

Consideration of Combined Hazards – A WGEV and WGRISK Perspective

Marina Röwekamp
GRS, Germany

John Nakoski
U.S. NRC, USA

Attila Bareith and Tamás Siklóssy
NUBIKI, Hungary

Dana Havlín Nováková
SÚJB, Czech Republic

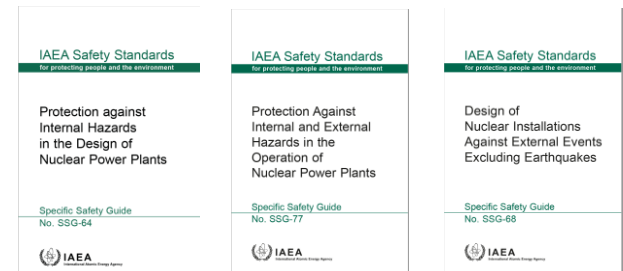
PSAM 16
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Introduction

- Combinations of hazards have gained more attention after the Fukushima Dai-ichi reactor accidents
- Importance of adequate consideration of hazard combinations, particularly involving external hazards, within all types of safety assessments of nuclear installations has been recognized



- Various national /international activities on combinations of hazards are ongoing
 - Extensions of IAEA Safety Guides
 - A currently ongoing activity conducted jointly by the OECD Nuclear Energy Agency (NEA) Working Groups on Risk Assessment (WGRISK) and on External Events (WGEV) initiated in 2020: “Combinations of External Hazards – Hazard and Impact Assessment and PSA for Nuclear Installations



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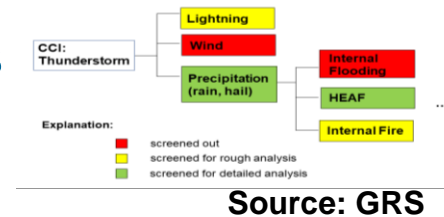
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Task Objectives

- Task objectives:
 - Collecting information on
 - ❖ Current regulatory practices
 - ❖ Technical approaches and methods applied in hazard assessment for nuclear installationsregarding combinations of external hazards and integrated hazard impacts, i.e. loads and conditions resulting directly or indirectly from hazards, as an aggregate of different impacts
 - Identification of key issues of interest
 - Overview of the current state-of-the-art with respect to risk analysis for combinations of external hazards
 - Review of methods applied in risk analyses as a basis for advances

Task Scope (1)

- The following types of hazard combinations are considered (description see IAEA SSG-64):
 - Combinations of causally related, so-called **consequential** (or subsequent) **hazards** or other events (hazard and consequential hazard or event)
 - Combinations of **correlated hazards** (two or more hazards correlated by a common cause initiator)
 - Combinations of two or more independently (randomly), but simultaneously occurring hazards, named **unrelated hazards**



Task Scope (2)

- Scope of the task
 - **Phase 1 – Member Survey** (already completed)
to develop an informed understanding of regulatory requirements and technical approaches in WGEV and WGRISK member countries
 - ❖ Regulatory requirements for hazard combinations
 - ❖ Methodology for identifying possible combinations of hazards and relevant aspects of hazard assessment and for determining resulting integrated impacts
 - ❖ PSA aspects., e.g. methodologies for identification, interpretation, selection and screening of combined hazards, plant response and fragility analysis, event and fault tree development and quantification (including uncertainties) for all plant operational states (POS)

Task Scope (3)

- Scope of the task (contd.)
 - **Phase 2 – Task Workshop** (planned in 2023) based on survey results and interpretation for addressing key issues and identifying technology gaps
 - ❖ Identify and characterize important hazard combinations
 - ❖ Understand state-of-the-art in assessing integrated impacts of hazard combinations and developing PSA for hazard combinations
 - ❖ Specify further needs for (R&D)
 - ❖ Improving assessment of external hazards in the design and in safety assessment of nuclear installations including PSA and risk-informed decision-making

Task Phase 1 – Member Survey (1)

- Member survey (nearly completed) with 42 questions classified into 8 technical and scientific areas

Technical Area		No. of Questions
No.	Description	
1	Regulatory Environment Related to Assessing Combinations of External Hazards	11
2	Definitions and Terminology Used for Classifying Combinations of External Hazards	2
3	Selection of Combined External Hazards (Identification and Screening)	9
4	Hazard Assessment for Combinations of External Hazards	4
5	Plant Response and Fragility Analysis in Support of PSA	5
6	Modelling of Accident Sequences in PSA	5
7	Risk Quantification	5
8	Ongoing Efforts (Research and Development)	1
Total		42

Task Phase 1 – Member Survey (2)

- In most questions respondents were encouraged to share their views on different issues rather than just providing factual information
- Use of this approach increased level of subjectivism in the answers making evaluation of the survey more demanding
- However, this choice appeared justifiable and beneficial, as safety assessment for combinations of external hazards is generally viewed as an evolving discipline with a spectrum of challenges and less than fully resolved issues
- Questionnaire was distributed to participating NEA member countries
- Multiple institutions/organizations were invited to provide answers with the opportunity for member states to provide more than one answer to a question if necessary
- Sixteen member states provided responses

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Task Phase 1 – Member Survey (3)

- Questions raised in relation to technical area no. 3 “Selection of Combined External Hazards (Identification and Screening)”

Question	Description
3a	Do you use an initial list of single external hazards as a basis for defining hazard combinations?
3b	Have you performed screening of the initial list of single external hazards before using it for defining hazard combinations relevant to your NPPs / sites?
3c	Please provide the screening criteria applied for screening of combined external hazards.
3d	What is the method used to evaluate the dependence between the different external hazards in order to identify combinations of external hazards? Did you use a formalized procedure and/or supporting tool, e.g., a cross-correlation chart in support of the analysis?
3e	Did you consider combinations of independent external hazards during hazard selection? What was the rationale for excluding or including this kind of hazard combination?
3f	Did you consider combinations of more than two external hazards during hazard selection? What was the rationale for including more than two external hazards during hazard selection?
3g	Please provide the list of hazard combinations selected for detailed assessment after screening.
3h	Are combinations of external hazards listed in response to question 3g explicitly modeled in your existing PSA models, so that risk results are produced for these combinations?
3i	Are there national regulatory guidance documents or any other methodology documents in place for selection and screening of hazard combinations?

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Task Phase 1 – Member Survey (4)

- Evaluation of survey responses has been completed
- Draft survey task report has been prepared as a joint activity of WGEV and WGRISK for comments by both groups
 - Report structure is in good agreement with survey questionnaire – each dedicated report section is assigned to each technical area addressed
 - Interpretation of survey responses is demanding – in few instances, respondents were consulted for clarification and additional information enabling a meaningful review of the survey results
 - First overall conclusions are foreseen based evaluating the state-of-practices in each technical area
 - Final draft of survey task report will be available by end-2022

Task Phase 1 – Member Survey (5)

Examples of preliminary conclusions from member survey: regulatory environment

- Requirements to address combinations of external hazards in safety assessments, often relying on PSA, are explicitly stated in national nuclear safety regulations of all responding countries
- For siting and licensing of new NPP units, most participating members do not apply a specific regulatory approach for assessing combinations of external hazards
- In most countries, there is a requirement for considering combinations of external hazards as part of meeting probabilistic safety targets or goals

Task Phase 1 – Member Survey (6)

Examples of preliminary conclusions from member survey: modelling of accident sequences in PSA (contd.)

- Combined external hazards have been subject to modelling in PSA in several countries
- Typically, no new, specific modelling methods have been developed and applied for this purpose
- External hazards, including their combinations, modelled were often limited to the most common natural hazards, e.g. earthquakes and floods, but also included extreme wind, tornado, extreme snow loads and ice storms
- In some PSA studies, there are no specific models for combinations of consequential external hazards, but the effects of the subsequently occurring hazard(s) are addressed directly in the model of the initial hazard

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Task Phase 2 – Task Workshop (1)

- In-person 3-4 days task workshop is intended to take place in fall 2023
- Interim results from Phase 1 can usefully support technical workshop
- Understanding state-of-practices throughout member states concerning regulatory requirements as well as regulatory and utility approaches for assessing combinations of external hazards is of particular importance
- Subject matter experts on hazards analysis and PSA will be invited
- Participation by experts from national, international, and multi-national organizations for sharing knowledge and experiences on hazards analysis and assessment of risks at nuclear installations and other critical infrastructures (e.g., water supply installations, electrical energy distribution networks)

Task Phase 2 – Task Workshop (2)

- Workshop panel discussions will include topics such as:
 - Phenomenological aspects of combined external hazards
 - Potential impact of combined external hazards on critical infrastructures
 - Discussions on impacts from these combined hazards on nuclear installations and their assessment using probabilistic and statistical approaches within state-of-practice PSA tools
- For each topical area of the Phase 1 member survey a separate session is foreseen
- Outcome: workshop proceedings (published as CSNI Report) integrating insights from the survey task report with additional insights gained during the workshop

Conclusions and Outlook

- The joint OECD/NEA CSNI WGEV and WGRISK task on safety assessment for combined external hazards is a multi-year task with 2 phases
 - Member survey (nearly completed) with responses from 16 member countries to 42 questions for 8 dedicated technical areas
 - Task workshop for addressing in more detail key issues from phase 1 and identifying technology gaps
- Task will help to better identify and characterize important hazard combinations and understand the state-of-the-practice in assessing integrated impact of combined external hazards, particularly supporting PSA developments for combined hazards
- Task outcome published by CSNI may result in follow-on activities of WGEV and/or WGRISK on consideration and treatment of combined hazards in safety assessments

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Thank you for your attention!

**For further questions, please contact
the authors of this presentation:**

Marina Röwekamp Marina.Roewekamp@grs.de

John Nakoski john.nakoski@nrc.gov

Attila Bareith bareith@nubiki.hu

Tamás Siklóssy siklossyt@nubiki.hu

Dana Havlín Nováková dana.havlinnovakova@sujb.cz