

Report

WENRA Safety Objectives for New Nuclear Power Plants and WENRA Report on Safety of new NPP designs – RHWG position on need for revision

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01

Introduction

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[WENRA Safety Objectives for new nuclear power plants](#) have been published in 2009 followed by [WENRA statement on these objectives](#) in 2010. As almost ten years have passed since, it has been considered necessary to identify possible need for revising these objectives.

Throughout the years, RHWG has gone through many discussions on these safety objectives, and rather soon after they had been published it was seen necessary to clarify some of these in more detail to support practical approach on how to achieve the safety level set by the objectives. Based on these considerations RHWG produced the [Report on Safety of new NPP designs](#) published by WENRA in 2013. This report (Booklet) also took into account the lessons learnt from the Fukushima Daiichi accident.

Among the reasons that may be relevant to further revise the Safety Objectives or the Booklet, there may be:

- Improvements in state of knowledge or in some WENRA members safety approaches,
- More recent documents, such as SRLs, VDNS and NSD that may provide additional or different expectations.

02

Country Comments

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Based on the questionnaire, a total of 86 comments (FR 20, BE 26, AT 10, SE 8 and UK 13) were submitted on the need to revise the Safety Objectives for new NPPs and/or the Booklet. In addition two comments were provided wishing no revision to either of these documents (BG, HU). As a general view, the comments received can be grouped in several families concerning topics:

- Hazards
- Multi-unit aspects
- Practical elimination
- NSD
- Terminology (IAEA, NSD, VDNS, etc.)
- Emergency preparedness in the design
- New technologies, e.g. SMRs
- Human and organisational aspects
- Safety-security interface
- SRLs (vs. new reactors)

03 Hazards

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Several comments on the Booklet concerned hazards, especially natural hazards. The current Safety Reference Levels (SRLs) for existing reactors have introduced expectations and requirements for protecting plants against natural hazards in more detail than the Booklet. Furthermore, expectations concerning internal and external hazards more widely are being introduced in the SRLs to be published in near future. This raises the question of writing more detailed requirements on protection against hazards also for new reactor designs. However, it is generally expected that new reactors follow SRLs when those set more detailed requirements than those derived from the Safety Objectives or those mentioned in the Booklet. Therefore, the update of neither the Safety Objectives nor the Booklet is seen necessary.

04 Multi-unit aspects

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Multi-unit aspects are not included in detail in the Booklet. The Safety Objectives are general enough, so that they need no modification from this perspective. Multi-unit aspects are, however, introduced in the SRLs for existing reactors, and the most significant safety considerations are included there. Deployment of SMRs may introduce new issues concerning multi-unit aspects, but based on the views above there is no need for revision of the Safety Objectives or the Booklet from this perspective at the moment. SMRs are discussed in Section 8.

05 Practical elimination

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Practical Elimination has been under discussion after the publishing of the Booklet, and the topic has been further elaborated in a dedicated report by the RHWG. Some of the statements in the Booklet may be seen as ambiguous, and these are dealt in more detail in the new report. As the specific report on Practical Elimination goes deeper into the topic there is no need to introduce the same level of detail in the Booklet. Furthermore, no such discrepancies have been found that would require update. The new dedicated report can rather be considered as an extension of the topic to the Booklet. Thus, there is no need to modify either the Safety Objectives or the Booklet.

06 Nuclear Safety Directive

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The NSD gives the high-level requirements on the safety of the new reactors, namely those for which a construction licence is granted for the first time after 14 August 2014. Also expectation is given on how these high-level requirements should be met in operating reactors. The WENRA SRLs were revised in 2014, taking into account similar lessons that are reflected in the NSD directive. A new version is foreseen on short term for issues concerning the hazards. The following tries to explain how the WENRA documents and requirements cover and are consistent with the NSD.

Article 8a 1. (a) and (b)

- Covered by O1, O2, and O3

Article 8a 2. (a)

- Covered by WENRA statement on Safety Objectives

Article 8a 2. (b)

- This has been introduced in the WENRA SRLs 2014 (SRL A2.3 & Issue P on PSR) and this concept is also detailed in the WENRA Guidance – Article 8a of the EU Nuclear Safety Directive: “Timely Implementation of Reasonably Practicable Safety Improvements to Existing Nuclear Power Plants” June 2017.

Article 8b 1. (a)

- Booklet & Issue TU (issue T on natural hazards was introduced in SRLs in 2014 and will be complemented with unintended man-made hazards in Issue TU).

Article 8b 1. (b) and (c)

- O1

Article 8b 1. (d)

- O2

Article 8b 1. (e)

- O3

Article 8b 1. (f) and Article 8d

- SRLs (Issue R)

Article 8b 2. (a), (b), (c) and (d)

- SRLs (issues A, C, J, and D)

Article 8c (a)

- This requirement of the NSD is related to the regulatory process (“any grant of a licence”), which is not addressed in the WENRA SRLs as they are requirements for the utilities. However, the content of the safety demonstration and requirements for operation are covered by O1, O2, O3, and the SRLs.

Article 8c (b)

- SRLs (Issue P)

The safety goals of the NSD (i.e. Article 8a 1.) are effectively covered in the Safety Objectives. The topic of "implementation at the plants" and contents of other articles of the NSD are covered by the SRLs and other WENRA documents. Thus there is no need to revise either the Safety Objectives or the Booklet.

07

Terminology (IAEA, NSD, VDNS, etc.) and editorial comments

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The analysis of other more recent documents generally shows that they take into account insights of WENRA works (WENRA works may even be a basis for these documents) rather than there is a need for WENRA to take their insights into account.

The documents under discussion have taken into account necessary dependencies available at the time of writing the documents, especially IAEA Safety Standards, and they do not necessarily follow the most recent evolution of terminology in IAEA publications. It is considered that updating the Safety Objectives or the Booklet due to changes of the terminology in other documents is not worthwhile as the study does not show real conflicts that could possibly lead to confusion.

It is also noted that some of the wording in the Safety Objectives is not necessarily optimal, but the main ideas behind goals are clear enough. Therefore there is no need to start polishing the statements. Introducing minor changes might cause a lot of work without any safety impact.

08

Technology neutrality (new technologies)

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In general, the Safety Objectives for new NPPs can be considered goal-oriented, and as such neutral from the technology utilised. There are, however, some aspects that would need more attention, as the new technology may differ significantly e.g. from the LWR technology currently in use. Therefore, some of the approaches may show inapplicable to the new designs.

- O1 – O4: The implementation of Defence-in-Depth (DiD) may differ from that what has been considered when writing the Safety Objectives and that is implicitly expected from the design.
- O2&O3: Core melt may not be applicable to some of the designs, as the core is already during normal power operation in molten form (e.g. molten salt reactors).
- O3: For some new designs it may be possible to show that core melt itself cannot occur, and this may affect the expectations on dealing with situations of core melt accidents (Level 4 of DiD).
- O7: The operation of the reactors may differ significantly from those of large power reactors if e.g. Small Modular Reactors would be widely utilised. Arrangements between the designer, owner, licensee, operator and other stakeholders (e.g. module fabricator or fuel vendor) may differ from current practices. The new technologies may consider utilising more standardised components and larger plant parts manufactured far away from the plant. This may result in very different practices from those utilised now, and this could affect the expectations and requirements set on different organisations participating in manufacture, construction and installation.

These new technologies are unlikely to be widely installed in near future, say within a few years, but it would be worthwhile to reconsider some of the aspects in more detail in order not to hinder the development of advanced technologies which may offer nuclear safety benefits. These considerations would require more insight on the topics, and therefore it could be beneficial to try to develop some ideas within a separate group considering e.g. Small Modular Reactors (SMRs). The outcome of this work may show some need to modify the Safety Objectives in future, and therefore the conclusion on whether modifications are needed or not, should remain open at the moment from this perspective.

09

Human and organisational aspects

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Human and organisational aspects are not covered in detail in the Booklet, although the topic is considered very important for safety. The Booklet, however, does not try to touch all of the safety significant aspects in a detailed way, but rather tries to develop some of the most complex issues to explain the expectations on those. Human and organisational aspects are included in all of the activities taking care of safety in an integrated way, and some topics may require further considerations when e.g. new technologies are studied.

One such topic is the awareness on safety in organisations other than the licensee "involved in siting, design, construction, commissioning, operation and decommissioning of new plants" as stated in Safety Objective O7 "Leadership and management for safety". This aspect is also brought up in the EC Nuclear Safety Directive 2014/87/EURATOM Article 6 (a) saying

the prime responsibility for the nuclear safety of a nuclear installation rests with the licence holder. That responsibility cannot be delegated and includes responsibility for the activities of contractors and sub-contractors whose activities might affect the nuclear safety of a nuclear installation.

Although Objective O7 itself is open for different kind of solutions for a licensee to carry its prime responsibility, there may be some underlying assumptions how the existing NPPs and utilities have organised themselves and their activities. The differences that the technology may bring up should be identified and necessary changes to the expectations introduced, but this remains to be identified by the SMR work, as stated in the previous section. Therefore, from the human and organisational aspects point of view only, there is no need to modify either the Safety Objectives or the Booklet.

10 Safety-security interface

Safety and security interfaces are an important aspect that needs to be taken into account when designing new NPPs and it has been identified in O5. This topic as such has not been paid much attention in the Booklet, but there is an on-going WENRA and ENSRA activity that tries to identify the interfaces in the current SRLs for existing reactors. Therefore it is not advisable to start a new activity within WENRA to cover the same topic. The topic may be developed in more detail later, if seen necessary based on the outcome of this work.

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Overall conclusions

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RHWG has not found a real need to modify either the Safety Objectives or the Booklet. Although some potential needs to update the existing Safety Objectives in order to clarify terminology or some statements in the objectives have been identified, possible modifications are not considered to have such safety impact that the work would be worthwhile. Furthermore, the Booklet gives detailed explanations on some of the Safety Objectives and they are still considered as valid. For some topics not covered in the Booklet it could be beneficial to provide more detailed explanation on the expectations as separate reports, rather than revise the Booklet by widening the scope and covering the areas identified. Trying to develop a single document to cover all aspects every time a new issue comes up may require a lot of work and it is not seen as efficient way of working.

The identified aspects to the more detailed expectations are not advised to be implemented in the Booklet or make modifications to the existing Safety Objectives too hastily. Updating the objectives for minor changes would not seem a reasonable allocation of work, and would have only slight effect on safety of NPPs. Modifying the Safety Objectives would result in a need to modify the reports that explain the expectations in more detail, and therefore the whole work can be more easily carried out by introducing the missing topics in separate reports, if seen to be necessary. This is the procedure that has been applied e.g. to further elaborate Practical Elimination.

The existing Safety Objectives have been considered as good high-level objectives that are flexible enough to provide expectations to many different designs due to their nature of being technologically neutral in most cases. In spite of that, when developing the Safety Objectives, there has been some expectations of near future development of reactor designs, and therefore some aspects may have a strong basis in the technology currently utilised, e.g. large power reactors. The recent technological development, e.g. with Small Modular Reactors (SMRs), has brought up the possibility of using inherent safety features to reduce the number of systems important to safety in some levels of DiD that are seen as necessary for current technologies. The suggested operation of these reactors may differ significantly from the current technologies. These aspects have not been considered in this evaluation in detail, and thus it is suggested that a separate process would be initiated, whether they can affect the Safety Objectives as they are written now.

In comparison with the SRLs, the Booklet has a different status. It is not intended to be a collection of strict requirements, but rather explain the philosophy and thinking behind the Safety Objectives, when they were written, and give expectations on some of the issues brought up in the Safety Objectives. Within this context, it has not been developed as a living document that should be updated regularly.

Based on the views above it can be concluded that:

- There is no need to revise the Safety Objectives;
- The revision of the Booklet is not advised: if some topics need a further development, the preferred way is to develop new dedicated reports.

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Way Forward

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The identified topics of SMRs and SRLs for new reactors need further consideration in order to make the decision on how to take into account possible changes in the WENRA documents.

RHWG already initiated a subgroup to evaluate the possible impacts of SMRs on the Safety Objectives. This WG may take into account insights of different new approaches in the reactor design that could have impact on the Safety Objectives and consequently the expectations on the design.

The potential need to develop SRL for new reactors, instead of modifying the current Safety Objectives should be evaluated. Within this work the need of developing SRLs for new reactors need to be discussed, including the consideration between

- the possible two sets of SRLs, one for existing reactors one for new reactors, or
- only one set of SRLs written to be applied to new reactors as such, and as far as applicable to existing reactors.

RHWG has agreed on review of the existing SRLs, and the evaluation of the need for SRLs for new reactors could be incorporated in this task. It is expected that new reactors follow the SRLs established for existing reactors, as well. In this context, it should be made clear what is meant with "existing reactors" and "new reactors" or should some other terminology be used. Currently the Safety Objectives indicate that existing reactors are those in operation before 2010 and the NSD those that have received construction license before 14 August 2014.

As a conclusion, the RHWG considers that the Safety Objectives are still adequate, and there is no need to revise either the Safety Objectives or the Booklet at this point.

Annex 1: WENRA Safety Objectives for New Nuclear Power Plants

Compared to currently operating nuclear power plants, WENRA expects new nuclear power plants to be designed, sited, constructed, commissioned and operated with the objectives of:

O1. Normal operation, abnormal events and prevention of accidents

- reducing the frequencies of abnormal events by enhancing plant capability to stay within normal operation.
- reducing the potential for escalation to accident situations by enhancing plant capability to control abnormal events.

O2. Accidents without core melt

- ensuring that accidents without core melt induce¹ no off-site radiological impact or only minor radiological impact (in particular, no necessity of iodine prophylaxis, sheltering nor evacuation²).
- reducing, as far as reasonably achievable,
 - the core damage frequency taking into account all types of credible hazards and failures and credible combinations of events;
 - the releases of radioactive material from all sources.
- providing due consideration to siting and design to reduce the impact of external hazards and malevolent acts.

¹ In a deterministic and conservative approach with respect to the evaluation of radiological consequences.

² However, restriction of food consumption could be needed in some scenarios.

03. Accidents with core melt

- reducing potential radioactive releases to the environment from accidents with core melt³, also in the long term⁴, by following the qualitative criteria below:
 - accidents with core melt which would lead to early⁵ or large⁶ releases have to be practically eliminated⁷;
 - for accidents with core melt that have not been practically eliminated, design provisions have to be taken so that only limited protective measures in area and time are needed for the public (no permanent relocation, no need for emergency evacuation outside the immediate vicinity of the plant, limited sheltering, no long term restrictions in food consumption) and that sufficient time is available to implement these measures.

04. Independence between all levels of defence-in-depth

- enhancing the effectiveness of the independence between all levels of defence-in-depth, in particular through diversity provisions (in addition to the strengthening of each of these levels separately as addressed in the previous three objectives), to provide as far as reasonably achievable an overall reinforcement of defence-in-depth.

05. Safety and security interfaces

- ensuring that safety measures and security measures are designed and implemented in an integrated manner. Synergies between safety and security enhancements should be sought.

³ For new plants, the scope of the safety demonstration has to cover all risks induced by the nuclear fuel, even when stored in the fuel pool. Hence, core melt accidents (severe accidents) have to be considered when the core is in the reactor, but also when the whole core or a large part of the core is unloaded and stored in the fuel pool. It has to be shown that such accident scenarios are either practically eliminated or prevented and mitigated.

⁴ Long term: considering the time over which the safety functions need to be maintained. It could be months or years, depending on the accident scenario.

⁵ Early releases: situations that would require off-site emergency measures but with insufficient time to implement them.

⁶ Large releases: situations that would require protective measures for the public that could not be limited in area or time.

⁷ In this context, the possibility of certain conditions occurring is considered to have been practically eliminated if it is physically impossible for the conditions to occur or if the conditions can be considered with a high degree of confidence to be extremely unlikely to arise (from IAEA NSG1.10).

O6. Radiation protection and waste management

- reducing as far as reasonably achievable by design provisions, for all operating states, decommissioning and dismantling activities:
 - individual and collective doses for workers;
 - radioactive discharges to the environment;
 - quantity and activity of radioactive waste.

O7. Leadership and management for safety

- ensuring effective management for safety from the design stage. This implies that the licensee:
 - establishes effective leadership and management for safety over the entire new plant project and has sufficient in house technical and financial resources to fulfil its prime responsibility in safety;
 - ensures that all other organizations involved in siting, design, construction, commissioning, operation and decommissioning of new plants demonstrate awareness among the staff of the nuclear safety issues associated with their work and their role in ensuring safety.

Annex 2: COUNCIL DIRECTIVE 2014/87/EURATOM of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations

Article 8a

Nuclear safety objective for nuclear installations

1. Member States shall ensure that the national nuclear safety framework requires that nuclear installations are designed, sited, constructed, commissioned, operated and decommissioned with the objective of preventing accidents and, should an accident occur, mitigating its consequences and avoiding:
 - (a) early radioactive releases that would require off-site emergency measures but with insufficient time to implement them;
 - (b) large radioactive releases that would require protective measures that could not be limited in area or time.
2. Member States shall ensure that the national framework requires that the objective set out in paragraph 1:
 - (a) applies to nuclear installations for which a construction licence is granted for the first time after 14 August 2014;
 - (b) is used as a reference for the timely implementation of reasonably practicable safety improvements to existing nuclear installations, including in the framework of the periodic safety reviews as defined in Article 8c(b).

Article 8b

Implementation of the nuclear safety objective for nuclear installations

1. In order to achieve the nuclear safety objective set out in Article 8a, Member States shall ensure that the national framework requires that where defence-in-depth applies, it shall be applied to ensure that:
 - (a) the impact of extreme external natural and unintended man-made hazards is minimised;
 - (b) abnormal operation and failures are prevented;
 - (c) abnormal operation is controlled and failures are detected;
 - (d) accidents within the design basis are controlled;
 - (e) severe conditions are controlled, including prevention of accidents progression and mitigation of the consequences of severe accidents;
 - (f) organisational structures according to Article 8d(1) are in place.

2. In order to achieve the nuclear safety objective set out in Article 8a, Member States shall ensure that the national framework requires that the competent regulatory authority and the licence holder take measures to promote and enhance an effective nuclear safety culture. Those measures include in particular:
 - (a) management systems which give due priority to nuclear safety and promote, at all levels of staff and management, the ability to question the effective delivery of relevant safety principles and practices, and to report in a timely manner on safety issues, in accordance with Article 6(d);
 - (b) arrangements by the licence holder to register, evaluate and document internal and external safety significant operating experience;
 - (c) the obligation of the licence holder to report events with a potential impact on nuclear safety to the competent regulatory authority; and,
 - (d) arrangements for education and training, in accordance with Article 7.

Article 8c

Initial assessment and periodic safety reviews

Member States shall ensure that the national framework requires that:

- (a) any grant of a licence to construct a nuclear installation or operate a nuclear installation, is based upon an appropriate site and installation-specific assessment, comprising a nuclear safety demonstration with respect to the national nuclear safety requirements based on the objective set in Article 8a;
- (b) the licence holder under the regulatory control of the competent regulatory authority, re-assesses systematically and regularly, at least every 10 years, the safety of the nuclear installation as laid down in Article 6(c). That safety reassessment aims at ensuring compliance with the current design basis and identifies further safety improvements by taking into account ageing issues, operational experience, most recent research results and developments in international standards, using as a reference the objective set in Article 8a.

Article 8d

On-site emergency preparedness and response

1. Without prejudice to the provisions of the Directive 2013/59/Euratom, Member States shall ensure that the national framework requires that an organisational structure for on-site emergency preparedness and response is established with a clear allocation of responsibilities and coordination between the licence holder, and competent authorities and organisations, taking into account all phases of an emergency.
2. Member States shall ensure that there is consistency and continuity between the on-site emergency preparedness and response arrangements required by the national framework and other emergency preparedness and response arrangements required under Directive 2013/59/Euratom.'