SPESS F
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1. IDENTIFICATION

Document Category: Specific Safety Guide

Working ID: DS508, rev. 1

Proposed Title: Assessment of the Application of General Requirements for Design of Nuclear Power Plants

Proposed Action: New document

Review Committee(s) or Group: NUSSC, NSGC

Technical Officer(s): Javier Yllera (NSNI/SAS)

2. BACKGROUND

Over the last decade the safety standards publications on nuclear power plant design safety and safety assessment have experienced substantial modifications. The publication of SSR 2/1, "Safety of Nuclear Power Plants: Design" in 2012 and its subsequent revision after the Fukushima Daiichi accident, introduced relevant changes in the design requirements of nuclear power plants. Such changes include requirements for strengthening the implementation of defence in depth and practically eliminating plant event sequences that could result in high radiation doses or radioactive releases. GSR Part 4, Safety Assessment for Activities and Facilities, was issued in 2008 and was also revised after the Fukushima Daiichi accident. GSR Part 4 is a generic standard and is intended to cover the whole lifecycle of all type of facilities and activities. However, the requirements for safety assessment are not sufficiently detailed for the safety assessment of NPPs. Therefore, three safety guides for the deterministic and probabilistic safety analysis of nuclear power plants were developed thereafter.

A proposal for a new safety guide on safety assessment of NPPs to complement the existing ones was submitted to the last NUSSC meeting in June 2017. NUSSC concluded that the scope of the safety guide that was proposed included many diverse topics and was too ambitious. Therefore, NUSSC expressed its interest and support for the development of a new safety guide with a reduced scope particularly addressing design extension conditions and the practical elimination of early radioactive releases or large radioactive releases. This revised DPP is proposing a new safety guide in accordance with the decision of NUSSC.

3. JUSTIFICATION FOR THE PRODUCTION OF THE SAFETY GUIDE

As a result of the changes introduced in the new safety requirements for nuclear power plant design and safety assessment, overarching guidance is needed on the application of some requirements. Guidance is needed in particular in relation to the implementation of some important changes in SSR

2/1, such as the inclusion of the so called “design extension conditions” in the plant design envelope as well as the need to demonstrate that event sequences leading to large radioactive releases or early radioactive releases have to be practically eliminated. Other relevant changes made in SSR 2/1 after the Fukushima Daiichi accident include requirements for strengthening the implementation of the defence in depth concept. Since by their nature these changes of the requirements are cross cutting, recommendations for meeting them are better reflected in a single safety guide.

The two latest IAEA Topical Issues Conferences (2013 and 2017) confirmed the importance of the effective implementation of defence in depth for both existing and new plants, as well as the need for further guidance on it also related to the achievement and demonstration of the practical elimination of early radioactive releases or large radioactive releases. Some insights on such topics obtained in the development of TECDOC 1791, “Considerations on the Application of the IAEA Safety Requirements for the Design of Nuclear Power Plants”, could be used for the development of the safety guide.

4. OBJECTIVE

The objective of this safety guide is to provide recommendations on the assessment of the implementation of selected requirements in SSR 2/1, Rev.1, and GSR Part 4, Rev. 1, relating to defence in depth and practical elimination of event sequences leading to early radioactive releases or large radioactive releases.

5. SCOPE

The scope of this safety guide will cover the assessment of the defence in depth implementation and the practical elimination of event sequences leading to early radioactive releases or large radioactive releases. Special attention will be given to the assessment of design extension conditions and the requirement for independence of safety systems from safety features for design extension conditions (especially features for mitigating the consequences of accidents involving the melting of fuel).

The most relevant requirements for this purpose in GSR Part 4 include the requirements:

- 7: Assessment of safety functions and
- 13: Assessment of defence in depth

together with their corresponding requirements for NPP design in SSR 2/1, rev. 1:

- 4: Fundamental safety functions
- 7: Application of defence in depth

The application of these requirements is closely related to other requirements for general plant design in SSR 2/1, rev. 1, such as:

- 13: Categories of plant states
- 16: Postulated initiating events
- 19: Design basis accidents
- 20: Design extension conditions and
- 21: Physical separation and independence of safety systems

which will be taken into account in the safety guide in as much as they are related to the implementation and assessment of defence in depth and safety functions, with specific focus on the

aspects of design extension conditions and practical elimination event sequences that would lead an early radioactive release or a large radioactive release. It is not the purpose of this safety guide to provide recommendations for the full implementation of these requirements. Further guidance on these requirements can be found in the safety guides listed in section 6 on design of nuclear power plant systems and deterministic safety analysis. This safety guide, currently under revision, addresses the deterministic analysis for all plant states, including design extension conditions as well the deterministic analysis in relation to the demonstration of practical elimination of event sequences that can lead to an early radioactive releases or large radioactive releases. It is expected that when the safety guides on probabilistic safety assessment will be revised, these topics will be also considered in them.

The assessment of safety provisions related to the 5th level of defence in depth, i.e. for emergency preparedness and response, will be outside of the scope of the safety guide. A preliminary table of contents is provided in section 7.

6. PLACE IN THE OVERALL STRUCTURE OF THE RELEVANT SAFETY SERIES AND INTERFACES WITH EXISTING AND/OR PLANNED PUBLICATIONS

The safety guide will be a specific guide for nuclear power plants related to the following IAEA Safety Standards and Nuclear Security Series (this should not be regarded as an exclusive or exhaustive list):

Safety Standard Series

1. Fundamental Safety Principles. Safety Fundamentals No. SF-1, Vienna (2006)[FR]
2. Safety of Nuclear Power Plants: Design, Specific Safety Requirements No. SSR-2/1 (Rev.1), Vienna (2016);
3. Safety Assessment of Facilities and Activities, General Safety Requirements No. GSR Part 4 (Rev.1), Vienna (2016);
4. DS449: Format and Content of the Safety Analysis Report for Nuclear Installations (revision of GS-G-4.1, 2004)
5. SSG-30 Safety Classification of Structures, Systems and Components in Nuclear Power Plants (2014)
6. SSG-39 Design of Instrumentation and Control Systems for Nuclear Power Plants (2016)
7. DS487: Design of Fuel Handling and Storage Systems for Nuclear Power Plants (revision of NS-G-1.4, 2003)
8. DS498: External Events Excluding Earthquakes in the Design of Nuclear Installation (Revision of NS-G-1.5, 2003)
9. DS490: Seismic Design and Qualification for Nuclear Power Plants (Revision of NS-G-1.6, 2003)
10. DS494: Protection against Internal Hazards in the Design of Nuclear Power Plants, revision and combination of NS-G-1.7 and NS-G-1.11 (Revision and combination of NS-G-1.7 and NS-G-1.11, 2004)
11. SSG-34 Design of Electrical Power Systems for Nuclear Power Plants (2016)
12. DS481: Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants (revision of NS-G-1.9, 2004)
13. DS482: Design of Reactor Containment Structure and Systems for Nuclear Power Plants (revision of NS-G-1.10, 2004)
14. DS488: Design of the Reactor Core for Nuclear Power Plants (Revision of NS-G-1.12, 2005)

15. NS-G-1.13 Radiation Protection Aspects of Design for Nuclear Power Plants (2005)
16. DS491: Deterministic Safety Analysis for Nuclear Power Plants (revision of SSG-2, 2009)
17. SSG-3: Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (2010)
18. SSG-4: Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (2010)

Nuclear Security Series

1. NSS13: Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities
2. NSS4: Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage [FR]

In addition, the IAEA TECDOC-1791 (2016): "Considerations on the Application of the IAEA Safety Requirements for the Design of Nuclear Power Plants" is a relevant publication that provides insights on some topics that are also within the scope of the safety guide and will be taken into account for its development.

7. OVERVIEW

The new safety guide will be structured in line with the current structure and content of specific safety guides and a scope as indicated above. The detailed table of contents will be defined during the development of the guide. Preliminarily, the following structure is proposed for the safety guide:

1. INTRODUCTION
2. OBJECTIVES AND SCOPE
3. STRUCTURE
4. ASSESSMENT OF DiD IMPLEMENTATION
   - DiD implementation strategy for new NPPs (general part)
     - Objective of levels of DiD and plant states
     - Assessment of effectiveness and reliability of the design provisions:
       - Identification of safety functions and challenging mechanisms (e.g. PIEs, sequences, hazards and phenomena)
       - Identification of safety provisions for the applicable plant state
       - Deterministic assessment (demonstration of compliance with applicable requirements supported by the complete safety analysis)
       - PSA (assessment of reliability of the design provisions)
       - Integration of deterministic and probabilistic assessment

   - Assessment of safety provisions for different plant states
     - Assessment of safety provisions for normal operation (all modes)
     - Assessment of safety provisions for abnormal operation
     - Assessment of provision for DBA
     - Assessment of provisions for DEC without significant fuel degradation
     - Assessment of provisions for DEC with core melt
   - Assessment of independence between safety provisions for different plant states
     - Functional independence between different plant states
     - Assessment of common cause failures and defensive mechanisms, including use of PSA for identification and assessment of dependencies

5. **PRACTICAL ELIMINATION OF EVENT SEQUENCES THAT WOULD LEAD TO EARLY RADIOACTIVE RELEASES OR LARGE RADIOACTIVE RELEASES**
   - Introduction, general aspects and interpretation of the concept for new NPPs
   - Identification of sequences to be practically eliminated
   - Demonstration of practical elimination (general aspects)
     - Physical impossibility
     - Very low likelihood with high confidence in the assessment
   - Elements of demonstration

6. REFERENCES,
7. ANNEX I: Assessment of practical elimination of specific common cases

     - Catastrophic break of major RCS equipment
     - Prompt reactivity accidents
     - Direct containment heating

- Hydrogen explosions
- Steam explosions
- Severe accidents with containment by-pass, including open containment
- Containment boundary melt through
- Practical elimination of severe accidents at the spent fuel pool
- (Other cases for non LWR reactors that could be identified)

8. PRODUCTION SCHEDULE:

Provisional schedule for preparation of the safety guide, outlining realistic expected dates for each step:

	A*	B*	C*
STEP 1: Preparing a DPP	DONE	DONE	DONE
STEP 2: Approval of DPP by the Coordination Committee	September 2017		
STEP 3: Approval of DPP by the relevant review Committees	November 2017		
STEP 4: Approval of DPP by the CSS	April 2018		
STEP 5: Preparing the draft a TM is not expected to be organized	January 2018		
STEP 6: Approval of draft by the Coordination Committee	3Q 2018		
STEP 7: Approval by the relevant review Committees for submission to Member States for comments	4Q 2018		
STEP 8: Soliciting comments by Member States	1Q 2019		
STEP 9: Addressing comments by Member States	2Q 2019		
STEP 10: Approval of the revised draft by the Coordination Committee Review in NS-SSCS	3Q 2019		
STEP 11: Approval by the relevant review Committees	4Q 2019		
STEP 12: Endorsement by the CSS	1Q 2020		
STEP 13: Establishment by the Publications Committee and/or Board of Governors (for SF and SR only))			
STEP 14: Target publication date	4Q 2020		

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- *Column A for Safety Fundamentals, Safety Requirements and Safety Guides.*
- *Column B for Nuclear Security Series publications noting that for Technical Guides a fast track may be proposed and justified for approval by the NSGC at step 3. If approved, the draft will not be subject to the steps 4 to 10 and, be provided at step 11 to the NSGC to take note of it before its publication*
- *Column C for TECDOCs, safety reports and other publications*

9. RESOURCES

It is envisaged that the development of the document will entail the organization of two consultancy meetings for the production of the draft and two further consultancy meetings for addressing comments from MSs, NUSSC and CSS.