Results of the application of AMPs	✓	✓	✓	✓
Identification and resolution process of *GS)* applicable to the facility	✓	✓	✓	✓
Monitoring of IPs	✓	✓	✓	✓
Monitoring of DMs and equipment replacements related to ageing management.	✓	✓	✓	✓
Monitoring of support document revisions	✓	✓	✓	✓
Obsolescence management	✓	✓	✓	✓
TLAA			✓	✓
Periodic reports		✓		✓
SSC condition		✓		✓

✓= applicable topic

For this purpose, the RB shall have to perform the following general inspection activities:

— Verify that the assessment reports of the PLiM plan application, including the lifetime extension during the LTO, show the real situation of the NPP and that they are complete;
— Analyse the condition assessment reports of the SSCs within the scope of ageing management, verifying that the analysis methodology is appropriate;
— Assess if the technical inspections and the data gathering performed by the licensee are adequate and whether the personnel performing them have the necessary skills and training;
— Identify the important safety recommendations and modifications in the ageing management of SSC;
— Monitor the implementation and execution of the recommendations, modifications or improvement proposals;
— Verify, if necessary, whether an increase in the frequency and/or extension of the inspection for some specific SSC has to be demanded.

Each SSC must be constantly monitored, using data from operation, maintenance, inspection and service tests, periodic surveillance programmes, operational experience, etc.

III-2.1. Design life inspections

III-2.1.1. Inspections during PLiM plan implementation (Type 1 Inspections)

A PLiM plan must include the basic strategy of SSCs ageing management, by the licensee's organization, during the design life of the nuclear plant and allow at least the detection, measurement and control of natural ageing and obsolescence of the SSCs, as well as those caused by adverse or severe operating conditions.

It should be noted that the number of stages, called phases, of a PLiM plan depends on the methodology used by the licensee's organization. It is worth mentioning that most IAEA member countries consider the PLiM plan a binding document. In this case, the RA shall establish a period for implementation of the updates in the plan. These periods usually vary from one to five years.

The PLiM plan is complemented and developed with periodic reports, which shall list the main ageing management activities carried out during the period of interest or evaluation, according to the criteria and methodology proposed in the PLiM plan. **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation** provides guidelines on these issues.

Below is a description of the basic contents for the development of a PLiM plan.

A PLiM plan's first step is to develop policies and strategies, planning and procedures that outline the basic rules to carry out its implementation at the nuclear power plant. The development of this stage is the analysis of SSC by defining control, inspection, testing and monitoring methods and procedures. These controls should be based on updated and existing programmes available at the nuclear power plant. These tasks require a preliminary analysis by the inspector, to ensure that all SSC and the effects of ageing applicable are being considered.

The PLiM plan is supported by specific documents containing the details of the various stages of ageing management. It is common for the PLiM plan to contain, in supporting documents and references, a set of reports on the scope and screening of SSC; the study of degradation phenomena applicable; the study of control, inspection, testing, monitoring practices performed at the plant and, finally, the list of improvements to be implemented as a result of previous process steps.

III-2.1.1.1. Objective of the inspection

The fundamental objective of type 1 inspections is to verify the development of a nuclear power plant's PLiM plan during the design life of their SSC, by monitoring the following aspects:

— The environment of application along with the scoping and screening of critical components (mechanical, electrical, instrumentation and control, structural);
— The analysis of ageing phenomena, degradation mechanisms and the effects thereof, from the materials and environments in the facility;
— The ageing management programmes (AMP).

Depending on what stage the nuclear power plant is at, a variety of SSC related to the PliM plan shall be inspected. It is worth noting that in some cases, this may be similar in the different phases, while other aspects will be specific to a certain stage (for example, inspection of AMPs).

These objectives are developed in sections III-2.1.1.2 to III-2.1.1.11.

III-2.1.1.2. Management and organizational aspects

The main aspects to be inspected are:

III-2.1.1.2.1. Structure of the licensee's organization in relation to ageing management

In this part of the inspection the particular aim is to identify the organization, group, committee, etc., established at the nuclear plant, responsible for carrying out the aspects of the PLiM plan, according to:

— Composition

It must be ensured that the group is preferably formed by experts in various disciplines and activities related to AMPs. For guidance, listed below are some examples of disciplines or activities related to AMPs:

- Operation;
- Maintenance (mechanical, electrical, I & C, civil, etc.).
- Maintenance rule (MR);
- Design modifications (DM);
- Service inspection programme;
- Environmental qualification;
- In-service and periodic testing (monitoring);
- Operating experience;

- Engineering (R & D).

— Operation

On this, the inspection shall verify:

- Functions and activities performed by these groups;
- The existing hierarchical relationship;
- The frequency of meetings, the topics discussed and decisions made (meeting minutes);
- The existence of people in the organization responsible for the practical aspects related to the AMPs;
- The availability of adequate and sufficient resources;
- If the responsibilities at all levels are clearly identified and defined;
- If the personnel involved in the ageing management activities, provides and has the necessary knowledge of the details of these aspects.

It must be verified that both the PLiM plan and the periodic execution report contain information on all of the above, through inquiries made during inspections conducted by the RA, related to ageing management.

III-2.1.1.2.2. Acquisition and recording of information related to ageing management.

According to IAEA Safety Guide NS-G-2.10 [III-2], point 4 and **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants**, the licensee must have a system for acquisition and systematic recording of data supporting the AMP.

Therefore, inspections should carry out an assessment of this system (data, analysis, etc.), by verifying its main characteristics and effectiveness.

This system shall be established at the start of the life of the nuclear power plant to provide complete historical data. This information is essential for making decisions that help avoiding the loss of functionality of some of the equipment. Among others, it can be mentioned that the recorded data shall be related to different stages of management.

The data obtained as a result of tests, inspections, monitoring and controls on the practical application of the PLiM plan, are especially important, since this information will allow an assessment of components and structures, and also to establish a management strategy to preserve its functionality.

The quality of the documentation should also be verified, both from the methodological and analysis results points of view. These should be properly documented, for they will be subject to control of the nuclear power plant's quality assurance systems.

III-2.1.1.3. Monitoring of licensee accepted and RA introduced commitments (conditions, non-conformities, regulatory requirements, etc.)

The progress made (or the solution ultimately provided by the licensee's organization) in relation to the commitments accepted or imposed, compared to the information obtained from previous inspections, must be identified.

To this end, in addition to the information provided in the periodic reports, the information obtained during the inspection itself will be of great importance.

III-2.1.1.4. SSC scoping and screening

Several SSC may be replaced during the normal operation of the facility, as they are easily replaceable, but there are others whose replacement during its design life may involve technical difficulties, high economic costs and/or staff doses.
To avoid these situations it is important that the licensee, before the development of the PLiM plan, perform studies for the identification (scope of PLiM) and screening of the SSC, also establishing a prioritization system of these SSC. These tasks will be verified during the inspection process.

In the international practice there are different methodologies to determine the scoping and screening of SSC important to safety, or of economic relevance to the nuclear power plant, as described in Section II-3.3.3 of **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants**. It is worth mentioning that the inspection should have an impact on the SSCs within that scope, as defined in **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**, Section I-3.

The process shall be initiated by the identification of the SSCs considered in the methodology established by the licensee, to perform their analyses of scoping and screening of the SSC important to safety. This information shall be submitted to the RA within a specified period that, after reviewing it under the process outlined in **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants**, will accept them or establish their conditions and/or recommendations.

The final objective, in this process, is to define adequately the SSC that are within the scope of PLiM, in accordance with the methodology previously defined. The resulting information should be organized by SSC.

It is expected that each SSC within the scope of the PLiM plan is identified by a specific name or code. This will facilitate the verification of the elements present and absent on the final list.

The licensee shall submit a list of the SSC within the scope of ageing management, which must be approved by the RA before their final inclusion in the PLiM plan. The RA may also establish the need to include any other SSC that were not initially considered by the licensee, which could be verified in an inspection.

The key issues to be inspected are:

— The scoping and screening of the SSC to be subjected to the PLiM process;
— The result of the application of the methodology for different SSC of the nuclear power plant.

In the verification of the aforementioned aspects, inspectors should assess the use of regulatory documents that are part of the licensing conditions of the nuclear power plant, for example:

— SAR; project bases; technical specifications; normal, abnormal and emergency operating procedures and even guidelines or procedures for severe accident management;
— Seismic class equipment qualification reports;
— Reports related to natural external events such as floods, storms, hurricanes, tornadoes, earthquakes, tsunamis, as well as internal events such as fire hazards, internal flooding, etc.;
— Probabilistic safety analysis (PSA) to identify SSC important from the risk point of view;
— Electrical and I&C equipment environmental qualification studies or analysis;
— Technical reports presented to the RA, dealing with transient phenomena such as pressurized thermal shock, anticipated transients without automatic reactor shut down and total loss of electric power;
— Documentation related with the application of the MR to equipment, when applicable;
— Process diagrams, drawing and isometrics of safety important systems and components;
— New regulation implementation analysis.

Below are two examples, synthesized in schemes, of SSC scoping and screening methodologies in Figures III-1 and III-2. Prior to the development of PLiM plan, and according to the SSC identification and selection criteria, a prioritization scheme of SSC important to safety or of economic relevance must be established.

The analysis of the less important SSC supposes a residual risk whose analysis is not shown in next Figure III-1.

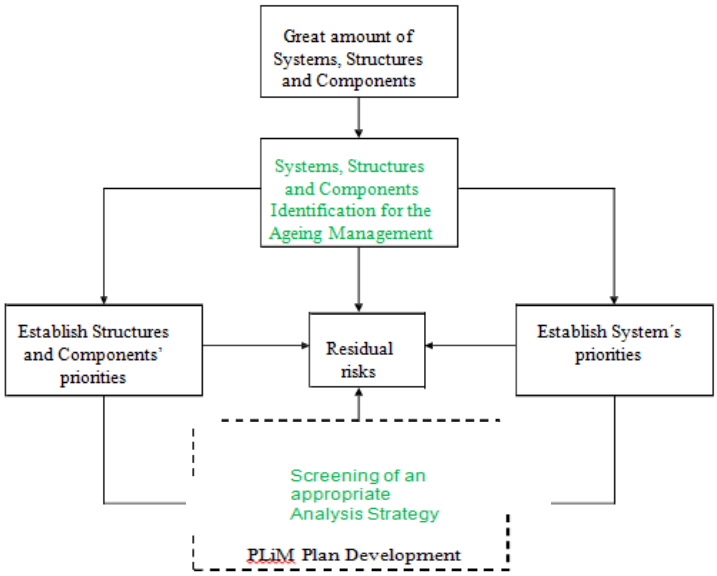

FIG. III-1. Scoping and screening of SSCs important to safety or of economic relevance to be treated in a CANDU nuclear power plant's PLiM plan.

III-2.1.1.4. Results of methodological application of scoping and screening of SSC

The objective in this part of the inspection is to ensure that the methodology to determine the scoping and screening was applied correctly and that the results obtained are satisfactory. Issues related to the suitability of the methodology used by the licensee and its development, are more typical of the assessment activities than of the inspection ones, **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants** addresses these aspects.

Consequently, and unless the individual cases justify it, the methodology to be followed by the inspection will be the assessment of a sample of a representative set of SSC to which the scoping and screening criteria have been applied.

The inspector shall identify and examine the initial sample. If the results are not satisfactory, the sample shall be enlarged as needed. The criteria to define samples shall be different and in all cases adapted to the type of SSC to be inspected, as well as the current life stage of the facility.

Some general criteria that can be applied to the definition of inspection samples are the identification of:

- SSC particularly important for safety;
- SSC with greater representation in the PSA assessments;
- SSC of different categories or types such as reactor and internals, core systems, mechanical, electrical/I&C, auxiliary systems, etc.;
- SSC recommended by the operating experience;
- SSC with critical operating conditions or where the materials are particularly vulnerable and/or the environments are more aggressive;
- SSC with project criteria not fully demonstrated in the tests;
- SSC with multiple functions in the MR (if applicable) or in the support to multiple systems;
- SSC that have not been inspected in the past;
- SSC that have been altered by design changes, repairs, etc.

The following section highlights the main aspects to be inspected:

(a) **The overall results at complex systems and structures level:**

- Contents of the complex systems and structures final list.

From the final list of complex systems and structures derived from the process, the systems and structures clearly expected to be included due to their performed intended safety functions shall be identified.

To complement aforementioned, a system or structure that does not appear on the list should also be selected in order to verify whether they really do not perform any intended safety function.

- Process for the establishment of systems and structures within the application field.

In order to verify the correct application of the methodology, the systems and structures on the final list shall be selected, by verifying in each case the correct identification of their functions and therefore, the parts of the system and structure within the application field.

(b) **Results at mechanical components level:**

Usually these components belong to all the systems in the following categories:

— Reactor cooling system (vessel, internals, primary system pressure boundary, pressure pipes, feeders, steam generators, etc.);
— Safety systems (containment spray system, containment isolation system, high pressure injection system, etc.);
— Auxiliary systems (ventilation, firefighting, cooling, air systems, etc.);
— Steam and power conversion systems (main steam turbine, condensation system, etc.).

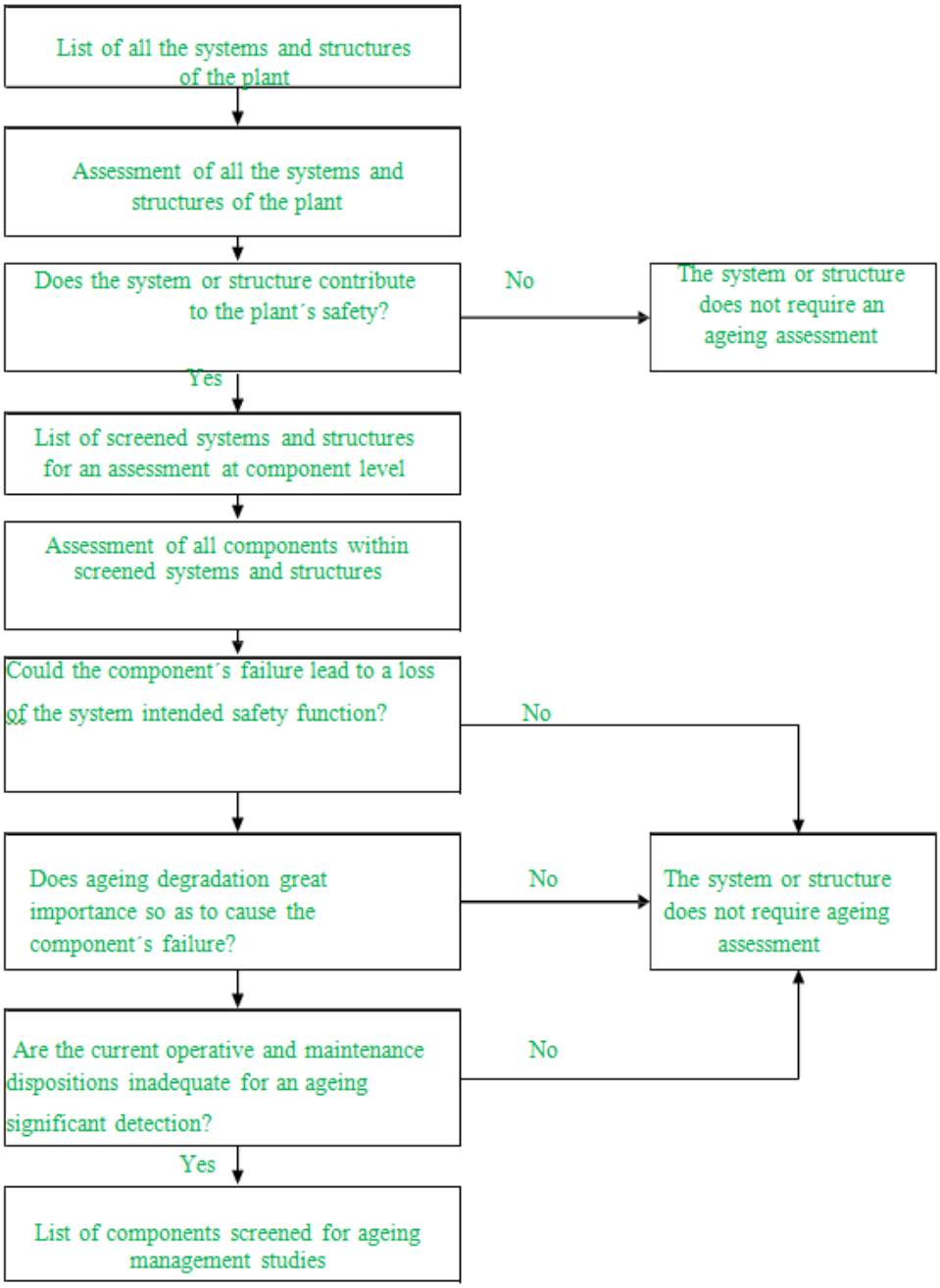

FIG. III-2. Scoping and screening of SSCs in the PLiM plan of PWR, BWR or PHWR NPP.

For mechanical components, the inspection should focus on performing the following verifications:

— Identification of mechanical components within the scoping and screening context.

The Inspection should begin with pre-selected systems to verify the correct identification of individual components in the field of application based on the intended safety functions they perform.
Special attention shall be given to the border limits, inside and outside the scope of application, as well as to those which, although still within the range of the system, the licensee has not considered them to be within the scope at this level. In the latter case, the bases supporting their inclusion shall be verified.

For the components identified in this context, it must be ensured that they really are passive and long life.

— Grouping components

If the operator has decided to organize the components into groups or *'commodities'*, several of these groups shall be selected and it must be verified that some important plant components are listed in the group.

The SSCs of the NSR type in the application field of criteria in I-3, second paragraph, of **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation** shall be selected. It shall be verified, through the licensee's analysis, that the methodological aspects associated with this approach have been successfully applied to obtain satisfactory results.

The review shall verify that the SSC identified within the scope really are passive and have long life.

— Specific verification of the selection criteria

In addition and complementary to the aforementioned verifications, several components in the application field (this is, with a defined individual intended function) that have not been selected for their inclusion in the PLiM plan, shall be selected, by verifying that they do not meet any of the screening criteria (passive and long life), and properly justifying their exclusion.

(c) **Results at structure and structural component level:**

In general, the structures and structural components resulting from the scoping and screening process shall be considered in one of the following categories:

— Primary containment structures;
— Other important structures such as those of the emergency diesel generators building, auxiliary building, turbine building, etc.;
— Structural components such as cable trays, pipe supports, elastomers to reduce vibration, mounting equipment, ventilation ducts supports, etc.;
— Structures not safety classed, but whose failure could prevent the performance of intended safety functions of a structure or a safety component, such as seismic category II structures in relation to category I.

For structural components, the inspection shall focus on performing the following verifications:

— Identification of structures and structural components within the scope

The complex structures have been identified in the scope, for example, the containment building, by verifying that its sub-structures and structural components with individual intended safety functions (foundations, slabs, retaining walls, cable trays, pipe supports, curbs, racks, bellows, coatings or 'liners', mechanical penetrations, drains, etc.) have been correctly identified.
The intended safety function is clearly identified in all cases and justifies their inclusion within the scope.

— Grouping components

If the licensee has decided to organize the components into groups or *'commodities'*, one of the groups of complex structures shall be selected to verify that some of the structural components are included, depending on their functions.

— Verification of the selection criteria

It shall be verified that most of the structures and structural components comply with the screening criteria, so that they are identified as passive and long life. The inspection shall focus on the justification submitted by the licensee in the case of exclusions from the final selection list.

(d) **Results at electric and I&C component level:**

For electrical and I&C components, whose typical elements are cables, power bars, high-voltage conductors, electrical penetrations, ground wires, connectors, insulators, etc., the inspection should focus on the following aspects:

— Identification of the electrical and I&C components within the scoping and screening

Several electrical and I&C systems shall be selected in the list for their verification, in order to demonstrate they were correctly identified according to their individual intended safety functions.

It shall also be verified whether these SSCs are passive and long life.

— Particular case of groups

In situations where the licensee has organized the components into groups or *'commodities'*, several of these groups shall be selected to ensure that some important components, clearly within the field of application, are on the list of the components of that group, also verifying that these SSC are passive and have long life.

For some of the NSR SSCs which, due to their characteristic, its intended safety function should be within the field of application of criteria I-3, second paragraph, of **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation**, it

shall be ensured, through verifications, that the methodological aspects related to this point of view have been properly applied by the licensee with satisfactory results.

— Verifications associated with the 'Analysis by Areas'

The 'analysis by areas' consists in verifying, for a set of components belonging to different electrical and I&C systems, which are within the scope all with an intended safety function, located inside in the site building or area which exceed the limit environmental conditions of such site.

If the licensee has used the 'analysis by area' methodology to define the scope, one or more areas within the scope shall be selected, by verifying that the individual components that compose them have been considered.

In addition, one or more areas not included in the scope of application shall be selected, in order to verify that they do not have any component with intended safety functions that complies with the inclusion criteria.

With the purpose of complementing all of the above mentioned verifications, several elements within the area that do not comply with the inclusion criteria, shall be selected, in order to verify that their exclusion is properly justified.

— Environmental qualification

It shall be verified that all electrical and I&C SSCs, passive and long life, which have an environmental qualification, have been identified correctly. These components will be included and studied later on in the corresponding TLAA analyses.

III-2.1.1.5. Methodological aspects related to PLiM plan analysis

The inspection of methodology used shall address the following issues:

— General criteria used by the licensee to define materials and environments

It shall be guaranteed that all criteria and methodologies established by the licensee allow obtaining a set of materials and environments, both internal and external surfaces, which are representative of all possible cases in the different operating modes considered in this analysis.

The supporting documentation used by the licensee's organization shall be inspected, and the support tools like databases and the types of analysis utilized in the identification of materials and environments.

Therefore, it shall be verified that the licensee has generated a clear and accurate definition of the materials and environments, both internal and external surfaces, to be used in the analysis.

— Operation modes considered in the analysis

It shall be demonstrated that the licensee has considered the different operation modes important in the analysis of the PliM plan, in order to determine the degradation phenomena affecting the SSC during normal operation, periodic functional tests, refuelling, etc.

— Assessment of operating experience

It shall be verified that the licensee uses a systematic methodology for the implementation of operating experience, both internal and external to the utility (i.e. national and international), in the identification of degradation mechanisms and ageing effects, as well as in the definition of AMPs.

— Reference documents and other sources of information

The specific sources used by the licensee shall be verified in the identification of degradation mechanisms and phenomena and the establishing of the AMP.

It shall be verified that the licensee considers in their analysis the development of programmes, such as information collecting programmes, generic programmes, generic safety issues (GSI), new testing and trial procedures, etc.

— Process for the definition of degradation mechanisms and phenomena

The specific procedure followed by the licensee in the assignment of the degradation phenomena and ageing effects shall be verified.

Groups of similar materials and environments shall be defined, since these aspects determine the acting degradation processes. Therefore, each group of SSC shall have a group of degradation phenomena and mechanism associated.

It shall be verified that the licensee takes into account the detection of certain elements that are particular cases derived from specific circumstances, such as stagnant flow areas, flow acceleration areas and especially aggressive environments, since maybe some components cannot comply with the requirements of their group if they are subjected to additional mechanisms.

It shall be verified that the methodology considers the definition of degradation mechanisms and ageing effects regarding the intended safety functions that the SSC performs in the system.

Special attention shall be given to the SSCs that perform several intended safety functions. In such cases, the specific degradation mechanisms and effects associated with each one of these functions shall be defined.

The existence of justifications for the exclusion of SSCs not affected by the ageing effects typical of their group shall be verified.

— Definition of AMP

It shall be verified that the licensee uses a methodology that includes the adoption of basic programmes with a direct application to the nuclear power plant, and specific programmes when necessary.

It shall be verified that the structure of these programmes includes at least:

- A complete list of the SSC, indicating materials, environments and associated degradation mechanisms;
- A description of the specific programmes for inspection, testing, monitoring and control used as a basis for the AMP;
- A list of IPs yet to be resolved and implemented;
- Identification of IPs.

It shall be verified that the licensee considers the systematic identification of IP associated with the AMP and that these are correctly defined and documented.

This process shall also generate IPs of the field of application whenever new SSC appear.

III-2.1.1.6. Results of the PLiM plan analysis

The results of the application of this methodology shall be inspected. Typically, regarding the inspection sample, it is advisable to continue the process with the same SSC or *'commodity'* groups used in the scoping and screening phase.

To verify the specific aspects, other SSCs, more appropriate for the issue to be addressed, shall be selected.

The main points to be inspected are:

- Verification of the definition of materials

T his part of the inspection aims to guarantee that the set of materials considered in the analysis is consistent with existing materials at the nuclear plant.

Various SSCs shall be selected in order to verify that the identification of material has been performed correctly, even at the subcomponent level.

The necessary basic information to perform this verification shall normally be included in the manufacturer documentation (catalogues), or in available databases on the components of the plant. Therefore, this shall be one of the most representative points in ageing management.

- Verification of the definition of environments

This part of the inspection aims to guarantee that the set of internal and external environments considered in the analysis is representative of the existing environments at the plant. Various SSCs identified with more than one operational mode shall be selected for their analysis, by verifying in each case that these environments are correct and no omission has occurred.

- Attribution of degradation mechanisms and ageing effects

This part of the inspection shall demonstrate in practice the correct attribution of degradation mechanisms and ageing effects of the SSCs within the field of PliM. The verification shall be based on the following aspects:

- When the licensee has defined generic groups of material/environment, multiple SSCs of the system subject to inspection shall be selected, by verifying the correct assignment of degradation mechanisms and ageing effects defined;
- Complementarily, a combination of material/environment not considered by the licensee, who should not a-priori disposable, shall be selected, since it is typical of similar facilities, by verifying that there is no SSC in this situation;
- Multiple SSC, subject to inspection, shall be selected to individually prove that the degradation phenomena and ageing mechanisms identified as applicable are correct and complete.

Out of the degradation mechanisms that have been properly identified due to the relationship between the elements and groups material/environment, it shall be verified that the SSC subjected to this inspection belongs to this group. If this methodology has not been used, the degradation mechanisms and phenomena identified by the licensee shall be quantified using reliable and recognized technical references.

It shall be verified, after the selection of the appropriate SSC, that the licensee has identified particular ageing mechanisms, in addition to the general mechanisms for the SSC group concerned. For example, in the case of an equipment or a pipe subject to the erosion/corrosion phenomenon, due to the particular condition of its geometry (which can be demonstrated as a result of internal operating experience), an additional mechanism to erosion/corrosion should have been proposed, or the same one but with aggravated characteristics.

It shall be verified that the degradation phenomena and ageing mechanisms applicable have been defined by taking into account the specific intended safety functions of the SSCs.

It shall be verified that the licensee submits technical justifications for the ageing phenomena that have not been qualified as significant in the list of phenomena applicable to groups of SSCs.

— Ageing managing programmes (AMP)

This requirement states that verifications shall be performed to ensure that all established maintenance practices and activities are appropriate and sufficient for the effective control of associated degradation mechanisms.

The maintenance, testing, inspection, verification and control activities are divided into specific programmes related to the AMPs. The groups previously selected shall be used as a reference for the inspection of these programmes.

Multiple SSCs applicable to particular defined combinations shall be selected, for example, by type of component, material, environment, degradation mechanism, etc., of the systems or groups selected.

The following issues and considerations shall be verified during the inspection:

- The USNRC NUREG-1801 (GALL) report [III-20] shall be used as a basic information tool. This report establishes, for each system, a proposal of one or more

valid AMPs for the different combinations of SSCs (type of component/material/environment/degradation mechanism);
- By using this reference, the AMPs proposed by the licensee for each selected combination shall be coherent with those in the GALL report.

Once the corresponding element has been identified in the GALL, it must be compared to the corresponding contents of the AMP, for the verification of equivalent attributes.

The level of coincidence or similitude between elements shall be verified.

The existence of situations where the GALL sets additional requirements regarding a basic programme of the checked AMPs, shall be as well verified.

In such cases, the licensee shall modify the AMPs or justify the deviations, exceptions or simplifications adopted.

In the cases where the AMPs have been used in conformity with the GALL, but with exceptions, it is necessary to verify that:
- The exceptions are properly founded;
- The alternative proposed by the licensee's to the unused GALL's requirements complies, when applicable, with the 10 attributes established, described below, for the specific AMP of the nuclear power plant.

Whenever the GALL report does not include information regarding a particular combination (components, materials, environments or degradation mechanisms), or whenever the GALL report indicates that the licensee must develop a specific AMP, the technical position RLSB-1, included in Appendix A of the USNRC NUREG-1800 (SRP) [III-19] and in the NEI-95-10 Guide [III-22], can be used as a guide for the verification of the proposed methodology.

The latter inspection reference is based on 10 generic attributes. This attributes are applicable to all types of AMP (mitigation, prevention, monitoring of control or operating conditions). For the quantification of attributes by the inspector in the absence of the GALL report, the plant's operating experience shall be used, which must justify the adequacy and efficacy of the content of the specific AMP. The experience of other nuclear plants that have already developed similar programmes approved by the RA can also be used.
Listed below are the 10 attributes that may characterize any AMP.

If the plant AMP matches, without exceptions, its counterpart in the GALL report, it is acceptable to make direct reference to it in all or most of these attributes without detailing each one, unless it is necessary.

(1) Scope of the programme

The AMP shall include within its field of application the general definition of applicable types of SSC, materials, environments and degradation phenomena. This information shall be coherent with analysis results of the PliM plan.

In addition, the AMP shall include a list with specific references to the SSCs within its field of application.

(2) Preventive actions

In the cases where the AMP sets the implementation of preventive measures as a strategy, such as a protection paint programme, the description of management actions scheduled to prevent or minimize the occurrence of degradation phenomena shall be verified.

These actions may include maintenance, testing, inspection, verification, operation optimization activities, etc., and even the DM to be implemented to control the degradation of the component or structure.

(3) Monitored or inspected parameters

The AMP shall describe the monitored parameters along with testing and inspection activities that aim to monitor and control the degradation phenomena.

(4) Detection of ageing effects

The AMP shall include techniques and methods for detecting ageing phenomena before the SSC is unable to perform its functions.

To this end, a suitable type and/or method for trial, inspection, frequency, sample size, measuring points, measuring instruments, etc. shall be indicated.

When the control strategy is based on a sample, it shall be demonstrated that the sample selection criteria are reasonable to guarantee the representativity of the total population.

(5) Trend monitoring and analysis

The AMP shall anticipate the trend monitoring and analysis that show the evolution of ageing phenomena and allow the adoption of additional control, corrective or mitigation measures for them.

The AMP shall include a description of the parameters or indicators used for monitoring, the methodology to determine the future perspectives and the acceptance criteria applicable to the decision making.

(6) Acceptance criteria

The AMP shall describe, for each of the controls, the acceptance criteria from which the need for corrective measures will be determined.

These criteria shall be sufficiently conservative to ensure that the SSC will be operational and available to carry out its functions during its expected operation period.

In addition, the AMP shall describe the analysis methods to determine whether the acceptance criteria are met.

(7) Corrective actions

If the acceptance criteria are not met, the AMP shall describe the corrective measures to be applied to, such as operational changes, repairs, replacements, etc.

When necessary, the need for a root cause analysis shall be specified.

Additionally, for each corrective action defined, the organizational units responsible for its application, along with the established chronogram/period, shall be specified.

(8) Confirmation process

The AMP shall include a description of actions aimed to monitor the full execution and effectiveness of the corrective, preventive or mitigation actions to be carried out.

(9) Administrative controls

The AMP shall be covered by the nuclear power plant's current quality control system.

(10) Operating experience

The efficacy of the AMP shall consider the internal and external operating experience gained, which shall be reviewed periodically to incorporate new experiences and lessons learned. In this context, the licensee shall consider information from other projects that can be applied to the AMP.

III-2.1.1.7. Process for identification and resolution of GSI associated with ageing management

For the inspection, several AMPs shall be selected, by verifying the results obtained over a period of time deemed convenient with respect to the SSCs in the field of application.

Also, in the inspection, those AMP defined as the result of a TLAA analysis, based on time, inspection frequency, and those derived from a *GSI*, shall be considered.

The plant specific AMPs, containing exceptions to the ones in the GALL, or the newly implemented AMP at the nuclear plant, shall also be verified, by also verifying their adequacy and effectiveness at controlling the degradation mechanisms applied.

The following aspects shall be verified for the AMPs selected:

- The monitored parameters and variables must be consistent with those specified in the AMP. Inspections, tests, etc., shall be performed by using the techniques, frequencies, sampling, etc., specified therein, and always in accordance with procedures;
- The staff responsible for carrying out these activities has the training and experience required;s
- The corresponding trend analysis has been performed when required by the AMP;
- In all the analyses of results obtained from application of the AMP, the acceptance criteria are clearly defined and a comparison of the results obtained to the criteria applied is made;
- In the cases where the acceptance criteria are not met, it shall be verified that:
  - When requested, the sample has been broadened;
  - The required subsequent analyses (root cause analysis, functionality loss prevention) have been performed;

- When necessary, corrective measures, substitutions and necessary DM and their implementation strategies have been defined;
- The different activities of the AMP are carried out by following the applicable quality assurance requirements;
- As appropriate and as a result of experience acquired from the practice programmes, a programme of the improvements needed to increase the adequacy and effectiveness has been defined. In this context, the definition of performance indicators may be of great help, along with the results obtained from the application of each AMP.

III-2.1.1.8. Monitoring of IPs

The IPs arises as a consequence of the following activities:

— The initial process for the definition of the AMPs, considering the 10 characteristic attributes;
— When the expansion of the scope of AMPs to include new SSCs is required;
— Operating experience gained in the practical application of AMPs;
— Consequence of the analysis of operating experience.

It shall be verified that the licensee has established a clear mandate to monitor the IPs and that the results are satisfactory. This verification shall at least have as a basis:

— The results of the inspections conducted on ageing management aspects, where the control of the improvement management programme shall be verified;
— The information contained in the periodic reports submitted to the RA by the licensee.

The information obtained will act as reference to verify the effectiveness of the process, by showing among other things: the number of IPs that have been issued and resolved during the period, the estimated resolution time versus the actual time required, definition of performance indicators, results of these indicators etc.

III-2.1.1.9. DMs and replacement of equipment associated with ageing management

It shall be verified that the licensee has undertaken an adequate treatment of DM and replacement of equipment at the nuclear power plant.

Particularly, for power up-rate projects, which may involve DM, changes in the operating conditions, equipment replacement, etc., specific care shall be taken if it affects ageing management.

It should be verified that any change in the SSCs and the operating procedures performed at the nuclear power plant, have the corresponding implication in the existing ageing management analyses.

With this purpose, some DM or equipment replacements shall be selected, by verifying that:

— The licensee has explicitly considered ageing management aspects in the general criteria of the project, in the case of DM, or in new equipment specification in case of replacements. These shall have implications in the selection of materials, systems, project margins, sampling systems, monitoring, inspection, tests, etc.;
— The licensee has examined the effects of the DM or equipment replacement that may indirectly affect the operating conditions of existing SSC at the nuclear power plant,

considering that their variation may cause changes in the environments and possible ageing mechanisms;
— The new SSC included at the nuclear plant have been analysed according to the general methodology of ageing management analysis.

The licensee may have established a DM and replacement strategy based on the acquired operating experience, condition of SSCs, as well as their obsolescence conditions. This plan must be specifically inspected, by analysing among others, the reasons and adjustments of the proposed measures.

III-2.1.1.10. Review of supporting documents

These controls are related to the monitoring of previously developed supporting documents, that after a certain period of time have been updated for several reasons, such as incorporation of the results obtained in the analysis of operating experience, research programmes, new GSI, etc.

During the inspection some of the revised documents shall be selected, taking into account the updated list of supporting documentation developed at different stages of the process (scoping and screening, identification of ageing effects, degradation mechanisms, definition of AMPs, etc.) in order to verify:
— The causes that led to this review;
— The adequacy and coherence of the changes with the modification and its support.

When appropriate the documentary verifications shall be inspected according to the methodology described above, taking into account the scoping and screening criteria, development management analysis, etc.

In cases where the inspector has new information on operating experience, both internal and external to the plant, or on results of research programmes that have been conducted at the nuclear power plant or other external areas, it should be verified if the licensee has assessed their impact on it, and if this situation leads to a further review of the relevant supporting documents.

III-2.1.1.11. Obsolescence management

The obsolescence of SSCs important to safety shall be managed proactively with foresight and anticipation during the design life of the nuclear plant.

The licensee shall establish a programme for managing obsolescence. This programme shall include the purpose, strategy, organizational aspects, definition of the necessary resources (human and financial), and programme monitoring to assure the fulfilment of its objectives [III-1].

In this context, two kinds of obsolescence can be mentioned:
— Regulatory: characterized by SSC which do not comply with the standards, criteria, etc., existing at the current moment, such as: equipment qualification, separation or redundancy, diversity or operation under severe accident conditions criteria, etc.
— Technological: characterized by the difficulty to find spare parts and specialized technical assistance (execution of maintenance or installation works, etc.).

The obsolescence management programme shall focus more on the management of technological obsolescence. It shall be mentioned that in the case of I&C, the regulatory obsolescence may affect both software and hardware. In addition, the programme should provide guidance for monitoring obsolescence management, taking into account the requirements set in the periodic safety review (PSR) [III-2] and in **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants**.

The licensee's obsolescence management activities shall be supervised by the RA during the design life of the nuclear facility.

It shall be verified that:

- The licensee has defined and implemented a programme for obsolescence management, by clearly establishing the scope, objectives, responsibilities, deadlines, actions, resources and monitoring to measure its effectiveness;
- Obsolescence management programmes incorporate:
  - A systematic and periodic assessment of obsolescence;
  - The strategy to follow once an obsolescence problem has been identified for a type of component.
- The programmes are effective in the definition of the actions and resources needed to ensure component functionality during the design life of the nuclear power plant (spare parts, replacement, availability of technical personnel, etc.).

III-2.1.2. Routine or periodic inspections of PLiM plan (Type 2 Inspections)

III-2.1.2.1. Objective of the inspection

Depending on the life stage of the nuclear power plant, a variety of SSC related to the PLiM plan established shall be inspected. Some aspects may be similar in the different stages, while other aspects are specific to a certain stage.

The objectives of such inspections are:

- To verify the implementation, control updating and maintenance of the AMPs integrating the PliM plan. This objective is developed in Sections III-2.1.2.2 to III-2.1.2.12. This kind of inspection should have a once per year or once every two years expected frequency;
- To verify the condition of the SSC sample from the perspective of the PliM plan, including documentary activities and field activities ('walkdowns'). A variety of PliM plan related SSC shall be inspected. This objective is developed in Section III-2.1.2.13. These inspections should be conducted more frequently (for example, quarterly or biannually).

Annexes I, II and III, containing examples of inspection verification lists or "check lists" may be used to facilitate the verification of different aspects of a type 2 inspection (Sections III-2.1.2.2 to III-2.1.2.13).

III-2.1.2.2. Management and organizational aspects

The main aspects to be verified in these inspections relate to the control of any changes or modifications in the organization structure defined by the licensee in relation to ageing management.

The objective of this part of the inspection is the same mentioned in Section III-2.1.1.1 of this guide, while insisting on those changes or modifications that may have taken place since the last inspection and which may affect the evolution of PLiM plan.

It shall be verified that in subsequent revisions of PliM plan and in the periodic reports of its execution, relevant information on all issues is presented, as described in the following sections.

III-2.1.2.3. SSCs scoping and screening

In this type 2 inspections, the main issues to be inspected are:

- Verify whether the scoping and screening of SSC subjected to the PLiM process have been modified by addition or deletion of SSC to/from the final list verified in previous inspections;
- Verify if the results of the methodology implementation process for new SSCs that are within the scope of PliM plan conform to the initial general process;
- Verify if the SSC excluded from the scoping and screening process final list do so justifiably.

In the verification by the inspectors, of items listed above, the use of regulatory documents that are part of the conditions of the nuclear power plant's OL and which are used to justify changes shall be assessed.

The inspection shall focus, through the assessment of all elements that have been included or excluded from the list or by a representative sample in case of a large amount, on verifying the results of variations at mechanical, electrical, I&C and structural components level of the nuclear power plant, even for complex systems and structures, both if it is regarding additions or deletions of SSC in the scoping and screening process final list.

The guidelines of Section III-2.1.1.4 remain valid for the analysis of the newly incorporated SSC.

III-2.1.2.4. Methodological aspects related to PLiM plan analysis

The inspection, in this case, shall address the possible changes in methodology, by identifying possible changes in the general criteria set out in the PliM plan, the operating modes considered, the application of new operating experience, alterations in the reference documents and other sources, process for definition of degradation mechanisms and phenomena, definition of AMP and the identification of IP.

In all of the elements above, it shall be verified that the changes made are supported so that there are no substantial changes in the analysis methodology as expressed in the PliM plan.

III-2.1.2.5. Results of PLiM plan analysis

The inspection shall identify whether any changes in the analysis results have occurred as a consequence of modifications in the definition of materials and environments, ageing effects, degradation mechanisms and AMP, especially for the SSC newly incorporated into the scope of the process, as defined in Section III-2.1.2.3, and applying the same techniques as described in Section III-2.1.1.6, particularly, the verification of the attributes analysis in the case of new or modified AMP

III-2.1.2.6. Process for identification and resolution of GSI associated with ageing management

In the case of Type 2 inspections, this aspect could be reduced to the verification of new GSI affecting both existing SSCs within the initial scope, and new SSCs that have been incorporated therein.

The criteria provided in Section III-2.1.1.7 are equally applicable in this case.

III-2.1.2.7. Monitoring of IPs

It shall be verified that the licensee maintains a clear mandate of monitoring IPs and that the results are satisfactory. This verification shall consider as a basis:

- The results of inspections conducted on ageing management aspects, which verify the control of the improvement programme management;
- The information contained in the periodic reports issued by the licensee.

Particularly, attention shall be given to the level of progress in the implementation of the IP by verifying its completion or the existence of a time schedule with a clear timetable, for the implementation of these.

III-2.1.2.8. DM and replacement of equipment associated with ageing management

The criteria for the content of the inspections to be carried on these aspects, shown in Section III-2.1.1.9, are fully applicable in this case.

Particularly, attention shall be given to the DM and replacement of nuclear power plant equipment programme, by verifying that the impact on ageing aspects of has been correctly analysed and documented.

III-2.1.2.9. Review of supporting documents

In this regard, the inspection shall continue to select documents that have been reviewed, from the updated list of supporting documentation developed at different stages of the process (field of application and scoping and screening, identification of ageing effects and degradation mechanisms, definition of AMP, etc..) in order to verify:

- The causes that led to this review;
- Adequacy and coherence of the changes with the modification and its support.

In cases where the inspector has new information on operating experience, both internal and external to the plant, or on results of research programmes that have been conducted at the nuclear power plant or other external areas, it shall be verified if the licensee has assessed

their impact on it, and if this situation shall generate a new review of the supporting documents involved.

III-2.1.2.10. Obsolescence management

In this inspections it shall be verified that the licensee maintains an obsolescence management programme with a clearly defined scope, objectives, responsibilities, deadlines, actions, resources and monitoring to measure its efficacy, and that the obsolescence management programmes incorporate:

- A systematic and periodic assessment of obsolescence;
- The strategy to be followed once the obsolescence problem has been identified for a type of component.

III-2.1.2.11. Periodic reports of PLiM plan.

The PliM plan periodic reports aim to submit to the RA the main activities carried out in a particular period (normally on an annual basis) related to ageing management and performed by the nuclear power plant licensee's organization.

These reports may be regarded as complementary documents to the PliM plan and shall allow the inspector to know the progress and evolution of ageing management activities carried out by the licensee. They shall also allow the licensee to know the current condition of the SSCs, which will facilitate the identification of potential age-related degradation mechanisms. The main points usually addressed in these reports are:

- Updated information about the organizational aspects;
- A summary of the meetings and discussions of the management committee on the already existing specific activities at the facility for the development of AMP;
- Basic ageing management activities conducted by the licensee during the period (additional testing or revision and updating of existing ones), including an updated list of documents and planned analysis and modifications performed;
- The monitoring of commitments to the RA, including the results of controls related to ageing management;
- The results related to the implementation of the PliM plan (activities, condition of SSC, new IP, etc.);
- Suggestions to verify the improvements;
- The results related to the participation of licensee's representatives in research groups or works related to ageing management of SSCs.

III-2.1.2.12. Condition of SSCs

The second objective of type 2 inspections is to verify the situation of a SSC sample from the perspective of the PLiM plan, including documentary verification activities and field activities (*'walkdowns'*). An appropriate inspection SSC sample size incorporates at least one structure, one system and two components per inspection.

This selection can be carried out based on the elements gathered from the operational records, such as the history of inoperability according to the Technical Specifications, the frequency of corrective maintenance, the availability and reliability indicators, the reports of operational events or maintenance history based on failure rates. It is also convenient to use risk-based information, from the PSA and other information sources available.

The USNRC GALL (NUREG-1801) report [III-20] contains tables with examples of identification of SSC, mechanisms and effects of degradation, the AMPs and its associated recommendations.

The activities described are applicable to the nuclear power plant in any operation mode. In the case of cold shutdown or fuel reload, the inspections shall include SSC inside the containment and other restricted areas.

The inspection shall be conducted in two parts:

First is the Verification of applicable documentation, through the following actions:

- Verify that the procedures related to the corresponding AMP are suitable for the monitoring of ageing effects on SSCs, for example, predictive control, inspection services, regular testing, thickness control, control of corrosion, etc.;
- Verify the existence and development of ageing mechanisms indicators of the selected SSCs;
- Verify the suitability of the Preventive and Predictive Maintenance Programme of the facility to identify, monitor, control or mitigate the effects of age-related degradation due to corrective maintenance, reports of operational events, history of inoperability according to technical specifications, or the inclusion of new maintenance activities in the programme;
- Verify, when applicable, the prevention, implementation and effectiveness of DM in the SSCs selected;
- Verify that the existing ageing degradation mechanisms have been identified and that any deficiencies or weaknesses are properly identified. Additionally, verify that there is an improvement plan or programme associated;
- Verify that the information on internal and external operating experience has been considered and assessed for the SSCs selected;
- Verify the impact of operational event reports which have as root-cause the age-related degradation, the exceeding of life-time, or unknown causes, in the SSCs selected;
- Verify if there are any SSCs considered to be obsolete in operation. Verify that these SSCs operate within appropriate or acceptable operational criteria and that these SSCs have improvement programmes associated;
- Field inspection or *walkdown*, incorporating the following actions;
- Perform a *walkdown* to verify the condition of the SSCs selected, and their environment and operating conditions. Identify any potential anomalies or degradation signs found.

For later analysis and determination of their relationship with age-related degradation mechanisms, at least the following aspects that apply to the SSC shall be recorded:

- Vibration levels above normal;
- Fluid leaks;
- Signs of corrosion;
- Signs of erosion;
- Observation of dust and contaminants;
- Observation/development of cracks or fissures;
- Condition of electrical connections;

— Verify that any age-related degradation conditions encountered have their degradation mechanism identified and that the monitoring, control, mitigation and restoration of normal conditions activities are in progress;
— Verify that any age-related degradation conditions encountered may be properly managed before the OL expire;
— Verify and identify the existence of internal and external environmental conditions that may cause age-related degradation in the SSCs selected.

III-2.2. Inspections during the Long Term Operation period

III-2.2.1. Inspections of ageing management plans incorporated into the OL renewal for the long term operation (IPA or LEP). (Type 3 Inspection)

III-2.2.1.1. Objective of the inspection

The fact that many nuclear power plants around the world have reached their design life with their equipment in generally good conditions has opened the possibility of carrying out life extension projects with a view to their long-term operation. This led to the development of an international set of regulations regarding these purposes. They include those related to ageing management during the development of the OL renewal process (life extension project) and the long term operation itself.

This chapter describes the considerations to take into account during type 3 regulatory inspections of aspects related to ageing when facing an OL renewal process resulting in the long term operation of the plant.

Many countries have incorporated, perfected or adjusted to their realities the documents and standards developed in the countries of origin of the technologies used at their nuclear power plants. In the case of nuclear power plants of American design, the methodology relies heavily on the one developed by its regulatory body, the USNRC, the license renewal rule (LRR) 10CFR54 [III-13]. In other cases, such as those of CANDU technology, the methodology is based on the process defined by the CNSC, the report RD-360 [III-12].

During these license renewal processes, which shall start 3 years before the expiration date of the OL, various inspections shall be performed.

Depending on what stage the OL renewal process is at, the inspections may be focused on particular sections of the IPA or the PLEX project in the case of CANDU plants, or be multidisciplinary, when it comes down to aspects related to different sections of them, and in all cases to verify aspects of the assessment. The works that go along with this process may be carried out both during the normal operation of the nuclear plant or during refuelling shutdowns.

In these inspections of the IPA and/or PLEX, as documents incorporated into the license renewal for the long term operation, the basic objective is to verify the development and content of the ageing management of the nuclear power plant for the application during the long term operation.

This chapter of the guide, developed in Sections III-2.2.1.2 to III-2.2.1.12, establishes the inspections to be performed by the RA, immediately before the start of the long term operation, to:

- Verify the acceptability of the scope, requirements, methodologies and results of ageing assessments up to that moment;
- Verify the acceptability of the scope of the reconditioning tasks and safety improvements proposed by the licensee;
- Verify that the tasks to be executed to implement the improvements have been properly planned by taking into account the issues related to nuclear and radiological safety;
- Verify the proper execution of the works related to those improvements;
- Verify that the mandatory documentation has been updated, by considering the extended period of operation.

If the plant's design requires an extended reconditioning shutdown with replacement of critical components before start of long term operation, the following shall also be performed:

- Verify that an appropriate radiation protection system is applied during the reconditioning shutdown;
- Verify the proper management of the radioactive waste generated during the reconditioning tasks of the plant;
- Verify that the technical conditions to initiate the restarting process of the nuclear plant are met;
- Verify that during the commissioning process the necessary conditions for a safe re-start are verified.

The IPA is the basic licensing document to be submitted by a licensee who is interested in getting a new OL, beyond the design life of the nuclear power plant and, by definition, it is a set of ageing management analyses that comprise the three classical stages: scoping and screening of SSCs, identification of ageing effects and degradation mechanisms, and definition of AMP. It also includes the TLAA needed for review of analyses carried out with a definite design life hypothesis.

This plan may have as a reference, in the case of PWR and BWR plants, the U.S. regulations contained in Rule 10CFR54 "Requirements for renewal of operating licenses for nuclear power plant" and the documents developed both by the USNRC [III-13, 14, 15, 16, 17, 18, 19, 20 and 21] and the nuclear industry [III-22].

III-2.2.1.2. Management and organizational aspects

The main aspects to be inspected are:

III-2.2.1.2.1. Structure of the licensee's organization in relation to IPA preparation

In this part of the inspection the particular aim is to identify the organization, group, committee, etc., established at the nuclear power plant, responsible for carrying out the aspects of the IPA, according to the same aspects of composition and operation described in Section III-2.1.1.2, by verifying:

- Functions and activities performed by these groups;

— The existing hierarchical relationship;
— The frequency of meetings, the topics discussed and decisions made (minutes of meetings);
— The existence of people in the organization responsible for the practical aspects related to the long term AMPs;
— The availability of suitable and sufficient resources;
— If the responsibilities at all levels are clearly identified and defined;
— If the personnel involved in the long term ageing management activities, has the necessary knowledge of the details regarding these aspects.

III-2.2.1.2.2. Acquisition and recording of information related to ageing management

Also according to IAEA Safety Guide NS-G-2.10 [III-2], and **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants**, the licensee must have a system for acquisition and systematic recording of data supporting the information contained in the IPA.

Therefore, the inspections shall carry out an assessment of this system (data, analysis, etc.), by verifying its main features and effectiveness as described in Section III-2.1.1.2.1 of this guide in the case of a PLiM plan.

III-2.2.1.2.3. Monitoring of licensee accepted and RA introduced commitments (conditions, non-conformities, regulatory requirements, etc.).

The resolution of all commitments made or imposed during the design life phase shall be identified before starting the long term operation.
To this end, in addition to the information provided in the periodic reports, the information obtained during type 2 inspections performed throughout the plant's design life will be of great importance.

III-2.2.1.3. Scoping and screening

In international practice there are different methodologies to determine the scoping and screening of safety or economic relevance SSCs to the nuclear power plant, as described in section II-2.3.3 of **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants**. It is worth mentioning that the inspection shall have an impact on the SSCs within such scope, defined in **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation,** Section I-3.

The regulatory activities related to the scoping and screening process of SSCs considered in the methodology established by the licensee for the long term operation phase, shall begin from the information submitted to the RA in the IPA who, after assessing them according to the process outlined in **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants**, shall accept them or establish any additional conditions and/or recommendations in that regard.

The licensee shall submit a list of SSCs within the scope of the long term ageing management, constituting the final list of SSCs within the scope of IPA, and that shall be integrated by the initial list of SSCs along with the modifications (additions or deletions) occurred during the nuclear power plant's design life. The RA may additionally establish the

need to include other SSCs that have not been initially considered by the licensee, situation which shall be verified in the inspection.

The key issues to be inspected are:

— The scoping and screening process of the SSC to be subjected to the IPA;
— The result of the application of the methodology for different SSCs of the nuclear power plant.

The verification by inspectors of the aspects mentioned above shall be in accordance with the contents of the various Sub-sections of Section III-2.1.1.3, but taking into consideration any changes that may have occurred throughout the design life, particularly, incorporations and replacements of SSCs resulting from DM.

Consequently, and unless it is justified by individual cases, the methodology to be followed by the inspection shall be the assessment of a representative sample set of SSC to which the scoping and screening criteria have been applied.

The inspector shall determine and examine the initial sample. If the results are not satisfactory, the sample shall be broadened. The criteria for defining the samples shall be different and in all cases adapted to the type of SSC to be inspected, as well as the current life stage of the facility.

The mechanical, electrical and I&C SSCs, as well as the passive and long life structures whose design is affected by a definite period of time (for example, SSC whose design is based on a lifetime of 30 or 40 years) shall have been correctly identified. These components shall be included and studied in the corresponding TLAA analyses described in Section III-2.2.1.12.

III-2.2.1.4. Results of methodological application of scoping and screening of SSC

The objective in this part of the inspection is to ensure that the methodology for defining the scoping and screening process was applied correctly and that the results are satisfactory. The aspects related to the suitability of the methodology used by the licensee and its development, are more typical of assessment activities than of inspection activities, **Annex II FORO Guide for Assessment of Ageing Management and Long Term Operation of Nuclear Power Plants** addresses this aspects.

The following section highlights the main aspects to be inspected:

— The overall results at complex system and structure level:

- Contents of the complex systems and structures final list

From the complex systems and structures final list derived from the process, the systems and structures clearly expected to be included due to the intended safety functions performed, shall be identified.

To complement the latter, a system or structure that does not appear on the list shall also be selected to verify if it really does not perform any intended safety function, by giving special attention to the variations resulting from DM.

- Process for the establishment of systems and structures within the field of application

In order to verify the correct application of the methodology, the systems and structures on the final list shall be selected, by verifying in each case the correct identification of their functions and therefore the parts of the system and structure within the field of application.

— Results at mechanical, electrical and I&C component and structure and building level:
  - The inspection shall focus on performing similar verifications to those described in Section III-2.1.1.4 of this guide for the case of a PLiM plan, with the same extension and method, including verifications associated with the "analysis by area" for electrical and I&C components, by selecting one or more of the areas within the scope and verifying that the individual components that comprise them have been considered.

III-2.2.1.5. Methodological aspects related to the IPA analysis

The inspection of the methodology shall address the following points within the content of the IPA:

— General criteria used by the licensee to define materials and environments

These criteria and methodologies shall allow obtaining a set of materials and environments, both internal and external that is representative of the existing situation in the different operating modes considered in the analysis.

The supporting documentation used by the licensee's organization shall be inspected, as well as support tools like databases, etc.

In addition, it shall be verified that the licensee has clearly and accurately defined all the existing materials and environments, both internal and external, at the end of the design life for their use in the analysis.

— Operation modes and functions considered in the analysis

It shall be verified that the licensee has considered the different operation modes important in the ageing management analysis as these condition the environments and degradation phenomena affecting the SSC (normal operation, periodic functional tests, refuelling, stagnant flow and transients).

— Assessment of operating experience

It shall be verified that the licensee uses a systematic methodology for the analysis of operating experience, both internal and external (national and international), in the identification of degradation mechanisms and ageing effects, as well as in the definition of the AMPs.

— Reference document

The specific sources used by the operator shall be verified in the identification of degradation mechanisms and ageing effects, as well as in the definition of the AMPs.

It shall also be verified that the licensee considers in their analysis and programmes the information from research programmes, GSI, new procedures, etc.

— Process for the definition of degradation mechanisms, phenomena and their effects

The specific procedure followed by the licensee to define the degradation mechanisms and phenomena shall be verified.

In general, groups of similar characteristics material/environment, ageing management groups or commodities will have been defined, since these aspects determine the acting degradation processes. Each group or commodity shall have an associated set of potential degradation mechanisms and phenomena, regarding the function that the component or structure performs.

It shall be verified that the licensee takes into account the detection of certain particular elements derived from specific circumstances, such as stagnant flow areas, flow acceleration areas and especially aggressive environments, etc.

The SSCs performing several intended safety functions shall be verified with special attention. In such cases, the degradation mechanisms and effects related to each function shall be established.

The existence of justifications for the elements that belong to a group and which are not subject to the characteristic effects of that group shall be verified.

— Definition of the AMPs

The methodology used to define the AMPs and control the degradation phenomena previously identified shall be verified. This definition shall be materialized in a supporting document with essential information about each AMP.

It shall be verified that the methodology includes the adoption of basic programmes with direct application to the nuclear power plant and specific programmes, when necessary.

It shall be verified that the structure of AMPs includes at least:

- A section where, in a comprehensive way, the SSCs in their field are presented by indicating their materials, environments and degradation mechanisms associated;
- A description of the specific programmes for inspection and control used as a basis for the AMP;
- A list of IPs.

— Verification of the monitoring of IPs

The systematic identification of IPs associated with the AMPs, which are properly defined and recorded, shall be verified.

The IPs may arise during the conciliation process of the plant AMPs with some reference standard programmes in the industry, such as the ones of GALL.

The ageing management process itself shall also generate what is defined as *'scope IP'* of the AMP, whenever new components or structures to be incorporated into the AMP arise.

III-2.2.1.6. IPA analysis results

The results obtained as consequence of the application of the methodology shall be verified.

The main points to be inspected are:

— Verification regarding the definition of materials

Multiple components or structures shall be selected to verify that the identification of materials has been successfully performed at sub-component level, with the purpose of ensuring that the set of materials considered in the analysis is compatible with the actual materials at the plant.

The basic information required for this control is normally included in the manufacturer's documentation (catalogues), or in the databases of available components at the nuclear plant. This item is subject to becoming a part of an AMP.

— Verification regarding the identification of environments

Multiple components or structures, where more than one significant operating mode has been identified, shall be selected, by verifying that in each case both the internal and external environment are correct and representative of the actual existing ones, and that no omissions are observed.

— Attribution of the degradation mechanisms and ageing effects

In practice, the correct identification of the ageing effects and degradation mechanisms for SSCs included in the field of application shall be verified.

The inspection shall focus on the following aspects:

- When the licensee defines 'material-environment' generic groups, multiple SSC subject to the inspection shall be selected, by verifying the correctness and completeness of the degradation mechanisms and ageing effects specified for that group;
- Complementarily, a combination of 'material-environment' not considered, and which is not a-priori discarded, as it is typical of similar facilities, shall be selected. It shall be certified that indeed there is no SSC in this situation;
- Multiple SSCs shall be selected to individually verify that the degradation phenomena and ageing mechanisms identified as applicable are correct and the list is comprehensive;

- When the degradation mechanisms have been identified through the relationship between the elements and a group, it shall be verified that indeed, the components or structures subject to the assessment belong to this group. If this methodology has not been used, the applicable mechanisms and phenomena shall be identified by using reliable and recognized technical references;
- It shall be verified, through the selection of an SSC suitable for that purpose, that the licensee has detected the particular ageing mechanisms affecting that SSC, and that the degradation mechanisms and ageing effects have been defined by taking into account the specific functions of the SSC.

— Definition of AMP

It shall be verified that the set of maintenance practices and activities established is appropriate and sufficient to establish an effective control of the associated degradation mechanisms.

In general, these maintenance, inspection and control activities are grouped into specific programmes, the AMPs.

The AMPs applicable to defined particular combinations shall be selected, for example, by type of component, material, environment, degradation mechanism, etc., of the SSCs or groups defined. The following aspects shall be addressed during the inspection:

— The USNRC NUREG-1801 (GALL) report [III-20] shall be used as the basic information tool. This report provides, for each system, a proposal of one or more valid AMPs for the different SSC combinations (component, material, degradation mechanism);
— It shall be verified that the AMPs proposed for the selected combination are coherent with the GALL report;
— Special attention shall be given to the cases where the GALL establishes that the applicable standard programme shall be broadened as a requirement to guarantee its validity. It shall be verified that the AMP has been actually improved in relation to the standard programme established in the GALL;
— In the cases where the licensee has categorized some of the AMPs as consistent and coherent with the GALL, but with exceptions, it shall be verified that:

  - The exceptions are properly founded;
  - The proposed alternatives to the GALL's requirements are satisfactory and suitable.

— Whenever the GALL report does not contain information regarding a particular combination or whenever the report indicates the need to develop a specific AMP, the technical position RLSB-1, included in Appendix A of the USNRC NUREG-1800 (SRP) [III-19], can be used to develop the specific AMPs of the nuclear power plant.

In the absence of support by the GALL, for quantification of the attributes, the nuclear power plant's operating experience shall be used to assess the content of the corresponding AMP.

The experience of nuclear plants with similar technologies that have those AMPs may be used as long as it is deemed acceptable by the corresponding RA.

— Inspection of AMP content by attributes

As a reference for the inspection, the AMPs shall be analysed according to the 10 attributes that should characterize any AMP, described in section III-2.1.1.6, by verifying their compliance in the immediate prior phase to the long term operation.

III-2.2.1.7. Process for identification and resolution of GSI related to ageing management

In the inspection, those AMPs defined as a result of a TLAA analysis, based on time, inspection frequency, and those resulting from a *GSI* shall be considered in the phase immediately preceding long-term operation.

For the selected AMPs, the same aspects described in Section III-2.1.1.7 shall be verified.

III-2.2.1.8. Monitoring of IPA improvement proposals (IPs)

The IPs of an IPA arises as a consequence of the following activities:

— The initial process of the AMP definition, during the PliM plan phase (design life);
— When expanding the AMP scope to include new SSC is required;
— Operating experience acquired from the practical application of the initial AMPs of the PliM plan;
— New AMPs defined during the development of IPA.

It should be verified that the licensee has established a clear mandate to monitor the IPs resulting from the AMPs incorporated into the IPA, and that the results are satisfactory. This verification shall have as its basis:

— The AMPs initially defined in the PliM plan and the new ones arising during the design life shall have all their IPs (mentioned first three activities of previous paragraph) fully implemented;
— The AMPs defined during the development of the IPA shall have their IPs fully defined, as well as the programme and timetable to implement them during the long term operation phase (last activity in previous paragraph).

The information obtained shall work as a reference to test the efficiency of the IP process, showing among other things: the number of IPs that have been issued and resolved during the PliM period, the number of IPs issued during the IPA, estimated time of resolution against actual time required, definition of performance indicators, results of these indicators, etc.

III-2.2.1.9. DM and replacement of equipment associated with ageing management

It shall be verified that the licensee has undertaken an adequate treatment of DM and replacement of equipment at the nuclear plant.

It shall be verified that all SSC DM or changes to the operation procedures performed at the nuclear power plant during the design life and that have the corresponding implication in the existing ageing management analysis have been incorporated conveniently in the various IPA phases (scoping and screening, definition of degradation mechanisms and effects, definition of AMP, etc.).

To this end, some DM or recent equipment replacements (those scheduled for implementation at the end of design life or at the beginning of the long term operation) shall be selected, verifying that:

— The licensee has explicitly considered ageing management aspects such as the selection of materials, systems, design margins, sampling systems, monitoring, inspection, tests, etc. in the general criteria of the project, in the case of DM or in the specification of new equipment in the case of replacements;
— The licensee has examined the effects of the DM or equipment replacement that may indirectly affect the operating conditions of existing SSC at the nuclear power plant, considering that their variation may produce changes in the environments and possible ageing mechanisms;
— The new SSCs included or modified in the DM have been analysed according to the general methodology of ageing management analysis.

The licensee may have established a DM and replacement strategy based on the operating experience acquired on the condition of SSCs, and their obsolescence conditions. This plan shall be specifically inspected, by analysing among others the reasons and adjustments of the measures proposed.

III-2.2.1.10. Review of supporting documents

During the inspection, some of the documents reviewed related to the results obtained in operating experience analyses, research programmes, new GSI, etc., shall be selected, and it shall be verified that they have been taken into account as supporting documentation for the different stages of the IPA process (field of application, scoping and screening, identification of degradation mechanisms and ageing effects, definition of AMP, etc.).

In cases where the inspector has new information on operating experience, both internal and external, or on results of research programmes that have been conducted at the nuclear power plant or other external areas, it shall be verified if the licensee has assessed their impact on the stages of IPA.

III-2.2.1.11. Obsolescence management

The obsolescence of SSCs important to safety shall be managed proactively, with foresight and anticipation during the design life of the nuclear power plant.

The licensee shall continue the maintenance and updating of the obsolescence management programme established during the PLiM phase including the purpose, strategy, organizational aspects, definition of the necessary resources (human and financial), and the monitoring of the programme to ensure the fulfilment of its objectives.

At this stage of the IPA, when the design life is about to end, both types of obsolescence, regulatory and technological (typical examples are: environmental qualification of equipment, difficulty in finding spare parts and specialized technical assistance, etc.) become particularly critical.

Therefore, the inspection, by taking into account the requirements of the periodic safety review (PSR) [III-2] and **Annex IV FORO Guide for Ageing Management Issues in the Periodic Safety Reviews of Nuclear Power Plants** shall verify that:

— The licensee maintains an updated programme for obsolescence management at the end of its design life, by clearly establishing the scope, objectives, responsibilities, deadlines, actions, resources and monitoring to measure its efficacy;
— The obsolescence management programmes maintain:
  - A systematic and periodic assessment of obsolescence;
  - The strategy to be followed once an obsolescence problem is identified for a type of component, at the end of its design life or during the long term operation.
— The programmes are effective in defining the actions and resources needed to assure component functionality during the design life and long term operation of the nuclear power plant (spare parts, replacement, availability of technical personnel, etc.).

III-2.2.1.12. TLAA

For the TLAA inspection, one or more analyses that the licensee has identified as TLAA, as well as others that potentially may be, as a result of the assessment carried out, and shall be selected.

For the TLAA inspection process, the following reference documents may be used:

— Documents that are part of the licensing conditions or mandatory documentation:
  - SAR;
  - OL and additional instructions for them;
  - Licensing letters between the licensee and the RA;
  - Design bases documents;
  - Technical specifications;
  - Any others mentioned in the licensing conditions such as: fire hazard analysis, environmental qualification studies, stress and fatigue analysis, etc.
— Generic TLAAs included in the Standard Review Plan, SRP (Chapter 4), in the GALL report (Chapter X) and in the NEI 95-10 Guide (Chapter 5) [III-19, 20 and 22];
— OL renewal applications and assessment of the USNRC or other reference RA for nuclear power plants with similar technology.

For those analyses not identified as TLAA, it shall be verified that the licensee has a reasonable justification for their non-inclusion within the list of the nuclear power plant's TLAA.

It shall be verified which of the three valid methods for resolution of TLAA the licensee has opted for. These methods are:

— Justify, through analysis, that the TLAA remains valid for the long term operation period;
— Extend the TLAA until the end of the long term operation period (considering the additional period starting from the initial analysis);

— Solve the TLAA through ageing effects management during the whole long term operation period (definition of an applicable AMP, or corrective or compensatory actions).

For the inspection, based on the final list of identified TLAA, some of them shall be selected, by giving particular attention to those that are plant specific, that is, not generically identified in the GALL report, SRP, etc.

In each case it shall be verified that they have been solved by following any of the valid methods and that the procedure followed, the calculation programmes used and the conclusions are correct and in accordance with applicable regulations.

If there is any TLAA solved by using the 'ageing effects management' option, it shall be verified that in those cases there is an associated AMP whose scope and content is coherent with the corresponding TLAA (structures and components affected, management strategy, etc.) If the definition of corrective or compensatory actions has been chosen, it shall be verified that there is an implementation programme and the associated timeframe is acceptable. If such timeframe supposes its implementation before the start of the long term operation period, this aspect shall be specifically tested in any of the scheduled inspections.

Finally, it shall be verified that the ageing management analyses, the application of TLAAs to the corresponding structures and components is properly reflected.

Similarly, some exemptions obtained by the licensee regarding licensing requirements, since they are dependent on the variable 'time' constitute a TLAA, and shall also be inspected. The requirements to be met by these exemptions are listed below:

— The exemption shall continue to apply during the long term operation period;
— The exemption affects SSC within the scope of the ageing management analysis;
— The exemption is based on a TLAA.

For their inspection, based on a list of valid exemptions, one or more exemptions shall be selected which, in the opinion of the inspector, may constitute a TLAA, but are not identified as such by the licensee. In these cases it shall be verified that the analysis provides a justification in that regard. In addition, one of the exemptions that do constitute a TLAA shall be selected, in order to verify that the licensee has adequately solved it for the long-term operation period.

III-2.2.1.13. Phases and contents of a PLEX project for long term operation

In some cases, like that of CANDU technology, the methodology is based on the process defined by the CNSC, regulatory document RD-360 [III-12].
During the OL renewal process, which typically begins 3 years before the OL expiration date, several inspections shall be performed.

Depending on the stage the OL renewal process is at, the inspections may focus on a single section of the PLEX project or be multidisciplinary, when dealing with aspects related to different sections of it, and in all cases to verify aspects of the assessment. The work that goes along with this process may be carried out both during normal operation of the nuclear power plant or during schedule maintenance shutdowns.

In these inspections of the PLEX as a document incorporated into the OL renewal for the long term operation, the basic objective is to verify the development and content of the nuclear power plant ageing management of the SSCs for the application during the long term operation, in such a way that they maintain their functions during the useful life of the plant.

On the following pages, Table III-2 and Figure III-3 show a summary of the content and the stages of a PLiM considered in a PLEX in the case of a CANDU nuclear power plant.

In the PLEX associated methodology three phases are distinguished.

III-2.2.1.13.1. Phase I

Figure III-4 below presents a classic example of the steps that comprise Phase I of a PLEX in the CANDU methodology.

The first step of this phase is the development of policies, plans and procedures that describe the basic rules to carry out its implementation at the nuclear power plant, with the analysis of the critical SSC through methodologies such as condition assessments, life assessments and systematic assessments of maintenance.

These assessments are based on the nuclear power plant programmes and require a continual review to ensure that all ageing effects have been considered.

The condition assessment report shall be constantly updated. These updates shall be performed shortly after the scheduled reviews, for they provide important information about the SSC. When there are other significant events or changes after publishing the initial condition assessment report or of its updates, it shall be inspected, especially by considering the proposals for life management.

These proposals may include changes in the systems' chemistry, operating procedure changes, new monitoring methods, more detailed studies of the degradation mechanisms, DM, SSC repairs, etc.

The typical minimum contents of a condition assessment report are presented in Table III-3 below.

The inspection of possible solutions to any problems that arise shall consider the acceptance by the RA of the solutions proposed by the licensee. In addition, the RA shall perform the following activities:

- Review the condition assessment reports of SR SSCs by verifying that the assessment methodology is appropriate;
- Ensure that the report reflects the actual situation of the nuclear power plant and that it is complete;
- Assess whether the technical inspections and data collection carried out are appropriate and whether the personnel performing them meet the qualifications required;

— Verify that the recommendations are sufficient and appropriate by identifying any deviations;
— Define the main safety recommendations;
— To monitor the execution of recommendations and modifications;
— To demand if properly justified, an increase in the frequency and extent of the inspection of a particular SSC.

A continuous monitoring of operational data, maintenance, in-service inspection programmes, periodic tests, operating experience, etc. for each SSC shall be carried out.

A general inspection of the set of condition assessment reports and technical and economic reports, from each analysis of the particular condition assessment report shall be performed.

The result should be documented in an integrated condition assessment report on the nuclear power plant life management.

Table III-2. SUMMARY OF THE PHASES OF PLiM CONSIDERED FOR A PLEX FOR CANDU NUCLEAR POWER PLANTS

PLiM policy for a PLEX
• Defines the main elements of the programme • Defines the roles and responsibilities; it may include specific personnel for the PLEX, as well as the necessary organizational structure
Programme
• General programme details and strategies: specific goals and schedule • Identification of necessary training, tools and information sources
Procedures for analyses

•Implementation process

• Prioritization process

•Procedures for implementation of life management and effectiveness (performance) measurement

• Condition assessments

• Life assessments

• Systematic assessment of maintenance

•Analysis monitoring process

• Quality assurance

• Plan verification

• Feedback and improvement process

Assessment methodologies

• Condition assessments

• Life assessments

• Systematic assessment of maintenance

Condition assessment report

The purpose of a condition assessment report is to establish the current condition of the equipment and provide the life expectation of the SSC, both to achieve their design life and for its possible life extension (long-term operation). This is based on the detailed study of degradation mechanisms and the development of models that allow predicting their behaviour (see Figure III-3 for Phase I).

The results of this stage, or Phase I, shall be recorded as condition assessment report, which will provide a preliminary assessment of the ageing degradation of the SSC selected (Phase II).

Additionally, this condition assessment report shall propose the research and development tasks to be carried out at a subsequent stage (Phase III) for a better understanding of the ageing mechanisms, their monitoring and necessary mitigation actions.

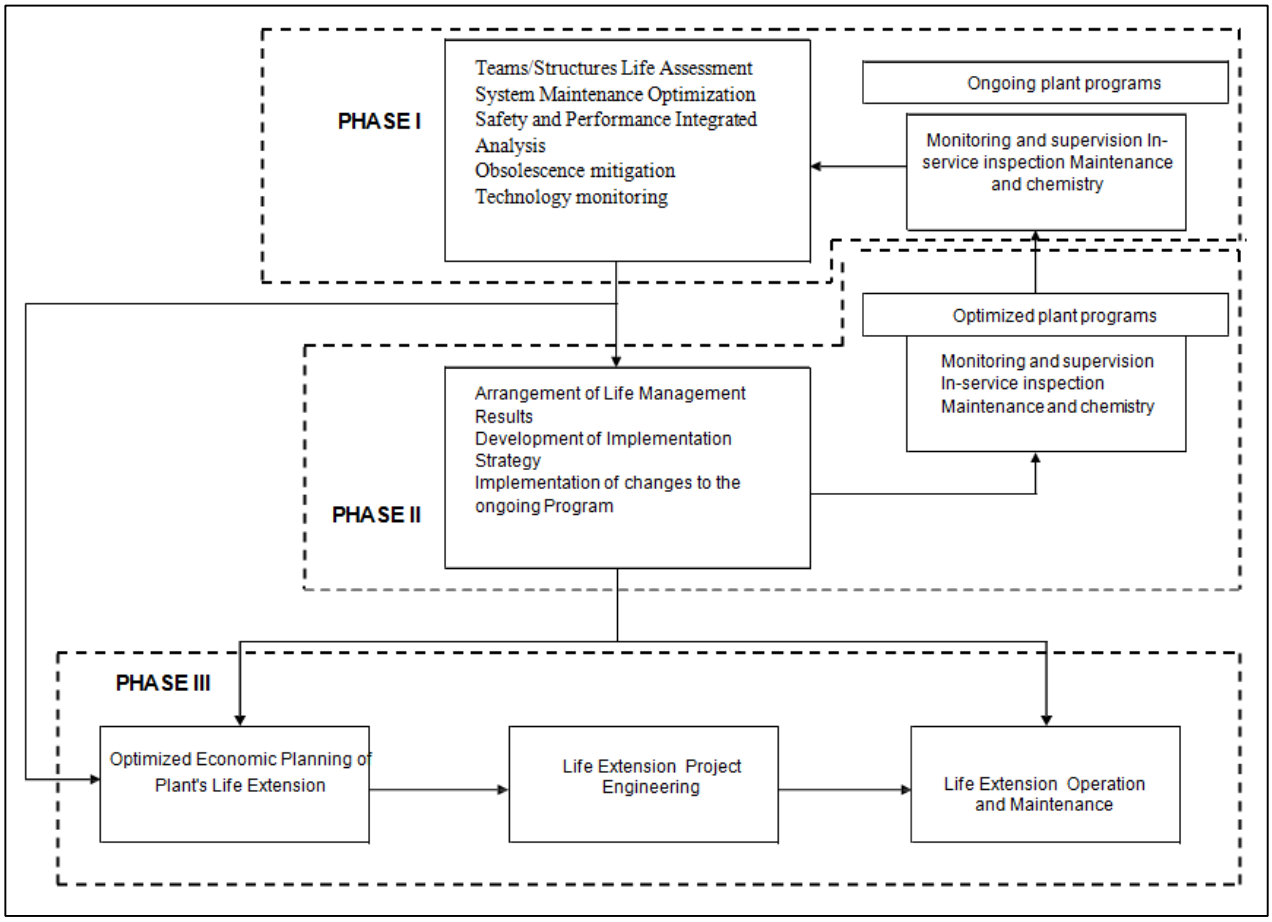

FIG. III-3. Phases of a life management process in a CANDU nuclear power plant.

III-2.2.1.13.2. Phase II

This phase includes a detailed study of ageing knowledge, with the purpose of going in-depth into the conclusions reached in Phase I of preliminary studies, particularly for the points of the technology related deficiencies and safety operation of SSCs during their life-time.

The main tasks to be inspected are:

— Research and development studies to improve the current understanding of relevant ageing mechanisms and to determine the root causes of age-related degradation of SSCs;
— Studies on ageing control in order to verify the existing diagnostics and assessment techniques that may, in a timely manner, detect the age-related degradation of an SSC;
— Studies on ageing mitigation to improve existing studies or develop new methods, operation and maintenance practices or new projects necessary to control the age-related degradation of an SSC;
— Compilation report of this stage detailing the conclusions obtained from the points above.

III-2.2.1.13.3. Phase III

Phase III includes the life extension project of a nuclear facility, PLEX, and includes the modernization, reconditioning and operation tasks beyond the design life of the plant, that is, during the long term operation.

In the cases where the inspections performed on the SSCs at earlier stages have shown that design life is reached in good conditions, the licensee is allowed to develop a PLEX in order to operate beyond the design life of the nuclear power plant.

In Phase III technical and economic studies are performed that provide a basis for achieving the long term operation, such as the ageing management analysis, the application of modernization modifications and the general reviews to assure the nuclear power plant's operation beyond the design life under safe and economic conditions.

These ageing management programmes are a structured set of activities designed to monitor, control and mitigate the ageing effects affecting the SSCs important to safety.

The management programmes are based on the various predictive, preventive and corrective maintenance practices, the in-service inspection programme, erosion-corrosion programmes and environmental qualification programmes, periodic testing of the Technical Specifications, etc., as well as any specific activity performed at the nuclear power plant with the same purposes.

To this end, the licensee shall have established a general methodology to perform the corresponding analyses. As a result of the application of these guidelines and criteria, some specific analyses shall be developed to determine the ageing mechanisms and phenomena and start to define the necessary AMPs.

For the definition, the final list of mechanical, electrical and I&C systems and components, as well as of the structures (including structural components) that have passed the scoping and screening stage of SSCs within the scope of the ageing management analysis, is used.

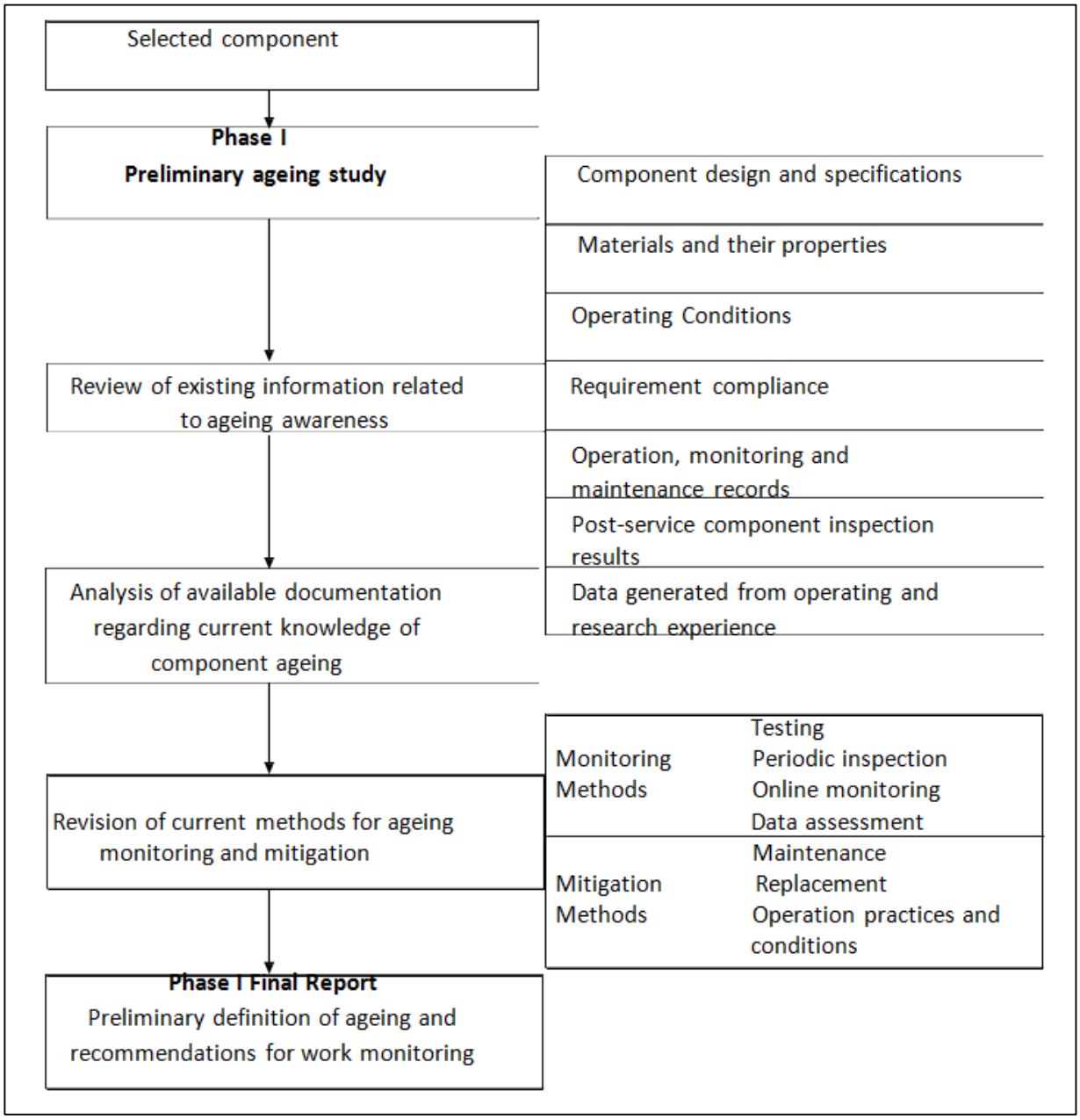

FIG. III-4. Basic scheme of Phase I of PLiM for a CANDU-PLEX.

The logical sequence to develop the ageing management analysis involves, in the first place, the definition of materials and environments corresponding to different elements of the field of application and selection; in addition, and based on the essential parameters, the mechanisms and effects associated with ageing shall be identified.

The AMPs appropriate for the controlling of the ageing mechanisms and effects identified above shall be defined.
The inspection strategy for the contents of an PLEX is thus very similar to the previously one developed for the IPA, consistent with the detailed aspects of the methodology and application of it and many aspects described earlier in Sections III-2.2.1.2 to III-2.2.1.11 can be applied.

The set of activities subject to Type 3 inspections to perform a PLEX is documented in an integrated condition assessment report of the nuclear plant, whose development scheme and typical content are shown in Figure III-5.

TABLE III-3 ASPECTS TO TAKE INTO ACCOUNT IN AN SSC CONDITION ASSESSMENT REPORT

TOPICS	**MINIMAL CONTENTS**
INTRODUCTION AND OBJECTIVES	
DESCRIPTIONS AND FUNCTIONS	Description Functions Scope and outlines Design codes and specifications Design changes Environmental qualifications Subcomponent prioritization Construction/fabrication, assembly and materials References Annexes
OPERATION HISTORY	Chronologic event log Chemical controls References Annexes
MANTEINANCE AND INSPECTIONS	Corrective maintenance Preventive maintenance and inspections Predictive maintenance Obsolescence/manufacturer information References Annexes
ASSESSMENT OF DEGRADATION MECHANISMS	Possible degradation mechanisms Assessment of existing degradation mechanisms at the nuclear power plant Degradation mechanisms matrix References Annexes
CONCLUSIONS AND RECOMMENDATIONS	Conclusions Life forecast Recommendations

Initially, the information sources used to prepare the inspection should take into account at least the following aspects:

— Maintenance history records;
— Technical specifications and SAR;
— Outline operating conditions with a focus on their reliability and data availability;
— Operational event reports, focusing on: submitted events with a root cause, age-related issues, unknown causes, occurrence at the end of life;
— Results of periodic examinations (inspection);
— In-service inspection results;
— DM, focusing on aspects of the operating experience, obsolescence or replacement of SSCs, including the assessment of their effectiveness and efficiency;
— OL related improvement programmes, including the safety improvement programme (SIP);
— PSR related improvement programmes.

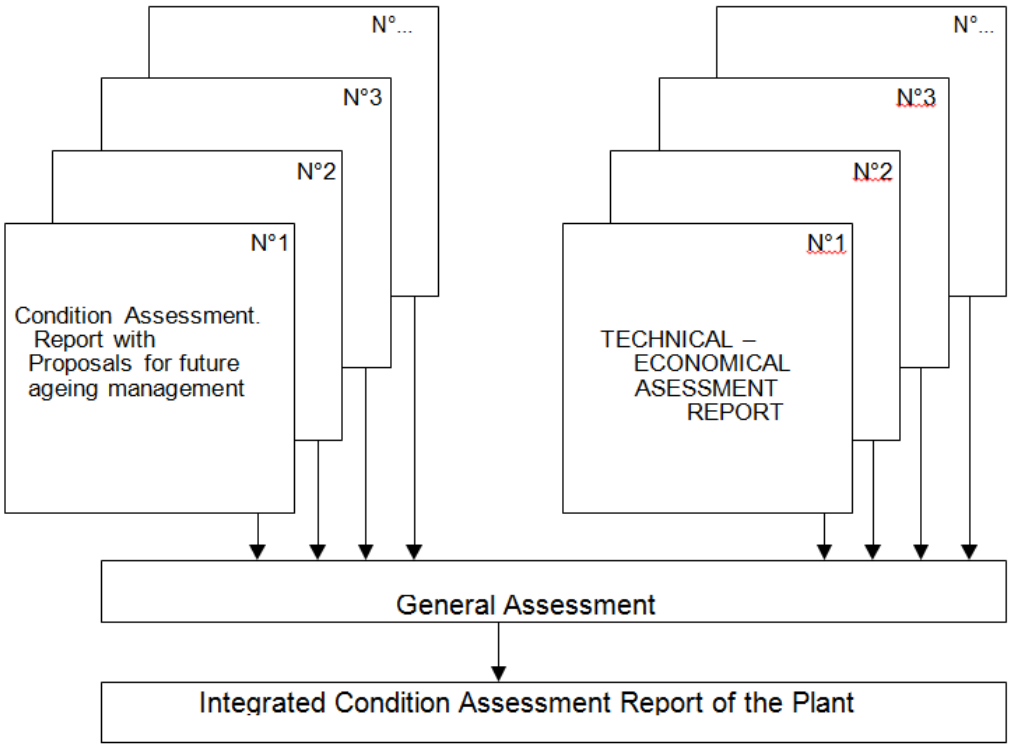

FIG.III-5. Scheme of an Integrated Condition Assessment Report of a CANDU nuclear power plant.

As particular aspects of the inspection of PLEX content, the following shall be verified:

— Existence of a list of all the programmes included in a programme called age-related degradation management programme (PGDE). These programmes shall be implemented through appropriate, formal procedures and approved by the licensee.

Some programmes that constitute the PGDE are:

— Programme for obsolescence management;
— Programme for ageing management of the reactor vessel, pressurizer and reactor vessel head;
— Programme for ageing management of the reactor internals;

— Programme for inspection of concrete structures;
— Programme for inspection of steel structures;
— Programme for polymers (coating, joints, etc.) monitoring;
— Programme for pipe fatigue monitoring;
— Programme for in-service inspection;
— Programme for boric acid leakage control;
— Programme for corrosion control.

The GALL (NUREG 1801) report may be used as a reference for the assessment and selection of SSCs monitoring and selection programmes. Tables 1 to 6 of GALL present examples of AMPs, including components, degradation mechanisms and recommendations for, respectively, primary circuit, safety systems, auxiliary systems, energy conversion systems, civil and structural components and electrical components.

— In the case of the TLAAs, it shall be verified that:
  - The tests remain valid for the validity period of the OL to be extended for the long term operation;
  - The analysis shall be projected for the end of such OL;
  - The age-related degradation effects shall be treated appropriately for the OL validity period.
— The existence of evidence that all safety relevant issues are addressed within the field of application of the PGDE shall be verified;
— The existence of evidence that the passive and durable components and relevant safety elements are considered in the programmes for control and mitigation of ageing effects shall be verified;
— The existence of criteria for establishing priorities based on the criteria of safety importance, availability and reliability of the proposed methodology shall be verified;
— The effectiveness and efficiency of PGDE activities through the creation and monitoring of indicators shall be verified. For these indicators the objectives, definition and acceptance criteria shall be defined. These indicators shall consider the start of the first events, the material operating conditions, the availability and reliability of the SSCs within the scope;
— It shall be demonstrated that the devices to identify, monitor, control, reduce or prevent ageing actions or effects are effective and sufficient to guarantee that the SSCs can achieve their design life performing their functions appropriately;
— It shall be verified whether signs that design life of the SSCs selected is consistent with the current operation mode. Furthermore, the SSCs shall be operational during the design validity and life extension (long term operation) period without the emergence of unexpected or premature deterioration;
— It shall be verified that there are devices guaranteeing the periodic reviewing of the PGDE, to demonstrate that budgets, criteria, requirements and reasons for its development are still valid and that this programme offers the efficiency and effectiveness to guarantee that SSCs selected reach the lifetime considered in the requested OL, without compromising its functioning, as presented in IAEA safety guide NS-G-2.12 [III-1].

III-2.2.2. Routine or periodic inspections of the application of IPA or PLEX during the long term operation (LT-PLiM) (Type 4 Inspections)

III-2.2.2.1. Objective of the inspection

The objectives of these inspections are:

— To verify the implementation, control updating and maintenance of the ageing management programmes (AMP) established in the IPA or PLEX, according to the LT-PLiM. This objective is described in Sections III-2.2.2.2 to III-2.2.2.12. The performance of the inspections has a once per year or every two years expected frequency;
— To continue with the verification of the condition of SSC samples from the perspective of the AMPs, including the document verification activities and the field activities (*'walkdowns'*) during the long term operation. A variety of SSCs related to the LT-PLiM shall be inspected. This objective is developed in Section III-2.2.1.13. These inspections are to be conducted more frequently (for example quarterly or biannually), with the exceptions described in III-2.2.2.13.

For both regulatory inspections during the design life (type 2 inspections) and the ones performed during the nuclear power plant's long term operation (Type 4 inspections), and provided that the operation mode allows it, for example, at cold or refuelling shutdowns, the inspections shall include SSCs within the containment or inaccessible areas during the normal operation.

Annexes I, II and III (sample verification lists or check lists) may be used to facilitate verification of the different aspects of a type 4 inspection (Sections III-2.2.2.2 to III-2.2.2.13).

III-2.2.2.2. Management and organizational aspects

The main aspects to be verified in these inspections relate to the control of any changes or modifications in the organization structure defined by the licensee regarding ageing management.

The objective of this part of the inspection is the same as the one mentioned in Section III-2.2.1.2 of this guide, while insisting on those changes or modifications that may have taken place since the last inspection and which may affect the LT-PLiM.

It shall be verified that the subsequent revisions of LT-PliM and the periodic reports of its execution present relevant information on all issues, as described in the following sections.

III-2.2.2.3. Scoping and Screening of SSCs

In type 4 inspections, the main issues to be inspected are:

— Verify whether the scope and selection of the SSCs subjected to the IPA process have been modified by addition or deletion of SSC to/from the final list verified in the type 3 inspection;
— Verify if the results of the methodology application process for new SSC that are within the scope of LT-PLiM conform to the general process initially performed;

— Verify if the exclusion of SSCs, from the final list of the scoping and screening process, is justifiable.

In the verification of the items listed above, the use of regulatory documents that are part of the conditions of the nuclear power plant OL and are used to justify changes shall be assessed.

The inspection shall focus, through the assessment of all elements that have been included or excluded from the list or by a representative sample, on verifying the results of variations at mechanical, electrical, I&C and structural component level of the nuclear power plant, even for complex systems and structures, both when it comes down to additions or deletions of SSC from the final list of the scope and selection process.

The guidelines of Section III-2.1.1.4 remain valid for the analysis of the newly incorporated SSCs, with the exceptions that may have arisen from Sections III-2.2.1.3 or III-2.2.1.13 regarding the scoping and screening of SSC (IPA or PLEX).

III-2.2.2.4. Methodological aspects related to the analysis of LT-PLiM plan

The inspection, in this case, shall address the possible changes in methodology, by identifying possible variations in the general criteria established in the LT-PliM plan, the operation modes considered, the application of new operating experience to the steps of the methodology, the modifications in reference documents and other information sources, the process for definition of degradation mechanisms and phenomena, the definition of a long term AMP and in the identification of IP.

In all of the elements above, it shall be verified that the changes made are supported so that there are no substantial changes in the analysis methodology described in the LT-PliM plan.

III-2.2.2.5. Results of LT-PLiM plan analysis

The inspection shall identify whether any changes in the results of the analysis have occurred as a consequence of modifications in the definition of materials and environments, ageing effects, degradation mechanisms and AMP, especially for the SSCs newly incorporated into the scope of the process, as defined in Section III-2.2.2.3, and applying the same techniques as the ones described in Section III-2.2.1.6, particularly, the verification of the analysis by attributes in the case of new or modified AMPs.

III-2.2.2.6. Process for identification and resolution of generic safety issues (GSI) related to long term ageing management

In the case of Type 4 inspections, this aspect could be reduced to the verification of new GSI affecting both the existing SSCs within the initial scope of IPA/PLEX, and new SSC that have been incorporated into the LT-PLiM plan.

The criteria provided in Section III-2.2.1.7 are equally applicable in this case.

III-2.2.2.7. Monitoring of IPA/PLEX improvement proposals (IPs)

It shall be verified that the licensee maintains a clear mandate for the monitoring of IPs and that the results are satisfactory. This verification should consider as a basis:

— The results obtained from inspections conducted on ageing management aspects, in which the control of the management of the improvement programme shall be verified;
— The information included in the periodic reports issued by the licensee.

Particularly, special attention shall be given to the level of progress in the implementation of the IP during the long term operation, by verifying its completion or the existence of a temporary programme with a clear timetable, for their implementation.

III-2.2.2.8. Design modifications (DM) and replacement of equipment associated with long term ageing management

The criteria for the content of the inspections to be carried out in these aspects, shown in Section III-2.2.1.9, are completely valid in this case.

Particularly, special attention shall be given to the programme for DM and replacement of the nuclear power plant's equipment in long term operation phase, by verifying the impact on the aspects of ageing has been correctly analysed and incorporated into the corresponding dossiers.

III-2.2.2.9. Review of supporting documents

In this regard, the inspection shall continue to select the documents that have been reviewed, from the updated list of supporting documentation of LT–PLiM plan developed at different stages of the process (field of application and selection, identification of ageing effects, degradation mechanisms, definition of AMPs, etc.) with the purpose of verifying:

— The causes that led to this review;
— The adequacy and coherence of the changes with the modification and its support.

In the cases where the inspector has new information on operating experience, both internal and external, or on the results of research programmes that have been conducted at the nuclear plant or other external areas, it shall be verified if the licensee has assessed their impact on it, and if this situation leads to a new review of the supporting documents involved.

III-2.2.2.10. Obsolescence management

These inspections shall verify that the licensee maintains an effective obsolescence management programme, clearly establishing the scope, objectives, responsibilities, deadlines, actions, resources and monitoring to measure its efficacy, and that the obsolescence management programmes still include:

— A systematic and periodic assessment of obsolescence;
— The strategy to be followed once an obsolescence problem has been identified for a type of component, during the long term operation.

III-2.2.2.11. Time-Limited Ageing Analysis (TLAA)

The criteria about the content of the inspections to be carried out on these aspects, shown in Section III-2.2.1.12, are completely valid in this case.

Essentially, it shall be verified that all the TLAA emerged from IPA/PLEX have been resolved, by using one of the three methods described in Section III-2.2.1.12 in the period proposed by the licensee and accepted by the RA.

It shall also be verified, from the supporting documentation of the LT-PLiM, if any new TLAA has arisen during the long term operation phase, which shall then be treated in accordance with the corresponding section described above.

III-2.2.2.12. LT-PLiM plan periodic reports

In the same way as in the case of PLiM, the LT-PLiM plan is complimented by periodical reports where the licensee describes the main activities related to ageing management performed during the previous period, by following the criteria and methodology set out in the LT-PLiM plan.

Amongst the basic issues addressed in this documents are:

— Organizational and management aspects related to the ageing management plan implemented at the facility;
— General aspects related to AMP implementation (SSC monitoring activities, IP management, etc.);
— Aspects regarding the review of the different ageing management analyses in connection with the DM undertaken at the facility, implementation of IPs, results of internal and external operating experience, research programmes, etc.;
— Progress of the activities to be performed by the licensee in accordance with the conditions of the new OL, for the long term operation period.

The LT-PLiM plan shall be fundamentally supported by the IPA/PLEX, as well as the specific documents from analyses developed during the OL renewal process, on the topics already mentioned.

III-2.2.2.13. Condition of SSCs.

The second objective of type 4 inspections is to continue verifying the situation of a sample of SSCs from the perspective of the AMPs, including documentary verification activities and field activities (*'walkdowns'*). A proper inspection SSC sample size incorporates at least one structure, one system and two components per inspection.

In general, for these inspections in the long term operation phase the guidelines and considerations established for type 2 inspections are fully applicable (Section III-2.1.2.12 of this guide). As a basic premise, it shall be taken into account that during long-term operation, ageing management is ruled by the LT- PLiM plan, instead of the PLiM plan.

In addition to the guidelines established in paragraph III-2.1.2.12, the following additional considerations shall be taken into consideration:

— Among the verifications to be carried out in regard to the periodic reports on the application of the LT-PLiM plan, with respect to the monitoring of commitments to the RA, the result of the new OL constraints shall be included, for the long term operation period;

— With respect to the verifications on the condition of SSCs, an increase in the frequency and/or the size of the sample during the long-term operation period shall be considered, depending on their potential degradation rate. Additionally, among the criteria to select an SSC sample to be inspected, the results, lessons learned and records obtained from the long term operation licensing process shall be considered.

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ANNEX IV. FORO GUIDE FOR AGEING MANAGEMENT ISSUES IN THE PERIODIC SAFETY REVIEWS OF NUCLEAR POWER PLANTS

IV-1. OBJECTIVE OF THE GUIDE

The aim of this guide is to provide guidelines to assess the documentation of the periodic safety review (PSR) of nuclear power plants, in the aspects related to ageing management of the SSCs of those facilities, as well as to the long-term operation licensing and to the long-term operation period itself.

IV-2. SCOPE OF THE GUIDE

This document is applicable to all nuclear power plants (NPPs) containing PWR, BWR, CANDU and PHWR type reactors.

IV-3. GENERAL PURPOSE OF THE PSR

The purpose of the PSR is to demonstrate that the level of compliance with the regulation framework is maintained, as well as the licensing bases fulfilled, taking into account the evolution of the regulation during the established PSR period, whether the RPS is associated with long-term operation or not.

To carry out the PSR, it is necessary to take into account the evolution derived from design changes (or design modifications, DMs), the ageing of the SSCs, the maintenance works carried out, the feedback of the internal and external operational experience, the changes on the administrative processes, as well as the radiological impact in the environment.

During the authorization process for a long-term operation, and once the design life of the facility is reached, more attention shall be paid, within the PSR, to the accumulative effects of ageing with time (time-limited ageing analysis, TLAA), to maintain, during the period of life applied for beyond the design life, the safety levels established in the licensing process.

IV-4. SPECIFIC OBJECTIVES OF PSR REGARDING AGEING MANAGEMENT

The PSR complements the continuous nuclear safety assessment of NPPs, and it provides a global and integrated view of different aspects of nuclear safety.

The specific objectives of a PSR regarding ageing are the following:

- To analyse the behaviour of the plant in different aspects of nuclear safety regarding ageing management, such as relevant data on design, manufacture, construction, testing, maintenance, environmental qualification, inspection, DMs, component failures, operational incidents, etc., in a period of time enough to provide significant information on the most important aspects related to the NPP safe operation;
- To analyse the new regulations issued by the reactor's country of origin as well as IAEA's recommendations regarding ageing management by means of an applicability analysis containing a programme for its implementation, when applicable;
- To globally assess the facility's safety conditions, by taking into account the operational experience and technological advances related to the ageing of SSCs, due either to degradation or obsolescence.

IV-5. SCOPE OF THE PSR ACTIVITIES REGARDING AGEING MANAGEMENT

The Regulatory Bodies (RBs) carry out a continuous surveillance of the safety of nuclear power plants through the inspection and assessment of activities related to ageing management. Besides, these activities allow them to be properly prepared in case the licensee files a long-term operation request.

The PSR shall integrate a document with a global assessment of the activities carried out regarding ageing and update the status of the programmes related with ageing management, as well as determine the efficiency of these programmes, representing an additional support for an eventual long-term operation request. The document shall include the updates of the regulations applicable to ageing topics as well as the programmes generated for its implementation.

The PSRs shall include the essential information on ageing management during the last years of the facility (usually, the last ten years), as well as the associated, well-defined programmes, and they shall state the improvement areas and the possible deficiencies with the aim of implementing effective corrective actions derived from the safety analyses and from the operation experience.

In the PSR, the following safety factors shall be analysed:

- Plant;
- Plant Design;
- Current condition of SSCs;
- Equipment qualification;
- Ageing;
- Safety analysis;
- Deterministic safety analysis;
- Probabilistic safety assessment (PSA);
- Hazard analysis;
- Performance and feedback of the operational experience;
- Safety performance;
- Use of own and others' experience and research findings;
- Management;
- Organization and administration;
- Procedures;
- The human factor;
- Emergency plan;
- Environment;
- Radiological impact on the environment.

Ageing management is directly or indirectly related to most of these safety factors, as explained later on.

Section IV-6 of this guide includes the conditions applicable to PSR regarding the ageing in case of a request for long-term operation.

Section IV-7 includes the basis applicable to the documentation to be filed by the operation license (OL) holder as part of the safety factors analysis regarding ageing. In general, it can be stated that ageing aspects are present one way or another in practically each one of the safety factors; in this section the specific ageing aspects applicable to each safety factor are identified.

For the PSR to be acceptable, it shall develop each of the safety factors required by following the guidelines established in this guide. Also, such guidelines can be used as an assessment guide.

IV-6. SPECIFIC CONDITIONS FOR PSR ASSOCIATED WITH THE LONG-TERM OPERATION LICENSING

PSRs associated with long-term operation authorizations shall demonstrate that age-related degradation has not diminished the fulfilment of the safety functions. They must comply with the following conditions:

- To carry out the PSR, ageing management must be regarded with the starting point in a particular period (typically, the last ten years) of the design life of the facility, as well as the programmes of activities to be developed during the long-term operation period requested;
- It shall be demonstrated through specific analyses that the adverse effects of ageing, from both degradation and obsolescence, can be managed safely during the period requested;
- There shall be a study including the quantitative time-limited degradation analyses of physical ageing, as well as the obsolescence resulting from the new advances in technology and in the operational experience;
- The improvement proposals (IP) related to ageing shall be specified, both those in process of implementation, and those arisen as a consequence of the application of the PSR, for which it should described what the improvement consists of, and the implementation date;
- The modification proposals to the technical specifications affected as a result of the long-term operation of the facility must be included;
- The modification proposals to the safety analysis report (SAR) that will be affected as a result of the long-term operation shall be included, together with the technical justification for the requested period;
- It is necessary to have a well-defined preventive and predictive maintenance programme, which shall be properly managed (for example, through the maintenance rule, MR);
- An analysis of the radiological impact on the environment shall be included for the long-term operation period requested;
- A revision of the radioactive waste management plan shall be performed, by taking into account the forecast for waste generation in the long-term operation period requested;
- It is necessary to have an updated PSA.

IV-7. REVIEW AND ANALYSIS OF THE PSR DOCUMENTATION BY SAFETY FACTORS

The revision and analysis of the facility's documentation for each safety factor, concerning ageing management, shall be carried out by following the below mentioned guidelines.

In all cases, and especially when dealing with aspects identified as directly related to ageing, the compliance with regulations and with the license conditions associated shall be verified: national regulations, regulations issued in the reactor's country of origin, IAEA's standards and recommendations, limits and conditions of the OL, compliance with all the stated on the SAR, etc. Also, the suitability of the process of implementation of new regulations must be verified.

For each of the safety factors related to ageing, it is advisable to issue an assessment report containing a comprehensive description of the specific activities carried out, along with the necessary supporting documents.

IV-7.1. Safety factor No. 1 Plant design

The aim of the review of the nuclear power plant's design is to determine the sufficiency of the design and its documentation in an assessment compared to current standards and international practices.

The problems associated with ageing management, degradation phenomena and obsolescence have an important impact on the achievement of this objective, which is why it is convenient to carry out a review and a specific analysis on this factor.

IV-7.1.1. Scope of the review and analysis

With respect to the general scope and methods utilized to develop this factor, from the ageing management point of view, the assessment must assure the appropriate execution of the following tasks, which consist of verifying that the documentation related to the design bases:

- Is updated to reflect all the DMs caused by ageing (degradation or obsolescence);
- Contains the updating of all the design documents related to the ageing management programmes (AMPs) associated with the DMs;
- Contains the updating of the administrative and technical procedures related to the ageing management programmes as a consequence of DMs;
- Contains the implementation of corrective actions related to the incidents at the nuclear power plant whose root cause is ageing (degradation or obsolescence);
- Contains the management of the condition reports derived from ageing.

IV-7.1.2. Expected results

At the end of the plant's design review process, the following is expected, regarding factors related to ageing:

- That the documentation related to the design bases has been updated to reflect the DMs derived from ageing that have been carried out at the facility;

— That the DMs have been implemented appropriately in regard to the documents and procedures related to the AMPs;
— That there is an assessment of the DMs carried out, the actions derived from their implementation, the improvements obtained, and the deficiencies detected, in the context of ageing related DMs.

IV-7.2. Safety factor No. 2 Current condition of SSCs

The aim of the review is to determine the current condition of SSCs important to safety, and if they comply with design requirements and regulations. Also, the review shall confirm that the SSCs' condition is properly documented and considered.

This objective is directly related to ageing management, and thus, it is necessary to carry out a specific review and in-depth analyses on this factor.

IV-7.2.1. Scope of the review and analysis

The assessment shall verify that the PSR demonstrates the appropriate execution of the following tasks, in regard to the current conditions of the SSCs:

— Compliance with the design bases and the original licensing terms;
— That the SAR is up to date;
— That the status of the SSCs is described;
— That the systems and their parameters are identified and verified;
— That modifications to the regulations issued in the reactor's country of origin affecting the status of the SSCs have been implemented;
— That special attention is given to SSCs belonging to the systems with a larger number of nonconformities, reports of incidents at the plant and condition reports;
— That the current status of the systems is assessed on the basis of inspections and tours;
— That the current status of the inspection programmes is reviewed;
— That degradation mechanism of the SSCs is reviewed.

IV-7.2.2. Expected results

At the end of the review process of the SSCs' current conditions, the following is expected:

— To determine when the SSCs need to be replaced because their capability to fulfil their safety function cannot be guaranteed, and to identify which components are obsolete and have no replacements, or if their functions can be performed with more advanced components;
— To review the status of the passive SSCs important to safety and designed for to not be replaced as part of a maintenance programme which shall comprise all degradation mechanisms related to ageing;
— To determine the current status of the SSCs and guarantee that they are still capable of performing the safety function with which they were designed and that they continue to comply with the design bases after the changes carried out.

IV-7.3. Safety factor No. 3 Equipment qualification

The aim of the review of the Equipment qualification factor is to verify whether the equipment important to safety, installed in severe conditions, are environmentally and seismically qualified to perform their safety function during the OL's validity period, verify that the documentation required is included, and that this process is continuous from the plant design stage to the end of the equipment's service life.

This factor can be divided into environmental qualification and seismic qualification.

This objective is directly related to ageing management, and thus, it is necessary to carry out a specific and in-depth review and analysis on this factor.

IV-7.3.1. Scope of the review and analysis

The assessment shall verify that the PSR demonstrates the appropriate execution of the following tasks, in regard to equipment qualification:

- To verify compliance with applicable regulations;
- To verify the status of the equipment through the equipment qualification programme and control procedures, both for the seismic and environmental qualifications;
- To analyse qualification reports and their supporting documents;
- To analyse the surveillance and control programme to guarantee that the ageing-caused degradation of the qualified equipment remains acceptable;
- To check the current environmental conditions and to identify high-radiation and high-temperature points, as well as the presence of humidity;
- To check the protection of qualified equipment in adverse environmental conditions;
- To verify the documentation of the equipment installed;
- To analyse the records of the qualification measures taken during the operating life of the equipment.

IV-7.3.2. Expected results

At the end of the equipment qualification review process, the following is expected:

- Having checked and demonstrated that the equipment is qualified to remain installed at the plant and that the qualification documents are integrated in a package that provides the basis to establish the required maintenance as well as the list of the necessary spare parts to preserve the qualified status of the equipment through the qualification maintenance reports;
- That the maintenance and spare parts specified are incorporated in programmes such as: qualification maintenance programme, routine maintenance programme, surveillances and spare parts programme;
- As for the seismic qualification, it shall be verified that it remains according to the original design during the life of the plant, when DMs are carried out to the seismically qualified SSCs.

IV-7.4. Safety factor No. 4 Ageing management

As this is the fundamental safety factor related to the purpose of this guide, it is divided into two sub-sections: the first is applicable to a PSR within the design life of the nuclear power

plant; and the second contains the specific elements in the event of a long-term operation request. In the second case, considerations from both sub-sections are applicable.

IV-7.4.1. Safety factor No. 4.a Ageing management during the design life

All the SSCs are subject to some form of ageing-caused degradation that can threaten the safety functions and reduce their service life and thus, the ageing of these elements (physical and due to obsolescence) shall be monitored and controlled. Both Safety Factor 2, 'Current conditions of the SSCs; and Safety Factor 3, 'Equipment qualification' review the current status of the SSCs installed in the plant; Safety Factor 4, 'Ageing', is mainly related to the SSCs' condition for the future.

The aim is to verify the existence of a plant life management (PLiM) plan that considers all the ageing related effects of the SSCs, through a set of ageing management studies, covering both the physical ageing and the obsolescence, and ensuring that those effects are controlled within defined limits, which shall be achieved with a systematic management process.

This objective is the most directly related to the purpose of this guide, and thus, it is necessary to carry out a specific review and an in-depth analysis on this factor.

IV-7.4.1.1. Scope of the review and analysis

Regarding PLiM plan, it shall be verified that the PSR proves compliance with the following aspects:

- Applicable regulations;
- The existence of a list of SSCs within the scope of the PliM plan;
- It guarantees that the records providing the support information are kept;
- That the potential ageing-caused degradation that may affect the safety functions of SSCs is assessed and documented;
- That significant ageing mechanisms of the SSCs are analysed;
- That the availability of data to assess ageing-caused degradation including the initial condition, operation and maintenance record is guaranteed;
- The effectiveness of operational programmes (among them, Pumps and Valves Programme, Vessel and Internal Surveillance Programme, Erosion-Corrosion Programme, Snubbers Programme, Water Chemistry Programme, Heat Exchangers Programme, Pressurized Container Programme, Fatigue Monitoring Programme, Buried Pipes Programme, Flexible Hose Programme, Cathodic Protection Programme, Concrete and Liner Inspection Programme, Cable Programme, Equipment Storage Programme, etc.) and maintenance programmes in ageing management of replaceable components;
- That the efficiency of the preventive and predictive maintenance carried out to the SSCs (usually, this aspect is based on MR compliance) is assessed;
- That the operating experience and the new technological advances in SSCs are analysed;
- That an obsolescence management programme is implemented.

IV-7.4.1.2. Expected results

At the end of the ageing management review process, the following is expected:

— That the status of SSCs is well defined at the facility and that systems with a higher failure incidence are identified;
— To have an appropriate PLiM plan that incorporates the identification, organization and integration of the activities that shall be covered to guarantee the equipment's reliability, and to have an appropriate procedure for the selection and scope of SSCs, which is the base for the management programme in the event of a possible long-term operation request for the facility;
— That the AMPs are aimed to prevent and mitigate the ageing mechanisms identified, including programmes of preventive and predictive maintenance, in order to avoid malfunctioning;
— That the obsolescence management programme supports the timely substitution of components when there are no spare parts in the market or when they become old-fashioned due to the evolution of technology.

IV-7.4.2. Safety factor No. 4.b Ageing management in the event of long-term operation request

This factor only applies to OL renewal applications for long-term operation, or during the long-term operation period itself. These applications must be accompanied by an ageing management plan that includes the TLAA and an obsolescence management programme as part of the IPA, in accordance with **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation.**

The aim of this revision is to guarantee that the facility has a suitable ageing programme to withstand the long-term operation, which shall constitute the long term plant life management, (LT-PLiM) plan in accordance with **Annex I FORO Guide for Regulatory Criteria on Ageing Management and Long Term Operation.**

This objective is the most directly related with the purpose of this guide, and thus, is necessary to carry out a specific revision and in-depth analysis on this factor.

IV-7.4.2.1. Scope of the review and analysis

It shall be verified that IPA and LT-PLiM plan comply with the following:

— Applicable regulations;
— That new procedures are available for the inspection, testing, surveillance and maintenance activities to be applied during the long-term operation;
— That a suitable updating mechanism of procedures is available for the new degradation effects identified as a consequence of the updating of the analyses or the application of the operating experience;
— That the obsolescence management programme systematically assesses the evolution of SSCs, as well as the applicable technological advances;
— That it guarantees that qualified personnel for the performance of the activities derived from LT-PLiM is available;
— That it includes the necessary TLAA;
— That it includes an ageing mechanisms detection and mitigation programme;
— That it manages the ageing to be applied during the long-term operation.

IV-7.4.2.2. Expected results

At the end of the ageing review process, the following is expected:

- To determine when the SSCs need to be replaced because their capability to perform their safety function cannot be guaranteed, and to determine which are the components that are obsolete and that have no spare parts available or whose function can be carried out with more advanced components;
- That the status of the facility's SSCs during the long-term operation period is well defined, and that systems with a higher failure incidence are identified;
- To have an appropriate LT-PLiM plan containing the identification, organization and integration of the activities that shall be covered to guarantee the reliability of the SSCs;
- That the AMPs are directed to prevent and mitigate the identified ageing mechanisms during the long-term operation period, including programmes of preventive and predictive maintenance, in order to avoid malfunctions of the systems;
- That the LT-PLiM plan has the necessary mechanisms so that during the long-term operation period, it assures that the assessment, revision, inspection, control and research processes are suitable to prevent any degradation caused by ageing;
- That the obsolescence management programmes have suitable procedures to systematically assess obsolescence and with suitable means to update the SSCs during the long-term operation period;
- That the TLAA carried out prove the ability of SSCs to keep carrying out their safety function after having exceeded their design life and that they continue to be valid during the requested period.

IV-7.5. Safety factor No. 5 Deterministic safety analysis

The aim of the deterministic safety analysis review is to verify whether the SAR analyses are still valid, when the following aspects have been considered: actual design of the facility; actual condition of the SSCs and their foreseen status at the end of the period covered by the PSR; current deterministic methods, current standards and knowledge. In addition, the review shall identify any weaknesses related to the use of the defence in depth concept.

This safety factor is not directly related to ageing management, so a specific analysis is not required from this point of view.

Nevertheless, in regard to ageing it is advisable to verify that the hypotheses used in the analyses as for the current and final condition of the SSCs are in accordance with the information provided by the ageing management.

IV-7.6. Safety factor No. 6 Probabilistic safety analysis (PSA)

The aim of the PSA safety factor is to determine that the scope of the existing PSA remains valid as a representative model of the plant when the following aspects have been taken into account: changes in the design and operation of the plant, new technical information and operating information.

This safety factor is not directly related to ageing management, so a specific analysis is not required from this point of view.

The only specific aspect associated with ageing that is worth verifying, is that the hypotheses regarding the condition of SSCs and any ageing-related aspect used in the PSA are in accordance with the information provided by the ageing management; and that the updating process of the PSA systematically takes into account the information provided by the ageing management.

IV-7.7. Safety factor No. 7 Hazard analysis

The aim of this safety factor is to demonstrate the appropriate protection of the nuclear power plant from internal and external threats by considering the current design of the facility, the location's characteristics, the condition of the SSCs and its expected status at the end of the period covered by the PSR, and the analytical methods and current safety standards.

This safety factor is not directly related to ageing management, so a specific analysis is not required from this point of view.

The only specific aspect associated with ageing that is worth verifying, is that the hypotheses regarding the condition of SSCs and their expected status at the end of the PSR period are in accordance with the information provided by the ageing management.

IV-7.8. Safety factor No. 8 Safety performance

The aim of this safety factor is to assess the safety performance based on the safety indicators established for the facility.

This safety factor is not directly related to ageing management, so a specific analysis is not required from the ageing management point of view.

IV-7.9. Safety factor No. 9 Use of internal and external operating experience and research findings

The lessons learned provided by the internal operating experience of the plant and the external experience of the nuclear industry help to prevent the recurrence of operational incidents and possible malfunctions of important equipment that could affect the safety of the facility. The use of this experience helps to improve equipment's performance, processes and human performance, and benefits the operation of the nuclear power plant; it also ensures that the experience of the nuclear industry incorporates preventive actions to improve the safety and reliability of the facility and to avoid similar events.

Regarding ageing management, the analysis and the use of operating experience is a very important element, so it is necessary to perform a review and specific analyses on this factor.

IV-7.9.1. Scope of the review and analysis

Regarding the general scope and methods used to develop this factor, from the ageing management point of view, the appropriate execution of the following tasks shall be verified in the assessment:

— To verify the dispositions for a feedback system of operating experience relevant to safety, in aspects related to own ageing and that of other nuclear and non-nuclear

facilities, which shall include the applicability, corrective and preventive actions, and the dissemination of research findings among the nuclear power plant's personnel;
— To verify the investigation of the operational incidents in which the ageing aspects have been the root causes or contributing factors, and their results; these analyses shall include the applicability, the definition of corrective and preventive actions, and the dissemination of the results of the root cause analyses among the nuclear power plant's personnel;
— To verify the process established to obtain the information about the conclusions of research programmes that are relevant to ageing aspects;
— Review of the effectiveness of the programmes of internal and external operating experience regarding ageing aspects.

IV-7.9.2. Expected results

At the end of the operating experience review process, the following is expected regarding ageing aspects:

— That there is an information system accessible to all personnel, which includes the databases of the internal and external operating experience information on ageing aspects, and that additional efforts are made to disseminate this information among the nuclear power plant's personnel;
— That training programmes of the operating personnel include the dissemination of the operating experience on ageing aspects;
— That as a result of the application of the operating experience, appropriate management is achieved in: 1) the updating or substitution of obsolete equipment, and 2) regarding physical ageing or obsolescence aspects: improvement of procedures, correction of deficiencies in the facility's documentation, staff training, dissemination of incidents, design changes and staff involvement;
— That the time for the implementation of corrective actions related to ageing aspects is appropriate to avoid the recurrence of events;
— That the recurrence of similar events to those occurred, related to ageing aspects, has decreased by virtue of the internal and external operating experience programmes.

IV-7.10. Safety factor No. 10 Organization and administration

The aim of this factor is to verify that the standards for a high performance in the activities related to the safe operation of the facility have been implemented in the organization. Management shall ensure that the organization is well structured with clear authority and communication lines, and that its safety policies are well implemented and followed by all its members.
These objectives are fully applicable to the ageing management activities, so a specific review and analysis on this factor should be performed.

IV-7.10.1. Scope of the review and analysis

Regarding the general scope and methods used to develop this factor, from the ageing management point of view, the assessment shall verify the proper execution of the following tasks:
— To verify the mechanisms used to establish the operation and safety objectives applicable to the AMPs;

— To analyse the functions and responsibilities of the organization responsible for ageing management, in accordance with the documentation and procedures applicable;
— To verify the formal requirements for external personnel working on ageing management activities;
— To verify the completeness of the records associated with the development of the AMPs, which shall be easily recoverable and auditable.

IV-7.10.2. Expected results

At the end of the review process of the management and organization, the following actions are expected, regarding ageing management aspects:

— That there is a specific organization responsible for the ageing management of SSCs, within the licensee's general organization, with suitable size, resources and composition to perform its functions;
— That the AMPs are subjected to a process assuring their continual improvement;
— That a programme of periodic audits to the organization responsible for ageing management is available;
— That the process to incorporate external personnel to ageing management activities is adequate and complies with the facility's quality assurance programme.

IV-7.11. Safety factor No. 11 Procedures

The aim of this factor is to verify that the plant procedures establish policies and administrative controls for a safe operation, that all activities affecting the safe operation are covered by specific procedures or instructions, assuring the compliance with the technical specifications as well as with regulatory requirements.

These objectives are applicable to the procedures associated with ageing management activities, so a specific review and analysis on this factor should be performed.

IV-7.11.1. Scope of the review and analysis

Regarding the general scope and methods used to develop this factor, from the ageing management point of view, the assessment shall verify the appropriate execution of the following tasks:

— To verify that procedures associated with the ageing management activities are operating, that they have been technically verified by qualified personnel in accordance with the requirements for quality assurance, and that their instructions are clear, understandable and detailed enough;
— To verify the suitability of the procedures associated with ageing management activities in comparison with the best practices at international level;
— To verify the suitability of the procedures associated with ageing management activities in regard to human factors;
— To verify the compliance with procedures associated with ageing management activities.
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IV-7.11.2. Expected results

At the end of the procedures review process, the following is expected, regarding ageing management:

— That ageing management activities are executed with procedures developed and approved in accordance with the facility's quality assurance programme; and that the periodic procedure reviewing and updating process is well established and controlled;
— That there are means to adapt the procedures associated with ageing management activities based on best practices, considering human factors, that feedback is properly given to the staff through training, and that continual improvement is included in the staff's performance to carry out these activities;
— That the procedures associated with the ageing management activities properly reflect the state-of-the-art in knowledge, technology, and the conclusions of the operating experience.

IV-7.12. Factor No. 12 The human factor

The aim is to determine the condition of different human aspects that may affect the safe operation of the facility. As an important part, the selection, training and improvement of the staff supporting the safe performance of the facility shall be included.

Some of these aspects (mainly, those related to the training and development of staff) are applicable to ageing management activities, so a specific review and analysis on this factor should be performed.

IV-7.12.1. Scope of the review and analysis

Regarding the general scope and methods used to carry out this factor, from the ageing management point of view, the assessment must verify the proper execution of the following tasks:

— To verify the training (initial, re-training) of the staff involved in ageing management activities;
— To verify the training of the staff involved in ageing management activities on safety culture;
— To verify the application of the operating experience feedback programmes to ageing management activities.

IV-7.12.2. Expected results

At the end of the review process of human factors, the following is expected regarding ageing management aspects:

— That the training and qualification of the staff in working areas related to ageing management is appropriate, in accordance with the responsibilities of the position and the activities to be carried out, and that there is a re-training programme;
— That the staff involved in ageing management activities is trained on safety culture.

IV-7.13. Safety factor No. 13 Emergency plan

The aim of this factor is to ensure that the organization has suitable staff, plans, facilities and equipment to face possible emergencies; that the organization itself has suitably coordinated agreements with the national and local systems, and that an integrated response is tested periodically through exercises and drills.

This safety factor is not directly related to ageing management, so a specific analysis is not required, from the ageing management point of view.

IV-7.14. Safety factor No. 14 Radiological impact on the environment

The aim is to determine that the facility has suitable programmes to monitor and assess the radiological impact on the environment, by verifying the compliance with the established regulation framework.

This safety factor is not directly related to ageing management, so a specific analysis is not required from the ageing management point of view.

However, in the case of a long-term operation application, it is necessary to assess the radiological impact on the environment, derived from the continued operation of the facility beyond its design life, taking into consideration the impact on the generation of radioactive waste, an issue that shall be addressed in the licensing process.

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