Western European

WENRA

Nuclear Regulator's Association

Pilot study on Long term operation (LTO) of nuclear power plants

Study by

WENRA Reactor Harmonization Working Group

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RHWG

Reactor Harmonization Working Group

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1. INTRODUCTION

Many operators in Europe have recently expressed their intention to operate their nuclear power plants longer than foreseen by their original design (this is referred to in this document as "long term operation" or LTO). This happens in a context where new plants are under construction in Europe and where these new plants are designed to meet higher safety levels than the existing ones.

Regulators will have to take position on the safety aspects of continued operation of nuclear power plants. To achieve better consistency between these positions, WENRA asked the Reactor harmonization working group (RHWG) to consider the issue of continued operation of existing nuclear power plants.

2. OVERVIEW OF THE SITUATION IN WENRA COUNTRIES

A questionnaire on "long term operation" was circulated inside the RHWG, from which the main conclusions are the following:

1) All WENRA member countries, except Italy and Lithuania, operate one or more reactors. About one quarter of these reactors are older than 30 years, a few of them having already exceeded 40 years of operation;
2) In most WENRA member countries, there is no reference to the lifetime of the plant in the license. However, in the safety analysis report, there are generally some design assumptions related to the lifetime of some key components, of which the reactor pressure vessel is the most important one. When such values are mentioned, they are generally between 30 and 40 years;
3) When a lifetime is specified in the license, the licensee has in general the possibility to ask for an extension, which needs to be supported by appropriate ageing management programmes and other relevant justifications;
4) In both cases (2) and (3), regulators generally give a position on continuation of operation through the process of periodic safety reviews (PSR), which periodicity is 10 years in every country;
5) In a majority of WENRA member countries, operators have already expressed their intention to operate some of their plants beyond the "design lifetime" and generally for an additional 10 to 20 years. Only a few LTO justification files have already been submitted and reviewed by the regulators;
6) As for safety, two most common limiting factors for long term operation are identified in WENRA countries:
    - ageing of key systems, structures or components (in particular, those that are not replaceable),
    - fulfilment of "modern" safety requirements.

    Other limiting factors were mentioned such as personnel competence and skills;
7) Enhancement of the safety level is generally achieved following the PSR process and not only for LTO applications. However, PSR is not considered as the only tool/occasion to enhance the safety level;
8) Replacement of components such as steam generators, vessel heads, are performed in many countries throughout the lifetime of the plant, but rarely coupled to LTO. No country reported about key components that have to be specifically replaced in link with LTO;
9) Research programmes related to ageing are common practice for all countries. However some countries initiated R&D projects specifically dedicated to LTO.

3. SUMMARY OF THE RHWG DISCUSSIONS

3.1. About the wordings "design lifetime" and "long term operation"

RHWG found useful to clarify the concepts of "design lifetime" and "long term operation".

3.1.1 Design lifetime

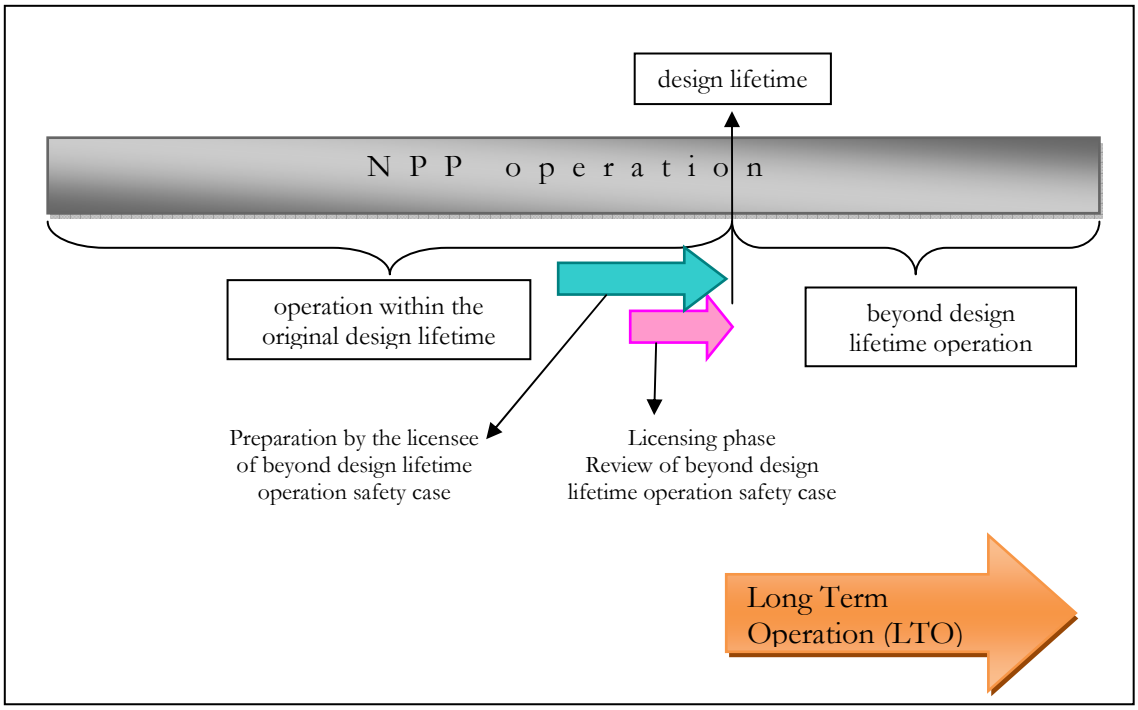
The definition of the design lifetime (or design life) can be found in the IAEA safety glossary: "***Design life*** *- The period of time during which a facility or component is expected to perform according to the technical specifications to which it was produced.*"

This definition is referring to certain values used in technical specifications. The concept seems clear regarding a specific component, but is more difficult to perceive when related to a whole facility. In most of WENRA countries, there is no reference in the license to the lifetime of the plant. However, in the safety analysis report, there are generally several design assumptions related to the lifetime of some key components that cannot be replaced, such as the reactor pressure vessel. When such values are mentioned, it is generally between 30 and 40 years. Assuming this, the RHWG has agreed on a definition that "Design lifetime of a nuclear power plant is the minimal value of lifetimes of all its non-replaceable structures, systems and components". It is to be underlined that in terms of safety, there may be no real cliff edge effect due to ageing when a nuclear power plant is being operated longer than the initial design lifetime of some of its components. For instance, the initial design lifetime of the reactor vessel may not be relevant anymore as having been re-evaluated considering actual plant operation and condition as well as current knowledge about ageing phenomena.

3.1.2 Long term operation

A definition of term Long Term Operation (LTO) can be found in IAEA Safety Report Series No 57 – Safe long term operation of nuclear power plants (2008): "***Long term operation*** *of a nuclear power plant may be defined as operation beyond an established time frame set forth by, for example, licence term, design, standards, licence and/or regulations, which has been justified by safety assessment, with consideration given to life limiting processes and features of systems, structures and components.*"

In this study, LTO has been understood as defined by the IAEA, taking as the "established timeframe" the design lifetime as understood by the RHWG (see above: design lifetime of a nuclear power plant is the minimal value of lifetimes of all its non-replaceable structures, systems and components), reminding that LTO should be in line with national regulation and nuclear power plant license.



3.2. The two aspects of "long term operation"

Continuation of operation of a nuclear power plant refers to two kinds of expectations:

- demonstrating and maintaining plant conformity to its currently applicable regulatory requirements;
- enhancing plant safety as far as reasonably practicable.

As a consequence, two reasons for limiting the lifetime of a plant to a certain value could be the following:

- it appears that at a given time, the plant will no more comply with its currently applicable regulatory requirements; or
- implementation of the safety enhancements that the regulator considers necessary for the plant to be further operated are not carried out.

RHWG considers that the first aspect (demonstrating conformity, even in the long term) is well addressed in the IAEA publications (as for example: Safety report series No. 57 – Safe long term operation of nuclear power plants or Technical report series No. 448 – Plant life management for long term operation of light water reactors). Exchange of experience feedback on the findings of conformity checks and on the acceptable methodologies to assess ageing of some key components (for instance the reactor pressure vessel) would be beneficial. This could be done under other frameworks than WENRA (for instance, bilateral relations, IAEA or NEA workshops…).

As a consequence, the discussions inside RHWG have been focused on the second aspect. New reactors will be commissioned which are designed to meet higher level of safety than the existing ones. Despite the fact that existing reactors undergo periodic safety reviews as a result of which safety enhancements are implemented, it is likely that there will remain a difference between the safety level of oldest and newest reactors (an example of a difference between existing and new reactors being the severe accident mitigation provisions – issue F in WENRA RLs). Whether this

difference is acceptable or not in the long term implies not only technical judgement but also political, economical and financial considerations which are clearly out of the scope of the RHWG work. However, the RHWG can provide indications about what is technically feasible and foster harmonisation of the regulator's positions on this issue across WENRA countries.

3.3. The role of periodic safety reviews (PSR)

In all WENRA countries, licensees are expected to perform regularly ("*at least every ten years*", WENRA RL P 1.1.) a periodic safety review of their plant, which is an opportunity to review not only the conformity of the plant, but also to identify the possible safety improvements which could be implemented[1][2][3].

Not all periodic safety reviews are related to "long term operation" as defined above: for instance the first periodic safety review of a nuclear power plant takes place well before the components have reached their envisaged design lifetime. However, all periodic safety reviews have a link with continuation of operation of the plant: on the basis of the results of the periodic safety review, regulators generally take position on the continuation of operation of the plant until the next periodic safety review.

Hence, there is a link between a regulatory position on "long term operation" of a nuclear power plant, and the orientations and results of the last periodic safety review of this plant, in particular in terms of safety expectations. As a matter of fact, most WENRA countries have made a more or less explicit link between considering LTO and performing the corresponding PSR.

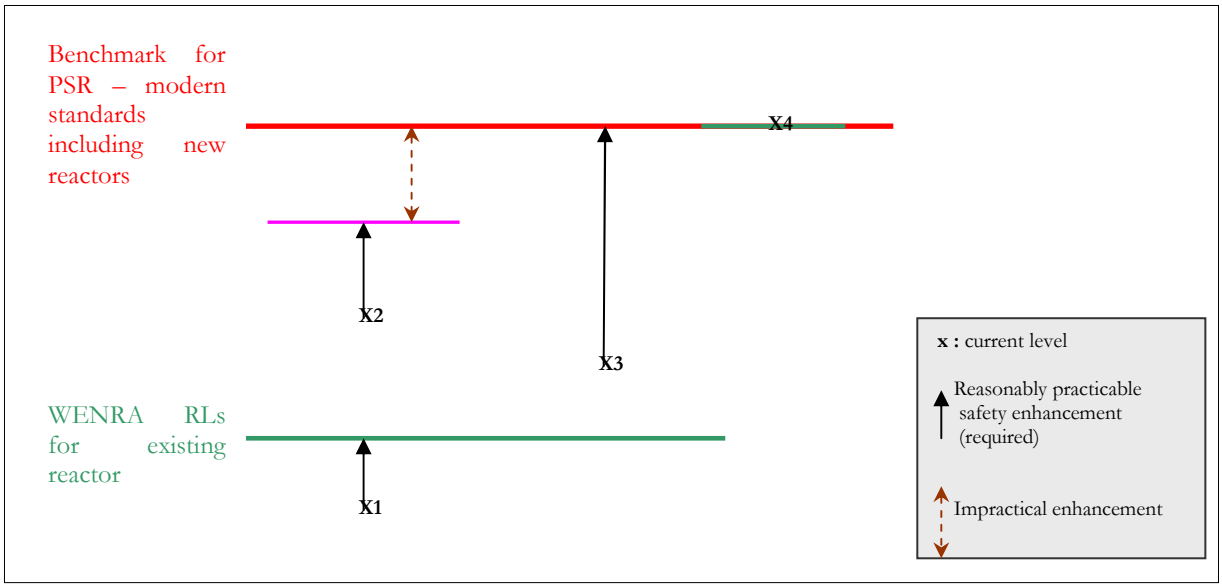
There were discussions whether a PSR related to LTO is or is not different from a "usual" PSR. The overall conclusion was that the methodology and scope are identical but some topics (e.g. ageing) would be paid a greater attention and that additional time for the review might be necessary. The forecast duration of further operation of the plant is a key parameter in the decision making process in such cases, in particular when identifying reasonably practicable enhancements. There was a general concern regarding potential consecutive applications for short periods of further operation in which some safety enhancements would not be reasonably practicable in one period but may be if the consecutive periods of time were amalgamated.

PSR scope and methodology are already described in IAEA safety standards and are not a priority topic for harmonisation inside WENRA. On the contrary, the "*applicable current safety standards and internationally recognised good practices currently available*" to be used as safety targets is a topic for harmonisation.

[1] Correcting anomalies actually improves the safety of the plant but should not strictly be considered as a "safety improvement" as it brings back the plant to its expected safety level.

[2] Safety improvements are related to plant design (plant modification) but also to operation practices (management system, operating procedures…)

[3] Improvements can also occur anytime between PSR Sometimes, it may not be acceptable to delay some safety improvements until the next PSR



The above diagram is conceptual and is intended to represent the process of comparing, for a particular feature, existing reactors with modern standards in a PSR and, where appropriate, moving towards the higher standard.

As for the horizontal lines:

- The green line represents WENRA RLs, and the "X" represent illustrative levels for a variety of safety issue;
- The red line represents modern standards, including but not restricted to WENRA's new reactor objectives, and is the bench mark for comparison in a PSR;
- The green and red lines may in some cases be at the same level (e.g. management for safety);
- The space between the green and red line represents the room for safety enhancements to be looked at.

As for the "x":

- The "X1" below the green line reflects the transition period to implement WENRA RLs allowed for in national plans for implementation;
- Those "X" below red line are safety issues that have to be compared to modern standards.
    - In some of these cases it will be reasonably practicable to enhance safety to reach the targets (redline) as in "X3";
    - In some cases, e.g. "X2", it will be reasonable to enhance safety to a level represented by the purple line, but further enhancement toward the benchmark is not reasonably practicable;
    - In other cases there may be no identifiable reasonably practicable options for enhancement;
- The "X4" represents these cases where the existing situation is already meeting the modern standard.

3.4. Applicable current safety standards and internationally recognised good practices currently available

It is stated in issue P of the WENRA Reference Levels" for existing plants, January 2008 version (P 1.1., 1.3., 1.4., 2.1.), that the periodic safety review shall "*identify and evaluate the safety significance of deviations from applicable current safety standards and internationally recognised good practices currently available*". It is also stated that "*All reasonably practicable improvement measures shall be taken by the licensee as a result of the review*".

In their position statement on safety objectives for new nuclear power plants, WENRA members have stated that "*these objectives [safety objectives for new nuclear power plants as defined in the November 2010 document] should be used as a reference for identifying reasonably practicable safety improvements for […] existing plants during periodic safety reviews*".

This notably clarifies the reference that shall be considered in the periodic safety reviews. Regarding safety improvements that will be required for long term operation, one important element in the evaluation of what is "reasonable" will be the remaining time for which the considered plant will be operated before final shutdown.

4. MAIN CONCLUSIONS AT THIS STAGE

As a result of the discussions within the RHWG, the following facts about LTO can be formulated:

- There is no real cliff edge effect neither in the level of safety or technical degradation due to ageing when reaching the original design lifetime. The licensee may be able to justify operation beyond the original design lifetime;
- Periodic safety review is an appropriate time to assess long term operation;
- Technical ageing of components is one aspect of the LTO and is covered by existing documents and international standards. This means that it is not the main focus of the harmonisation work proposed by the RHWG;
- In periodic safety reviews for existing reactors, WENRA safety objectives for new nuclear power plants and other relevant modern standards should be used as a reference with the aim of identifying reasonably practicable safety enhancements. Regarding safety enhancements that will be required for long term operation, one important element in the evaluation of what is "reasonable" will be the remaining time for which the considered plant will be operated before final shutdown.