REGULATORY ASPECTS TO BE TAKEN INTO ACCOUNT FOR THE RENEWAL OF OPERATING LICENSES FOR SPANISH NUCLEAR POWER PLANTS ASSOCIATED WITH LONG-TERM OPERATION

Spanish regulation regarding ageing management, which started in the 90s taking the American regulation as a reference, has been evolving to the present. The regulation has been adapting to the Spanish nuclear fleet circumstances but also to the last international trends, for example the WENRA reference levels. Different aspects related to the long term operation licensing and the documentation required by the Spanish regulation, which are included basically in IS-22 and GS-1.10 are exposed, as well as the aspects to be taken into account to the long term operation.

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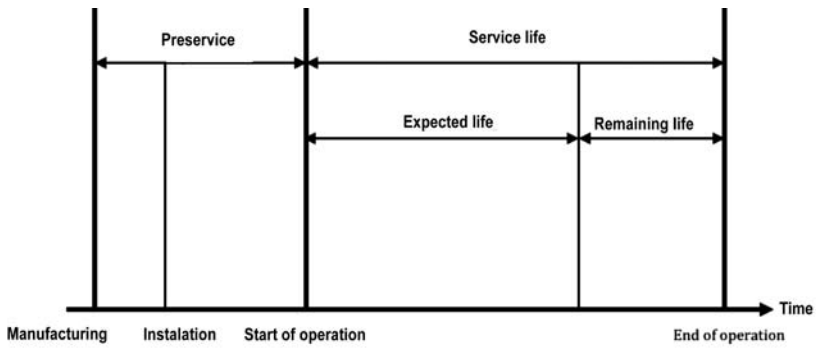
Spanish nuclear power plants currently have more than 30 years of operation, which entails the progressive aging of the structures, systems, and components (SSC) that, if not properly managed, could compromise the safety margins of the initial design, increase the risk of operating the plant, and even hinder the possibility of extending the operative or useful life of the plant beyond what is known as the design life for which it was initially planned.

Identification of the agents that accelerate the aging of the various structures, systems, and components (SSC) of the plant, as well as the degradation mechanisms that act on each one of them, is an aspect that must be considered in all stages of life of the plant, from the beginning of its commissioning (Figure 1), and not only because the plants are now closer to the end of their *design life*.

Operational experience shows that in recent years, problems of aging have been detected in both active and passive components, as well as a notable increase in problems associated with the obsolescence of spare parts for



- During the expected life of the SSC, maintenance and inspection (preventive and corrective) practices are established at the plant in order to keep their operability.
- In the eventual SSC life extension, the remaining life is evaluated, and new condition surveillance practices, aging mitigation, or SSC renewal/renovation are established.

Figure 1. Aging is inherent to all operational life cycles of the SSC.

equipment and components as a result of advancements in technology, which reaffirms the need for plants to have aging management programs, as well as technological replenishment or renewal plans for equipment that guarantee compliance with the safety functions allocated to SSCs throughout the plant's operating life.

In Spain, during the 80s and early 90s, there was no "technical-legal" normative body developed to determine the way to manage the aging of various SSC, so that when reaching 40 years of operation, the maintenance of license basis as well as the possibility of continuing operation of plants in the long term could be ensured.

Therefore, both the old Provisional Operating Permits that were issued until the mid-1990s and the current Operating Licenses for the various Spanish plants have included requirements in their *Conditions* related to the plans aimed at mitigating degradation from aging of the SSCs of plants. This is how the control of aging, as a fundamental element in ageing management, has been reflected in the regulatory requirements for operation during the first decades of the plants' lives.

In the mid-1990s, it was decided to grant Operating Permits every 10 years, following a safety review of each nuclear power plant based on the requirements of the CSN Safety Guide GS-1.10, rev. 0 (1995).

In Spain, there is currently no legal service limitation to establish the useful life of nuclear power plants, and there is currently not a fixed period established. Operating Permits are renewed periodically based on the continuous evaluation of the Nuclear Safety Council (CSN) through the Integrated System for the Supervision of Nuclear Power Plants (SISC) and Periodic Safety Reviews (PSR) every 10 years.

REQUIREMENTS FOR AGING MANAGEMENT

Currently, aging management requirements are established in:

- CSN Instruction IS-22 on safety requirements for the management of aging and long-term operation of nuclear power plants.
- Safety Guide 1.10 on periodic safety reviews for nuclear power plants.
- In addition, CSN Instruction IS-26 on basic nuclear safety requirements applicable to nuclear facilities, in Article 7.19 states that the facility must have a Life Management Plan that identifies the mechanisms of degradation of the structures, systems, and components important to safety, specifying their possible consequences and determining their expected operating life and the activities necessary to maintain their operability and reliability.

IS-22 is the fundamental standard by which the criteria for the aging management are regulated, including management for long-term operation, as this instruction is applicable to all Spanish nuclear power plants that contain one or more nuclear power reactors of the BWR and PWR types.

This IS was published in July 2009 after studies on different aging management methodologies that were already developed and partially implemented in Spanish plants, and mainly as a result of the criteria established by USNRC in Rule 10CFR54, and by the IAEA.

The essential characteristics of IS-22 are:

- It applies to the management of "physical" aging during the service life of the plant, not considering obsolescence.
- Its scope includes "passive" and "long-lived" components, since "active" components are managed through the Maintenance Rule (CSN Instruction IS-15) and other maintenance and inspection plant programs.
- It is deterministic, that is, it is not a risk-informed regulation.
- The methodological aspects for the definition of the SSC's scoping and screening, for monitoring of aging management, identification of aging mechanisms and effects, and the evaluation of maintenance practices to monitor, control, and mitigate aging, as well as the identification and resolution of Time-Limited Aging Analysis (TLAA), are based on the American regulatory guide 1.188, the NEI 95-10, and the NUREG-1801.

From the experience gained from plants applying this IS-22 since 2009, and from the results of the CSN's supervision through the biennial inspections program, the CSN has issued Revision 1 of mentioned Instruction, in which, although there were not important changes made, aspects such as the following were revised:

- Correction and improvement of the text of some requirements.
- Incorporation of new definitions.
- Modification of the structure, so that requirements are defined separately for the design life and long-term operation.
- Determination of the documentation that must be sent to the CSN by plant owners.

One aspect considered in the new revision is that the established requirements take into account the WENRA[1] reference levels (Issue I).

The requirements established by IS-22 are applicable to all operating conditions of nuclear plants, which cover from initial startup to the definitive shutdown, and therefore define common and specific requirements for each of the two phases of the useful life of a power plant:

- Design life for the facility (40 years for Spanish nuclear power plants): corresponds to the operational time of the plant, estimated or calculated in the design, during which it is expected to fulfill its function in the terms established by the license basis.
- Long-term operating period: corresponds to the operational time of the plant beyond the design life.

Within the design life, nuclear power plants must develop and implement an aging management action program that aims to achieve the original design life of the facility without impairing safety and maintaining compliance with the Current Licensing Basis. This requires analyzing all existing monitoring, control, and mitigating activities at the plant as well as determining the necessary improvements to ensure that aging mechanisms are properly managed. All of these activities must be included in the various Aging Management Programs (AMP) for each plant.

Given the long-term operation period, IS-22 requires from nuclear power plants, among others:

[1] Wenster Europe Nuclear Regulator Association

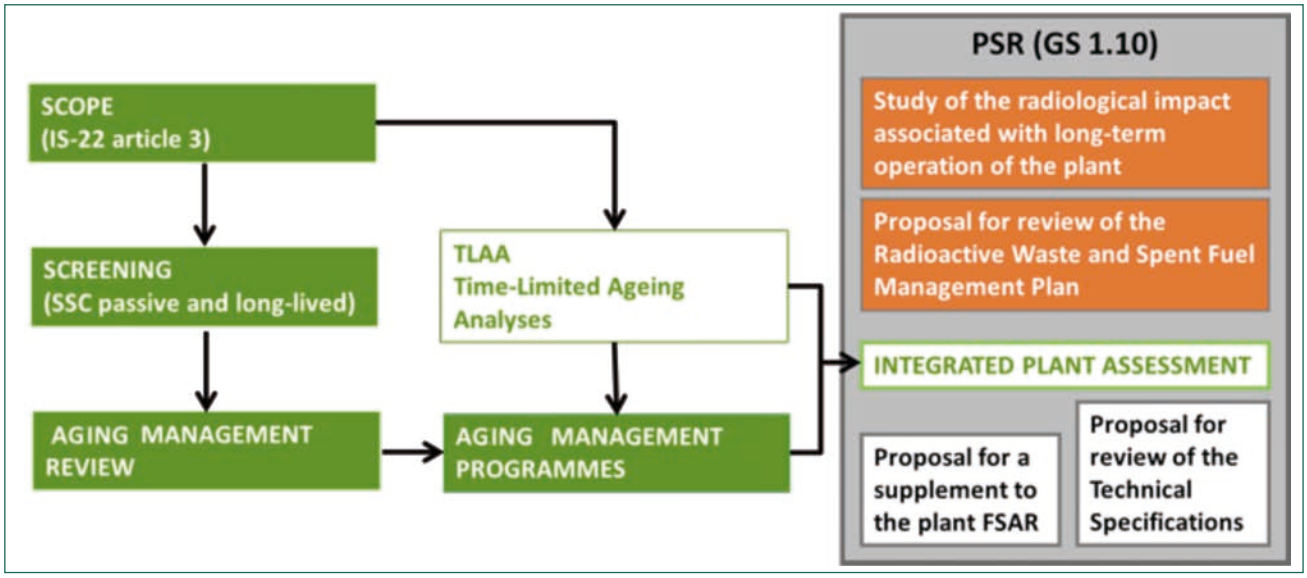


Figure 2. Aging Management Program Process, including long-term operation.

- The development of the so-called Integrated Plant Assessment (IPA), which must contain Aging Management Reviews (AMR) and the corresponding Time-Limited Aging Analyses (TLAA) (Figure 2).
- The development and implementation of a Plant Lifetime Management for Long-Term Operation (PLiM-LTO) that, supported by the conclusions from the IPA, corresponds to the program of aging management actions during the long-term operation period.

For the control of active components, and from the start of commercial operation, all plants have established programs for preventive maintenance of the SSC based on the recommendations of the manufacturers and suppliers, which have been subsequently optimized depending on internal and external operational experience, recommendations from international organizations, such as EPRI, INPO, WANO, supplier communications, etc. Preventive maintenance is the main tool for dealing with the aging problems for active equipment, and an important element of this program is understanding the useful life of equipment and components and establishing periodic replacement tasks before the end of their useful life.

In 1999, CSN Instruction IS-15 came into force for monitoring the effectiveness of maintenance at nuclear power plants (Maintenance Rule (MR)), in which a specific regulation was developed to improve maintenance programs based on monitoring SSC behavior.

The Maintenance Rule is a regulation that is currently firmly implemented in Spanish nuclear power plants and is a very effective tool for detecting aging problems in active components, but only once they manifest themselves and cause failures and/or unavailability. Through conducting root cause analysis (RCA) required in the case of exceedance of behavior criteria or failures with generic implications, and through a process of extent of cause, corrective measures must be adopted for all components with similar aging problems.

Likewise, Spanish plants have implemented other processes to control aging and obsolescence that respond to regulatory requirements (the case of the previously mentioned MR, analysis of operational experience, programs for maintaining environmental qualification, or quality assurance programs), as well as unregulated practices of the nuclear industry, as is the case for equipment reliability programs based on the INPO document, AP-913.

Additionally, according to what is established in IS-26, and in the requirements for Operating Licenses, Spanish nuclear power plants are subject to a Periodic Safety Review (PSR) every ten years, whose scope, content, documentation, and deadlines for submission are established in the CSN Safety Guide GS-1.10. Among the aspects to be reviewed according to this guide are the current or foreseeable aging processes of the SSC, the activities related to the Maintenance Rule, as well as the plans for technological updates to guarantee adequate management of obsolescence.

ASPECTS RELATED TO LONG-TERM OPERATION LICENSING

In IS-22, **"Long-Term Operation"** is defined as the continued operation of the facility, maintaining an acceptable level of safety, beyond the original design life of the facility, after conducting a safety assessment to ensure that the safety requirements applicable to the SSC of the facility are maintained. In the case of Western-designed nuclear power plants, part of the analyses that support plant safety assessment have been carried out with the hypothesis of a design life of 40 years.

The current Operating Permits for the Almaraz I and II, Vandellós II, Ascó I and II, Cofrentes and Trillo nuclear power plants expire between June 2020 and November 2024, and during the 10-year period following the next renewal of Operating Permits, they would all complete the 40-year period of their design life.

The second section of the Ministerial Orders by which the current Operating Permits were granted established that, at least three years prior to the expiration of the Operating Permits, the owner could request a new license that would be accompanied by various documentation, which would include:

(a). A PSR of the plant, based on the provisions of GS 1.10 revision 1;
(b). Analysis of the aging experienced by the SSCs, and
(c). Analysis of the experience accumulated throughout the period of validity of the Operating Permit.

Plant	Documents to be Years Prior to the Operating License Expiration	Submission of Draft PSR Documentation	Submission of Final PSR Documentation	Operating License Expiration
Almaraz	06/012017	12/31/2017	03/31/2019	06/07/2020
Ascó	10/01/2018	12/31/2018	03/31/2020	10/02/2021
Cofrentes	03/01/2018	12/31/2018	03/31/2020	03/20/2021
Trillo	11/01/2021	12/31/2021	03/31/2023	11/16/2024
Vandellós II	07/01/2017	12/31/2017	03/31/2019	07/21/2020

Table 1.

Recently, the CSN published revision 2 of the GS-1.10, based on the guide published by the IAEA, SSG-25 "Periodic Safety Review for Nuclear Power Plants," which also incorporates the reference levels from Issue P "Periodic Safety Review" from WENRA.

As a result of the revision of this GS, in June 2017, new Ministerial Orders were published modifying section two of the Orders by which the Operating Permits of nuclear power plants were renewed, incorporating the new system for the PSR established in this revision. Likewise, the documents that must accompany the request for operating license renewal for nuclear power plants that involve long-term operation, as well as the dates of submission for the same (Table 1), are identified.

In the Spanish regulatory framework, the GS from the CSN are not mandatory, but they establish acceptable methods for the CSN to meet the requirements of a mandatory standard. However, a GS can become compulsory if it is established in a mandatory document (Condition, IS, Technical Instruction or Supplementary Technical Instruction), which is the case for GS 1.10.

Revision 2 of the GS 1.10 incorporates a Section 6 relative to the additional conditions applicable to the PSR associated with request for operation licenses involving long-term operation.

For these cases, the GS establishes that three years before the expiration of the current Operating Permits, the owner must submit, along with the PSR documentation itself, the following documents taking into account the long-term operating period (Figure 2):

- IPA.
- Proposal supplement to the Final Safety Analysis Report (FSAR).
- Proposed revision of the Operating Technical Specifications.
- Study on the environmental radiological impact.
- Proposed revision of the management plan for radioactive wastes and spent fuel.

From the methodological point of view, revision 2 of the GS 1.10 modifies the way to perform the PSR, which should include a prospective analysis of the safety of the plant instead of doing so retrospectively, as was done with previous reviews. This change in methodology is considered an improvement from the nuclear safety and radiological protection perspectives since it allows for identifying modifications or improvements to maintain or increase the safety of the plant during the new period of operation.

Among the safety factors that must be reviewed in the PSR related to the aging management of active and passive components and obsolescence for the new period of operation, which includes long-term operation, include the following:

- **Safety Factor 1.** Plant Design: The objective is to verify the adequacy of the plant design against the licensing basis, standards, requirements, and national and international practices.
- **Safety Factor 2.** Status of Structures, Systems, and Components (SSC) Important to Safety: The objective is to review the current status of SSCs important to safety and to assess whether they are capable and adequate to meet design requirements, at least until the next PSR.
- **Safety Factor 3.** Equipment Rating: The objective is to verify if the rating of equipment important to safety is being preserved through an adequate program for maintenance, inspection, and testing, which provides confidence in the ability to perform its safety functions is assured.
- **Safety Factor 4.** Aging: The objective is to determine whether the plant has aging management programs that are effective and implemented, and if these are effectively managing aspects of SSC aging important to safety, so that safety functions can be carried out during the design life of the plant, or if appropriate, during long-term operation. The review of this safety factor includes programmatic and technical aspects of the aging management programs. This factor includes analysis on the obsolescence management.

In conclusion, it can be said that the licensing for long-term operation of Spanish nuclear power plants has a regulatory framework that covers not only the analysis of aspects related to the aging management of plants, but also the review of other aspects relevant to nuclear safety and radiological protection, which should allow for the identification of modifications or improvements to maintain or increase their safety during the new period of operation.

Finally, it is important to note that long-term operation (LTO) for Spanish nuclear power plants involves having a fully implemented aging management plan, as well as a systematic process for identifying and resolving Time-Limited Aging Analyses (TLAA).

It is therefore important to measure the effectiveness of the AMP implemented during the design life and have the actions specifically required for the long-term implemented, such as monitoring the condition of the tanks, or buried pipes, inspections of small pipes, and inspections of the condition of the cables and phase buses. Another specific program prior to LTO is that of "one-time inspections" to verify the effectiveness of other programs, confirming that the aging effect will not occur during long-term operation, or that it will develop so slowly that the component or structure's function will not be affected during the long-term.

Likewise, for the resolution of the TLAA, monitoring processes must be established well in advance of long-term operation in order to determine the margins of what was postulated in the design and the actual plant conditions in order to guarantee compliance with the licensing basis during the new period. Examples include the monitoring of actual transients to quantify fatigue consumption, or the monitoring of environmental conditions (mainly temperature and radiation) of rooms with important to safety equipment to check the maintenance of their environmental qualification.■