Document Preparation Profile (DPP)
Version 5 dated 17 May 2023

1. IDENTIFICATION

Document Category or batch of publications to be revised in a concomitant manner

Specific Safety Guides

Working ID: **DS541**

Proposed Title: **Assessment of Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations**

Proposed Action: **Revision of Specific Safety Guide SSG-18, Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations (2011)**

Review Committee(s) or Group: **NUSSC, WASSC**

External co-sponsoring Organisation: WMO

Technical Officer(s): **Kazuyuki Nagasawa (EESS/NSNI)**

2. BACKGROUND

This revised Specific Safety Guide will supersede the IAEA Specific Safety Guide SSG-18, "Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations", which has been extensively used in IAEA safety review services since its publication. SSG-18 was published in 2011 to supplement and provide recommendations on meeting the requirements of the IAEA Safety Requirements publication NS-R-3 on "Site Evaluation for Nuclear Installations" of 2003 regarding the assessment of meteorological and hydrological hazards. NS-R-3 was later revised by amendment and published in 2016 as NS-R-3 (Rev.1). NS-R-3 (Rev.1) was superseded by IAEA Specific Safety Requirement SSR-1, "Site Evaluation for Nuclear Installations" in 2019.

Because the current version of this Specific Safety Guide was in print when the Great East Japan Earthquake and Tsunami occurred in 2011, a Note by the Secretariat was added to SSG-18, which clearly supported the need for the revision by stating that the "lessons learned from studying the accident at the Fukushima Daiichi NPP in Japan following the disastrous earthquake and tsunami of 11 March 2011 will be reflected in this IAEA safety standard as revised and issued in the future". Within the framework of the IAEA Action Plan developed after the accident, IAEA and Member states have reviewed and revised their safety frameworks, including updates to the IAEA safety standards, to enhance nuclear safety at the national level and worldwide. The External Events Safety Section has also updated several relevant Safety Standards and Safety Guides and has developed a series of technical supporting documents by adding further recommendations in terms of the uncertainties in hazard estimation, beyond design basis external events and safety margins, and multiple hazard combination issues (e.g. SSR-1, SSR-2/1 (Rev.1), GSR Part 4 (Rev.1), SSG-3, SSG-68). This Specific Safety Guide complements these documents and other Safety Guides such as NS-G-3.1 (DS520), NS-G-3.2 (DS529),

SSG-9 (Rev.1), SSG-35, and SSG-68 that were revised or are in the process of revision since the publication of SSG-18 in 2011.

3. JUSTIFICATION FOR THE PRODUCTION OF THE PUBLICATION

This revision aims at updating SSG-18 for compatibility with the updated Safety Requirements and supporting technical documents. Considerations of the recent advances in research and development for tsunami hazard estimation will also be included. Important aspects in the planned revision include (but are not limited to): (i) reflecting the state-of-the-practice in hazard assessment and their impact on the hazard parameters (including tsunami), (ii) providing guidance for estimating beyond-design basis parameters for hazards, and (iii) providing methodologies for analysing multiple hazard combinations (e.g. earthquake and tsunami). Also, the effects on multiple units at nuclear installations on same site or on adjacent sites will be an important issue of the revision based of the experience of Fukushima Accident.

Moreover, new information has been recently discussed and developed by both the scientific community and by statistical analyses of the incidence of meteorological and hydrological scenarios in the events at nuclear sites that are connected to climate change issues. Meteorological and hydrological hazards significantly depend on the interpretation and use of meteorological and hydrological information datasets, which should include relevant aspects of climate variability and change. The Intergovernmental Panel on Climate Change reports that were published in 2021 and 2022 have provided a synthesis on climate change. Especially on the issues related to siting and operation of NPPs, such as the rise in the surface and water temperature, above normal precipitation, reduction in the Arctic Sea ice, and non-uniform sea-level rise across different regions were described in “The State of the Global Climate 2021, WMO”. Variations in these important parameters introduce new challenges in the assessment of relevant hazards for nuclear sites, considering that the historical data may no longer be sufficient to assess the safety of the site over its lifetime and a more developed analysis of the time variability and its uncertainties may be required. Those issues call for additional guidance on the implementation of state-of-the-practice statistical methods and supporting modelling approaches in assessing the extreme values of meteorological and hydrological hazard parameters and their uncertainties. Assessment tools developed in the framework of the IPCC-AR6 assessment reports could be a reference.

A revision of this Safety Guide will be timely to keep up with the pace of the scientific and technological progress in the modelling of climate change effects and the challenges that they pose to nuclear site safety. Changes of the applicable safety requirements in SSR-1, SSR 2/1 (Rev.1), SSR-3, SSR-4, and GSR Part 4 (Rev. 1) also justifies its revision.

The revision of SSG-18 will ensure consistency with the updated guidelines concerning both the contents and the scope of meteorological and hydrological hazards. The revision will also take into consideration feedback from existing experience, technical safety review services, advisory services, and the state-of-the-art practice in Member States.

4. OBJECTIVE

The objective of SSG-18 is to provide recommendations and guidance on how to comply with the applicable safety requirements, including those from SSR-1, SSR 2/1 (Rev.1), SSR-3 and SSR-4, on assessing the meteorological (associated with extreme meteorological conditions and rarely occurring meteorological phenomena) and hydrological (external flooding events and low water level conditions)

hazards. This Safety Guide is intended for use by regulatory bodies, for designers of nuclear installations, by operating organizations, consultants, advisory bodies and TSOs.

5. SCOPE

This revision is not intended to significantly change the scope of the Specific Safety Guide, that is primarily concerned with hazards associated with meteorological and hydrological phenomena external to nuclear installations over their entire lifetime. A draft plan for possible revisions is provided in the Feedback Analysis Reports given in the Annex.

This Specific Safety Guide addresses all nuclear installations as defined in the IAEA Safety Glossary (2018 Edition). The terminology in SSG-18 also needs to be amended and made consistent with the new definitions in the Safety Requirements and the IAEA Safety Glossary (2018 Edition).

The transport of radioactive material in the atmosphere and in surface water and groundwater and its dispersion in the environment are not within the scope of this Specific Safety Guide, and are covered in NS-G-3.2 (DS529).

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

This Safety Guide falls within the thematic area of Site Evaluation and will interface with the following IAEA Safety Standards and other publications (this is not, and cannot be, regarded as an exclusive or exhaustive list):

- IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), Safety Assessment for Facilities and Activities (2016)
- IAEA Safety Standards Series No. GSR Part 7: Preparedness and Response for a Nuclear or Radiological Emergency (2015)
- IAEA Safety Standards Series No. SSR-1, Site Evaluation for Nuclear Installations (2019)
- IAEA Safety Standards Series No. SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design (2016)
- IAEA Safety Standards Series No. SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation (2016)
- IAEA Safety Standards Series No. SSR-3, Safety of Research Reactors (2016)
- IAEA Safety Standards Series No. SSR-4, Safety of Nuclear Fuel Cycle Facilities (2017)
- Prospective Radiological Environmental Impact Assessment for Facilities and Activities (GSG-10) (2018)
- Deterministic Safety Analysis for Nuclear Power Plants (SSG-2, Rev.1) (2019)
- Seismic Hazards in Site Evaluation for Nuclear Installations (SSG-9, Rev.1) (2022)
- Safety Assessment for Research Reactors and Preparation of the Safety Analysis Report (SSG-20, Rev.1) (2022)
- Volcanic Hazards in Site Evaluation for Nuclear Installations (SSG-21) (2012)
- Safety in the Utilization and Modification of Research Reactors (SSG-24) (2012)
- Site Survey and Site Selection for Nuclear Installations (SSG-35) (2015)
- Format and Content of the Safety Analysis Report for Nuclear Power Plants (SSG-61) (2021)

- Design of Nuclear Installations Against External Events Excluding Earthquakes (SSG-68) (2021)
- Protection Against Internal and External Hazards in the Operation of Nuclear Power Plants (SSG-77) (2022)
- Human Induced External Hazards in Site Evaluation for Nuclear Installations (NS-G-3.1) (2002) (DS520, 2022).
- Investigation of Site Characteristics and Evaluation of Radiation Risks to the Public and the Environment in Site Evaluation for Nuclear Installations (NS-G-3.2) (2002) (DS529, 2022)
- Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Plants (NS-G-3.6) (2005) (DS531, 2020).

7. OVERVIEW

The planned table of contents includes the following sections (similar to table of contents of the present SSG-18 (2011)):

1. Introduction
2. General Considerations and Recommendations
3. Meteorological and Hydrological Database
4. Assessment of Meteorological Hazards
5. Assessment of Hydrological Hazards
6. Determination of Design Basis Parameters
7. Hazard Assessment for Beyond Design Basis External Events
8. Measures for Site Protection
9. Changes in Hazards with time
10. Monitoring and Warning Systems for Meteorological and Hydrological Hazards
11. Evaluation of Hazards for Nuclear Installations other than Nuclear Power Plants
12. Management System for Meteorological and Hydrological Hazards

References

Glossary

Annexes

The planned revision for each section is provided in the Feedback Analysis Report attached as an Annex.

This plan is not exhaustive and will incorporate other areas of update identified as part of the review process.

The publication is expected to be co-sponsored by World Meteorological Organization.

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)	July 2022
STEP 3: Review of the DPP by the review Committee(s) (Approval by review Committee(s))	November 2022
STEP 4: Review of the DPP by the CSS (approval by CSS) or information of the CSS on the DPP	April 2023
STEP 5: Preparing the draft publication	Q4 2023
STEP 6: First internal review of the draft publication (Approval by the Coordination Committee)	Q1 2024
STEP 7: First review of the draft publication by the review Committee(s) (Approval for submission to Member States for comments)	Q2 2024
STEP 8: Soliciting comments by Member States	Q3 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)	Q3 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	Q4 2025
STEP 13: Approval by the Board of Governors (for SF and SR only)	-
STEP 14: Target publication date	Q2 2026

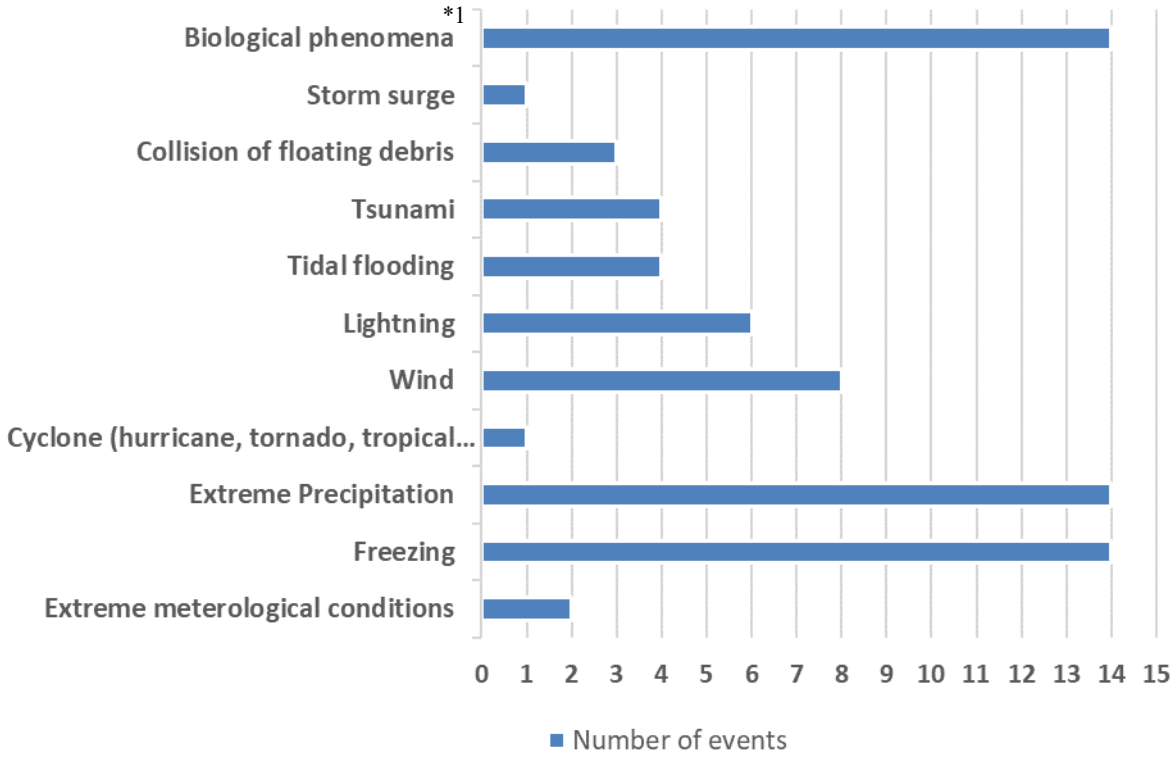
9. RESOURCES

30 staff-weeks of 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 – Feedback Analysis Reports

External Events Safety Section (EESS) had reviewed all the Site and External Events Design (SEED) missions that were implemented between years 2000 and 2020 by utilizing the TOSMA tool in terms of lessons learned, suggestions for improvement and feedback from the Member States. According to the statistical information provided in TOSMA system, EESS had conducted 220 SEED missions between 2000 and 2020 covering 188 nuclear power plants and 27 research reactors in 44 different countries. SSG-18 was used extensively in these SEED missions: nearly 15% of the recommendations provided in the SEED Mission Reports were related to SSG-18. Therefore, significant feedback was collected from the recommendations given in SSG-18 in the last two decades.

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 in meteorological and hydrological hazards. An in-depth analysis of these databases showed that external events related to the meteorological and hydrological phenomena affect the nuclear installations significantly, as presented in the figure below. Most reported incidents are related to combinations of events or consequential hazards.



*1: Meteorological / Hydrological correlated biological phenomena could be included in this category.

Figure A.1. Number of events in the IRS, FINAS and IRSRR databases related to meteorological and hydrological phenomena

Table A.1 given below summarizes the existing gaps and possible revisions in each section of current SSG-18 (2011), based on the feedback collected through the SEED missions, event reports in the above-mentioned databases and due to the scientific and technological progress in the field (this is not, and cannot be, regarded as an exclusive or exhaustive list).

Table A.1. Existing gaps and possible revisions in each section

Section #	Section Title	Existing gaps and possible revisions
1	Introduction	Update the contents (especially the background and objectives) is needed. Links to the new and updated safety publications will be provided. Links to relevant publications outside the nuclear industry will also be included.
2	General Considerations and Recommendations	General considerations in terms of periodic safety review, effect of climate change on previously screened hazards, and multiple combination of hazards will be added. Lessons learned from member states of the IAEA in terms of the process developed post-Fukushima and in the routine licensing and regulation of LWRs will be incorporated.
3	Meteorological and Hydrological Database	Review and update (as needed) of the guidance provided for database compilation on on-site, off-site, regional, and global scales is required. Recent sources of data (e.g. established datasets of track and intensity of tropical cyclones/hurricanes, wind speed data from airport stations, etc.) will be added. Correlation off-site/regional data to on-site circumstances are to be discussed. The use of synthetic datasets, derived from meteorological models will be included as well. Regional data, and where relevant global data, that is necessary to characterize the non-stationary characteristics (changes due to climate change) of the collected data will be added.
4	Assessment of Meteorological Hazards	Recommendations for estimating spatial distribution of a storm over a large watersheds and acceptable methodologies to estimate design basis will be provided. Accepted methodologies for combined hazards (e.g. joint probability method for estimating the hurricane hazard and coastal flood, earthquake and tsunami) will be elaborated. Methodological differences in estimating the wind hazard curves for tropical cyclones/hurricanes (simulations) and other storms, e.g. extratropical cyclones (measurements and historical data collection), will be clarified. Guidance on the use of these methodologies will be provided. The need and possible approaches for validation of simulations with collected data will be added. Wind borne missiles and debris and the assessment methodologies (e.g. TORMIS methodology in USA) for these hazards will be added. Consideration of meteorological event such as cloud bursts and acceptable methodologies for their hazard assessment will be included. Standardization of terminologies including assessment approach, combined events will be clarified. Deterministic approaches will be discussed, and the limits of "probable maximum" terms in risk-based approaches will be explained.
5	Assessment of Hydrological Hazards	The physics and mathematical modelling of deterministic methodologies for assessing flood hazard levels and possible comparison of probabilistic methodologies for assessing flooding hazards will be discussed. Process in assessing hydrologic hazards and characterization of the site will be discussed and be added.

		Accepted methodologies for combined hazards (e.g. joint probability method for estimating the hurricane hazard and coastal flood, earthquake and tsunami) will be elaborated. List of the water sources and events/combination of events for each water source will be added. More guidance on consideration of cascading failure effects of upstream dams on a nuclear installation site and estimation of dam breach parameters will be provided. Standardization of terminologies including assessment approach, combined events will be clarified. The limits of "probable maximum" terms in risk-based approaches will be explained.
6	Determination of Design Basis Parameters	Guidance in treatment of independent sources (hurricanes, thunderstorms, etc.) in estimating design basis parameters for wind speed is needed. The design basis for new hazards and combination of hazards will be provided with necessary links to SSG-68 in accordance with SSR-1 requirements. Annex I will also be updated accordingly. Uncertainties will be considered in estimating design basis parameters. Also, the effects on multiple units at nuclear installations on same site or on adjacent sites will be considered.
New Section	Hazard Assessment for Beyond Design Basis External Events	Guidelines for evaluating BDBEE from deterministic and probabilistic hazard assessment results – with reference to SSG-68 will be provided. The need for proper estimation of long-return period hazard parameters will be elaborated. Possible sources of uncertainties in hazard estimations for meteorological parameters (e.g. uncertainty in hazard parameter estimations – like estimated wind speed - due to uncertainties in simulations, epistemic uncertainties in tornado hazard models, differences in statistical methods for estimating the long return period estimates for thunderstorm wind speed, etc.) will be defined. Possible sources of uncertainties in hazard estimations for hydrological parameters (uncertainties in modelling/statistical analysis and variability in parameters/initial states) will be defined. Methodological guidance on the treatment of parameter and modelling uncertainties will be provided, underlining the importance of their effects on long-return period hazard parameters (especially for BDBEE). The relation between beyond design basis external events and safety margins will be discussed and recommendations/methods of assessment will be provided respectively. Effect of climate change on long return period estimates of hazard parameters will be discussed.
7	Measures for Site Protection	This section will be reviewed and updated as necessary, establishing consistency with SSG-68 and SSR-1, and taking adaptive approaches into consideration.
8	Changes in Hazards with time	This section will include identifying impacts of climate change on siting and design of nuclear installations. Also the concept of conducting periodic safety review considering the climate change will be described.
9	Monitoring and Warning Systems for Meteorological and Hydrological Hazards	This section will be reviewed and updated as necessary, establishing consistency with NS-G-3.2 (DS529) and SSR-1.
10	Evaluation of Hazards for Nuclear Installations other than Nuclear Power Plants	This section will include the graded approach to meteorological and hydrological hazards for SMR, fuel cycle installations, research reactors, etc.

11	Management System for Meteorological and Hydrological Hazards	This section will be reviewed and updated as necessary, establishing consistency with SSR-1.

* Annex I – IV of the SSG-18 will be revised based on above contents and the latest findings and technology.