

Document Preparation Profile (DPP)

Version 4 dated 11 October 2023

1. IDENTIFICATION

Document Category: Specific Safety Guide

Working ID: DS552

Proposed Title: Safety Evaluation of Nuclear Installations for External Events Excluding Earthquakes

Proposed Action: New Safety Guide

Review Committee(s) or Group: NUSSC, WASSC

Technical Officer(s): Michael Salmon (NSNI/EESS), Mazhar Mahmood (NSNI/EESS)

2. BACKGROUND

IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles, provides safety principles that constitute the basis for establishing safety requirements to achieve the fundamental safety objective of protecting people and the environment from harmful effects of ionizing radiation. Safety requirements for design, assessment and periodic review of safety against external hazards are established in IAEA Safety Standards Series Nos GSR Part 4 (Rev. 1), Safety Assessment for Nuclear Facilities and Activities; SSR-1, Site Evaluation of Nuclear Installations; SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design; SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation; SSR-3, Safety of Research Reactors and SSR-4, Safety of Nuclear Fuel Cycles Facilities. Meeting the safety requirements established in these IAEA standards will ensure that the fundamental safety objective of SF-1 is achieved. SSR-2/1 (Rev. 1) requires that a comprehensive safety assessment be carried out for design of nuclear power plants. The safety assessment should investigate the capability of the design to withstand postulated initiating events and accidents – including those triggered by external hazards. Requirement 17 of SSR-2/1 (Rev. 1) requires that items important to safety be designed for protection against internal and external hazards. The external hazards include seismic, meteorological, hydrological, volcanic hazards, and human induced events.

Recommendations on seismic safety assessment are provided in IAEA Safety Standards Series No. SSG-89, Evaluation of Seismic Safety for Nuclear Installations, and practical guidance is provided in Safety Report No. 103, Methodologies for Seismic Safety Evaluation of Existing Nuclear Installations. A new safety guide that provides recommendations on conducting safety evaluations of nuclear installations in relation to external events other than earthquakes is therefore needed. This new publication will provide recommendations on methodologies for the safety assessment for external events excluding earthquakes, validated by the current international state of the practice and intended to meet the requirements for nuclear facilities established in SSR-1, SSR-2/1 (Rev. 1), SSR-3 and SSR-4.

3. JUSTIFICATION FOR THE PRODUCTION OF THE PUBLICATION

The recommendations currently provided in the IAEA safety standards relating to the safety evaluation of nuclear installations apply mainly to seismic safety. A safety guide which provides recommendations for meeting the requirements promulgated in safety standards for external events other than earthquakes is therefore needed. This new safety guide will provide recommendations on the safety evaluation of nuclear installations in relation to external events such as high wind and tornadoes, flooding, extreme temperatures, volcanic activity, and accidental human induced external events as well as combinations of external events hazards.

The need for such a safety guide has also been communicated to the External Events Safety Section (EESS) by both donor and recipient Member States at Technical Meetings and in consultancies. This safety guide will complement existing safety standards on external events. It will also present methods for the use of a graded approach which may be applicable to nuclear installations other than power plants.

Additionally, this safety guide will provide guidance which can be used to address the impact of climate change on meteorological and hydrological hazards.

A gap analysis is attached.

4. OBJECTIVE

The objective of this safety guide is to provide recommendations on how to comply with the applicable safety requirements of GSR Part (Rev. 1), SSR-1 (e.g., Requirements 7, 17-24), SSR 2/1 (Rev. 1), (e.g. Requirements 10, 17, 19 & 20), SSR-2/2 (e.g. Requirements 6 and 8), SSR-3 (e.g. Requirements 5, 18-20 & 22) and SSR-4 (e.g. Requirement 5, 16, 20 & 21), regarding the safety evaluation of nuclear installations for external events excluding earthquakes. This safety guide is intended for use by regulatory bodies, designers of nuclear installations, operating organizations, advisory bodies and technical support organizations.

5. SCOPE

This new safety guide will provide specific recommendations on the conduct of safety assessments for both new and existing nuclear installations in relation to external events other than earthquakes. This publication will appropriately reflect lessons learned based on applied practices following the Great East Japan Earthquake and Tsunami of 2011 and the subsequent Fukushima Daichi accident. In addition, the use of a graded approach to safety evaluation of nuclear installations other than nuclear power plants in relation to external hazards excluding earthquakes will be addressed.

This publication will cover both new and existing nuclear installations as defined in the IAEA Nuclear Safety and Security Glossary, 2022 (Interim) Edition, Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. The safety guide will address the need for maintenance of the safety assessment of the nuclear installation throughout its life cycles. Re-evaluation of the safety assessment may be triggered by new information, advanced methodologies, or regulatory requirements. The methodologies developed for the safety evaluation of nuclear power plants in relation to external events are also applicable to other nuclear installations through the use of a graded approach. This safety guide will address external events in the safety evaluation of nuclear installations taking into account all operational and accidental conditions for those external events outlined in IAEA Safety Standards Series No. SSG-68, Design of Nuclear Installations Against External Events Excluding Earthquakes to include natural external events (e.g. floods, extreme meteorological conditions, extreme winds, volcanism), human induced external events (e.g. aircraft crashes, external explosions, external fire) and combinations of external hazards. This safety guide is

complementary to SSG-68. SSG-68 is focused on design of installations for external events, whereas this new safety guide will focus on safety assessments and not design.

Recommendations on the conduct of safety assessments which address of malevolent acts will not be provided in the proposed publication.

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

This publication will potentially interface with the following IAEA Safety Standards Series publications:

- International Atomic Energy Agency, Fundamental Safety Principles, IAEA Safety Fundamentals No. SF-1, IAEA, Vienna (2006).
- International Atomic Energy Agency, Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), IAEA, Vienna (2016).
- International Atomic Energy Agency, Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSR Part 5, IAEA, Vienna (2009).
- International Atomic Energy Agency, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSR-1, IAEA, Vienna (2019).
- International Atomic Energy Agency, Safety of Nuclear Power Plants: Design, IAEA Safety Standards Series No. SSR-2/1 (Rev. 1), IAEA, Vienna (2016).
- International Atomic Energy Agency, Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No. SSR-2/2, Rev. 1, IAEA, Vienna (2016).
- International Atomic Energy Agency, “Safety of Research Reactors,” IAEA Safety Standards Series No. SSR-3, IAEA, Vienna (2016).
- International Atomic Energy Agency, Safety of Nuclear Fuel Cycle Facilities, IAEA Safety Standards Series No. SSR-4, IAEA, Vienna (2017).
- International Atomic Energy Agency, Design of Nuclear Installations Against External Events Excluding Earthquakes, IAEA Safety Standards Series No. SSG-68, IAEA, Vienna (2021).
- International Atomic Energy Agency, Seismic Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-9, Rev. 1, IAEA, Vienna (2022)
- International Atomic Energy Agency, Hazards Associated with Human Induced External Events in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-79, IAEA, Vienna (2023).
- International Atomic Energy Agency, Investigation of Site Characteristics and Evaluation of Radiation Risks to the Public and the Environment in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. DS529, IAEA, Vienna (in preparation).
- International Atomic Energy Agency, Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Plants, Safety Guide, IAEA Safety Standards Series No. NS-G-3.6, IAEA, Vienna (2005).
- International Atomic Energy Agency, Volcanic Hazards in Site Evaluation for Nuclear Installations, Safety Guide, IAEA Safety Standards Series No. SSG-21, IAEA, Vienna (2012).
- International Atomic Energy Agency, Meteorological and Hydrological Hazards and Site Evaluation of Nuclear Installations, IAEA Safety Standards Series No. SSG-18, IAEA, Vienna (2011).

- International Atomic Energy Agency, Site Survey and Site Selection for Nuclear Installations, IAEA Safety Standards Series No. SSG-35, IAEA, Vienna (2015).
- International Atomic Energy Agency, Deterministic Safety Analysis for Nuclear Power Plants, IAEA Safety Standards Series No. SSG-2, IAEA, Vienna (2019).
- International Atomic Energy Agency, Protection Against Internal and External Hazards in the Operation of Nuclear Power Plants, IAEA Safety Standards Series No. SSG-77, IAEA, Vienna (2022).
- International Atomic Energy Agency, Safety Aspects of Nuclear Power Plants in Human Induced External Events; Assessment of Structures, IAEA Safety Reports Series No. 87, IAEA, Vienna (2018).
- International Atomic Energy Agency, Consideration of External Hazards in Probabilistic Safety Assessment for Single Unit and Multi-Unit Nuclear Power Plants, IAEA Safety Reports Series No. 92, IAEA, Vienna (2018).
- International Atomic Energy Agency, Evaluation of Seismic Safety for Nuclear Installations, IAEA Safety Standards Series No. SSG-89, IAEA, Vienna (in preparation).
- International Atomic Energy Agency, Evaluation of Seismic Safety for Nuclear Installations, IAEA Safety Reports Series No. 103, IAEA, Vienna (2020).
- International Atomic Energy Agency, Assessment of Vulnerabilities of Operating Nuclear Power Plants to Extreme External Events, IAEA-TECDOC-1834, IAEA, Vienna (2017).
- International Atomic Energy Agency, Storage of Spent Nuclear Fuel, IAEA Safety Standards Series No. SSG-15 (Rev. 1), IAEA, Vienna (2020).
- International Atomic Energy Agency, The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste, IAEA Safety Standards Series GSG-3, IAEA, Vienna (2017).

All other sections of the Division of Nuclear Installation Safety (NSNI) — namely the Operational Safety Section (OSS), Regulatory Activities Section (RAS), Research Reactor Safety Section (RRSS) and Safety Assessment Section (SAS) — were consulted for the development of this DPP. These sections will also be consulted as part of the drafting process.

7. OVERVIEW

The new safety guide is proposed to include the following contents:

1. Introduction: This section is the introduction and provides purpose, background, scope and plan of development for the remainder of the document. It follows the standard content and format found in IEAE safety guide series.
2. General Considerations for Safety Evaluation for External Events: This section provides general considerations and an overview of the overall safety objectives for all nuclear installations. It also provides reference to related safety guides, technical documents, and other related material that the user may find useful.
3. Selection of the Safety Assessment Methodology: This section introduces both deterministic (safety margin) and probabilistic approaches. It discusses the advantages and disadvantages of each methodology. It includes a discussion on which methods are applicable to certain external events. For example, it is very difficult to assign an annual frequency of exceedance to human induced events.
4. Identification of Site-Specific External Events Hazards – This section includes an overview of the type of external hazards that the document addresses.

5. Screening of External Events Hazards : This section includes a methodology by which hazards may be screened (excluded) from further evaluations.
6. Data Collection and Investigations – This section presents methodology to be used in defining the hazard in probabilistic deterministic terms.
7. Evaluation of External Events Hazards Safety for Nuclear Power Plants – This section describes techniques to be used for safety evaluations aimed at nuclear power plants. It will cover techniques for assessment of external hazards in relation to safety assessment, development of reference level parameters, determination of responses, determination of high confidence of low probability of failure (HCLPF) capacities, implementation of probabilistic safety assessment (PSA) etc.
8. Evaluation of External Events Hazards Safety for Nuclear Installations other than Nuclear Power plants using a Graded Approach: This section describes techniques which may be used to evaluation the safety of other installations such as waste processing facilities, fuel fabrication facilities, and other facilities which pose a radiological risk. It highlights the need for a graded approach that is commensurate with the radiological risk.
9. Use of External Events Hazards Safety Evaluation Results for Nuclear Installations . This section describes how the results of the safety evaluation may be used to reduce risk and perhaps to support regulatory requirements.
10. Management System for Safety Evaluation for Nuclear Installations – This section describes the requirements that are needed in a management system to be used in the safety evaluation. The management system may also be graded in accordance with the radiological risk of the nuclear installation.

Appendices – as needed

References

Annexes – as needed

8. PRODUCTION SCHEDULE: Provisional schedule for preparation of the publication, outlining realistic expected dates for each step.

	A*
STEP 1: Preparing a DPP	DONE
STEP 2: Internal review of the DPP (Approval by the Coordination Committee)	June 2023
STEP 3: Review of the DPP by the review Committee(s) (Approval by review Committee(s))	November 2023
STEP 4: Review of the DPP by the CSS (approval by CSS) or information of the CSS on the DPP	April 2024
STEP 5: Preparing the draft publication	Q1 2024
STEP 6: First internal review of the draft publication (Approval by the Coordination Committee)	Q2 2024
STEP 7: First review of the draft publication by the review Committee(s) (Approval for submission to Member States for comments)	Q3 2024
STEP 8: Soliciting comments by Member States	Q4 2024
STEP 9: Addressing comments by Member States	Q1 2025
STEP 10: Second internal review of the draft publication (Approval by the Coordination Committee)	Q2 2025
STEP 11: Second review of the draft publication by the review Committee(s) (Approval of the draft)	Q4 2025
STEP 12: (For Safety Standards) Editing of the draft publication in MTCD and endorsement of the draft publication by the CSS (For nuclear security guidance) DDG's decision on whether additional consultation is needed, establishment by the Publications Committee and editing	Q2 2026
STEP 13: Approval by the Board of Governors (for SF and SR only)	-
STEP 14: Target publication date	Q4 2026

9. RESOURCES

30 staff-weeks of IAEA professional staff plus 50,000 Euro for a Technical Meeting (approximately 60 participants for 5 days) and 30,000 Euros for 3 consultancy meetings (5 participants for 5 days in each meeting).

ANNEX – Gap Analysis Report

A Tool for SEED Mission Assessment (ToSMA) was used to analyse the effectiveness of the Site and External Events Design (SEED) missions conducted by the External Events Safety Section (EESS) between the years 2000 and 2020 in relation to lessons learned, suggestions for improvement and feedback from the Member States. Based on statistical data provided in the ToSMA system, EESS conducted 220 SEED missions between 2000 and 2020 covering 188 nuclear power plants and 27 research reactors in 44 different Member States. In addition to the SEED mission reports, incident (event) reports accumulated in the International Reporting System for Operating Experience (IRS), Fuel Incident Notification and Analysis System (FINAS), and Incident Reporting System for Research Reactors (IRSRR) databases for more than 20 years are another major source of feedback regarding external hazards.

An analysis of the event databases showed that external hazards significantly affected nuclear installations, as shown in Figure A.1 below. This Figure shows that significant numbers of external events other than earthquakes were reported at nuclear installation sites in different Member States, which clearly indicates a need for safety evaluation of nuclear installations in relation to external events. Although the number of events is not directly correlated to the risk, it does suggest that the events are frequent and some guidance on treatment of those events is needed.

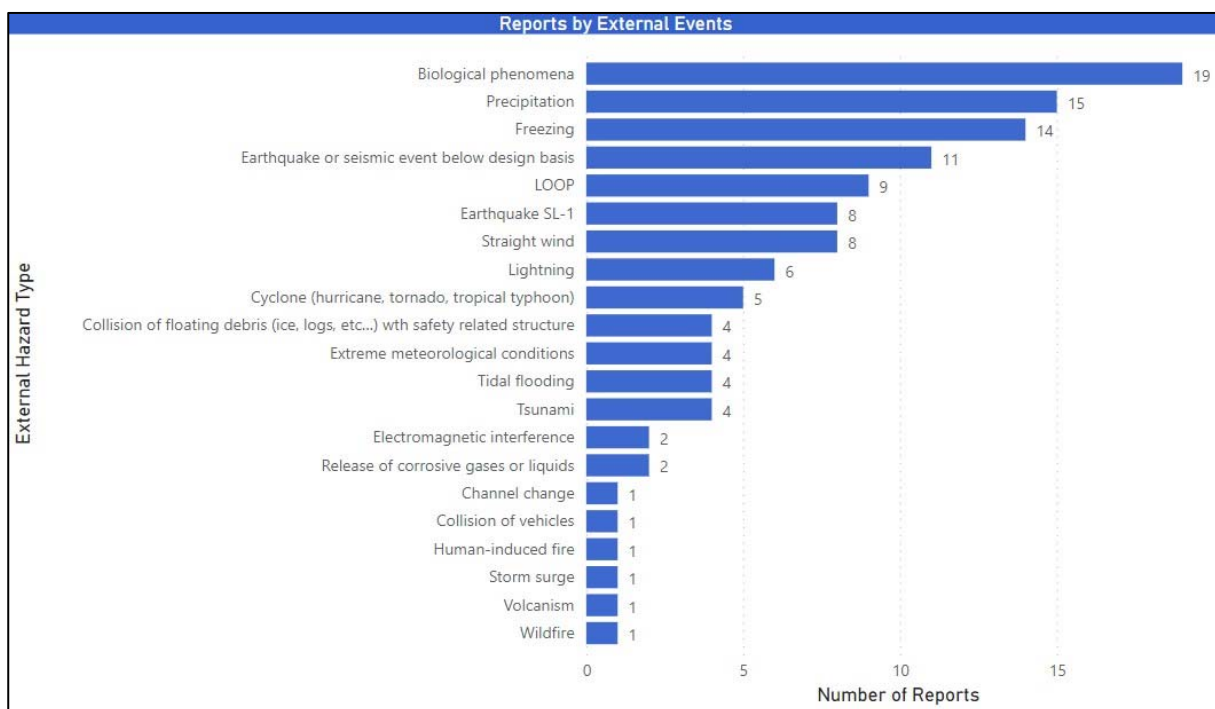


Figure A.1. Number of Events in the TOSMA Databases related to External Events

Moreover, the ToSMA analysis of SEED mission reports highlighted a significant gap between the number of recommendations issued by experts during the SEED missions in relation to safety assessment, and the number of available Safety Guides which are expected to support those recommendations.

There may be a gap in guidance on the evaluation of plant response to events more severe than those considered for design, derived from the site-specific hazard assessment. assessment of the safety margin for beyond design basis events other than earthquakes, which was extensively carried out by almost all Member States in the aftermath of the Fukushima Daiichi accident. The so-called “stress test”

programmes revealed many hazards related to computational and engineering issues that are not currently covered in any Safety Guide with enough detail to support the follow-up of those programmes.

In conclusion, there is a significant gap in IAEA publications in guidance on the safety evaluation of nuclear installations for external events, in particular in relation to beyond design basis scenarios. Currently, two publications are available related to the seismic safety evaluation of nuclear installations (SSG-89, Safety Reports Series No. 103) whose scope is limited to earthquake related hazards. A publication providing recommendations to Member States on safety evaluation for of nuclear installations in relation to external events other than earthquakes is clearly needed.

Some Member States provided encouraging feedback on the development of a publication related to this topic during the Annual Meeting of the Extrabudgetary Programme of the External Events Safety Section held on 4-7 October 2022, and during the Technical Meeting on Optimization of Protection of Advanced Reactors against External Hazards held on 28 November to 2 December 2022.