WENRA WGRR

Guidance Document

Issue O: Probabilistic Safety Assessment of Existing Research Reactors

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Guidance for the WENRA Safety Reference Levels for existing Research Reactors.

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Introduction

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The purpose of this Guidance is to provide explanations of the intent of the Safety Reference Level O1.1, requiring *to consider* the development of a PSA. In addition, this Guidance provides information on the WENRA expectations how to develop and use the PSA, once it has been decided. Furthermore, it is important to recognize differences in national regulations and in research reactor designs when using this document.

01
Consideration of developing a PSA

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O1.1 A PSA shall be considered as a complementary tool to deterministic method to determine significant contributing factors to the radiation risks arising from the research reactor and to evaluate the extent[1] to which the overall design is well balanced.

PSAs are required and used at NPPs for a wide scope of applications such as licensing applications, optimization of operations and judgement of modifications. In relation to the general requirements on continuous improvement, periodic safety review and the requirements of the Euratom directive on nuclear safety, a PSA may be a useful tool to support the identification of potential safety improvements. A recent WENRA inquiry has revealed that there is a clear trend in the development, application and use of PSA for research reactors, mostly the larger existing and new research reactors. For existing research reactors they are mostly introduced on a voluntary basis or related to a periodic safety review. However, some countries are not using PSA for research reactors at all. The aim of including this single reference level on PSA is to stimulate consideration of the development and application of a PSA for existing research reactors, in the spirit of continuous improvement and harmonization WENRA. It could be used at least for two purposes: identify weaknesses in the design and verify if the design is well balanced, i.e. the design should not be dominated by single type of failures.

At least a PSA L1 should be considered. The effort to develop a PSA L1 depends amongst other things on the size of the research reactor and its complexity. One of the greater benefits of a PSA L1 project is indeed the significant increase of knowledge of the research reactors' design, layout, strong and weak points, even if the reliability data are not as comprehensive as for NPPs. Once a PSA is available it can be used to identify reasonable improvements, but also to avoid unnecessary investments.

The key factors that determine a successful PSA project are:

[1] The development of a PSA is encouraged, as it may contribute to enhancing the safety of the research reactor. The PSA is indeed complementary to the deterministic approach, e.g. identifying ways of improvements.

- availability of up to date information and documentation about the research reactor design, layout and safety analyses;
- availability of sufficient experts in the research reactor organization dealing with the developers of the PSA;
- sufficiently reliable failure data of relevant components (experience shows that these data might well be available in other nuclear facilities or through the conventional industry);
- capability of performing support studies (evaluation of mitigation success criteria for a given accident sequence or operator available time);
- availability of methods and approaches to evaluate the human factor for inclusion into PSA;
- application of a stepwise approach for the development (e.g. first internal events/hazards, later external hazards):

In the following chapters the WENRA expectations are given for the development, once a decision has been taken to develop a PSA.

More detailed guidance on the development and use of PSA may be found in the following documents:

- IAEA Safety Standards Series No. SSG-3, IAEA, (2010) for Development and application of PSA-L1 in NPPs,
- IAEA-TECDOC-1511, (2006), Determining the quality of PSA for applications in NPPs,
- IAEA-TECDOC-400, (1987), Probabilistic Safety Assessment for Research Reactors,
- IAEA-TECDOC-517, (1989), Application of Probabilistic Safety Assessment to Research Reactors,
- IAEA-TECDOC-930, (1997), Generic Component Reliability Data for Research Reactor PSA
- Several other TECDOCs discuss specific applications for NPP,
- Issue O of the WENRA Safety Reference Levels for Existing Reactors.

02
Scope and content of a PSA

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Once decided, at least the level 1 PSA for a specific research reactor should be developed. This includes consideration of all relevant[2] operational states, covering fuel in the core and in the spent fuel storage and all relevant internal and external initiating events. External hazards should be included as far as practicable, taking into account the current state of science and technology.

PSA includes relevant dependencies.[3] The Level 1 PSA contains appropriate sensitivity and uncertainty analyses. PSA is based on a realistic modelling of the research reactor response, using data relevant for the design and operation, and taking into account human action in consistency with the operating and accident procedures. All the assumptions considered in the PSA, especially the system mission times, are justified.

Human reliability analysis is performed, taking into account the factors which can influence the performance of research reactor staff in all research reactor states.

03
Quality of PSA

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PSA is performed, documented, and maintained according to requirements of the management system of the licensee.

PSA is performed according to an up to date proven methodology, taking into account international experience currently available.

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[2] Relevant means that the considered initiating event (or operational state) is relevant for the risk as determined with the PSA. Adequate screening criteria shall be defined in order to identify the relevant initiating events and operational states.

[3] Such as functional dependencies, area dependencies (based on the physical location of the components, systems and structures) and other common cause failures. Site aspects and interaction with other units could also be relevant.

04
Potential use of PSA

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PSA could be used to:

- support safety management;
- identify the need for modifications to the research reactor and its operating and accident procedures, if applicable, in order to reduce the risk from the research reactor;
- assess the overall risk from the research reactor, to demonstrate that a balanced design has been achieved, and to provide confidence that there are no "cliff-edge effects";
- assess the adequacy of research reactor modifications, changes to operational limits and conditions and procedures;
- assess the significance of operational occurrences;
- provide insights as input to development and validation of the safety significant training programmes of the licensee, including training of control room operators;
- to ensure the items are included in the verification and test programmes if they contribute significantly to risk;
- to optimize maintenance and periodic testing programmes.

In those cases, the role of PSA in the process should be defined and documented.

05
Demands and conditions on the use of PSA.

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The limitations of PSA should be understood, recognized and taken into account in all its use. The adequacy of a particular PSA application should be checked with respect to these limitations.

When PSA is used, for evaluating or changing the requirements on periodic testing and allowed outage time for a system or a component, all relevant items, including states of systems and components and safety functions they participate in, should be included in the analysis.

The operability of components that have been found by PSA to be important to safety should be ensured and their role should be recorded in the Safety Analysis Report (SAR).

The PSA should be kept up to date in conformity with modifications of the research reactor.