

# OECD WGRISK – Challenges and Recent Tasks

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**Abstract:** The overall objective of the Working Group on Risk Assessment (WGRISK) of the OECD Nuclear Energy Agency (NEA) Committee on the Safety of Nuclear Installations (CSNI) is to advance the understanding of Probabilistic Safety Assessment (PSA) and to facilitate its utilization for enhancing the safety of nuclear installations. To accomplish this mission, WGRISK continuously performs a variety of activities to exchange information on PSA between member countries. This paper presents a brief overview on the actually on-going WGRISK activities and perspectives.

In addition to on-going tasks covering more traditional PSA challenges (e.g. tasks relating to human reliability analysis (HRA) and digital instrumentation and control (I&C)), new challenges for PSA have arisen from the recent nuclear power plant operating experiences and the insights from the post-Fukushima stress tests<sup>†</sup>. In response to these new challenges, WGRISK conducted an international workshop on “PSA of Natural External Hazards Including Earthquakes” in June 2013. This workshop revealed valuable insights on challenges associated with external events such as scope consideration for PSA, the need to consider combinations of external hazards, and multi-unit impacts. Another ongoing WGRISK activity is the second follow-up workshop on “Fire PRA” to be held in April 2014. The Fire PRA workshop will address many of the technical challenges associated with including fire hazards, which typically provide a non-negligible contribution to the overall core or fuel damage frequency, in PSA.

WGRISK recently initiated a task focused on obtaining insights from PSA related to the loss of electrical power sources. This task will collect examples of PSA insights related to a loss of electrical power sources, including those insights identified as a result follow-up activities to the Fukushima Dai-ichi reactor accidents. It is expected that this task will also highlight the capabilities of PSA as a tool for providing insights related to the potential consequences of the loss of a safety function, such as core damage frequencies or frequencies of radioactive releases. The use of PSA in this manner may provide a measure of defense-in-depth in case of loss of a safety function, which will augment more traditional analysis approaches that emphasize identification of failures that can lead to loss of system function.

**Keywords:** Risk, External Hazards PSA, WGRISK, fire, electrical power.

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## 1. INTRODUCTION

The main objective of the Working Group on Risk Assessment (WGRISK) of the OECD Nuclear Energy Agency (NEA) Committee on the Safety of Nuclear Installations (CSNI) is to advance the understanding of probabilistic safety assessment (PSA) and to enhance its utilization for improving the safety of nuclear installations. Due to its disciplined, integrated and systematic approach, PSA is considered as a necessary complement to traditional deterministic safety analysis.

To accomplish this mission, WGRISK performs a number of activities to exchange PSA-related information among NEA member countries. WGRISK provides a forum for exchange of information

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<sup>†</sup> For a summary of post-Fukushima Dai-ichi accident activities by OECD/NEA member countries see <http://www.oecd-nea.org/nsd/fukushima/>

and experience related to risk assessment in member countries. This exchange is not only limited to technical discussions on questions regarding risk analysis approaches, results, insights, applications and interactions with other disciplines and analysis techniques, but also includes identifying and prioritising important issues requiring additional research. WGRISK also prepares technical reviews (such as state-of-the-art reports, technical opinion papers, compilations of ongoing efforts, comparison studies etc. as appropriate) of work in all phases of risk assessment to assist further developments and the application of PSA in risk-informed decision making. This information sharing assists member countries in ensuring adequate safety of existing and future nuclear installations in their respective territories.

The scope of the activities carried out by WGRISK may involve, for current and future nuclear installations under the purview of CSNI, any or all of the two broad sets of activities pursued in managing risk:

- Risk assessment (including risk characterization as well as technical assessment) and
- Risk management (including the development and evaluation of options).

WGRISK provides timely, high-quality work products addressing, to the extent practical, a broad range of risk management needs identified and be forward looking in the identification of risk management issues that may need to be addressed by CSNI and the working group thus being sufficiently flexible to respond to emerging risk management issues, appropriately coordinated with the risk management programmes of the member countries as well as of other international organizations. It also serves as an internationally recognized, authoritative source on risk-related matters and as an important resource for risk-related knowledge management activities.

CSNI, in collaboration with the Committee on Nuclear Regulatory Activities (CNRA), maintains a joint strategic plan and mandates [1] identifying main challenges and focus areas. One main challenge identified in the CSNI/CNRA Strategic Plan is the safe operation of current, new, and advanced nuclear facilities. This paper presents a brief overview of ongoing or recently finished WGRISK activities (hereafter called “Tasks”) and perspectives, e.g. the recommendations resulting from these for future WGRISK activities that address this CSNI/CNRA main challenge.

## **2. RESULTS OF RECENTLY FINISHED TASKS**

### **2.1. Use and Development of Probabilistic Safety Assessment - An Overview of the Situation at the End of 2010**

In the recent past, the results of the continuous information exchanges among member countries related to PSA have been compiled in a standalone CSNI report entitled “The Use and Development of Probabilistic Safety Assessment”, first issued in 2002 [2], then updated in 2007 [3] and most recently updated in 2011 [4]. This report provides a description of the PSA activities in member countries at the time when the report was written. The latest report presents an analysis of the position on the use and development of PSA in WGRISK member countries as of the end of 2010. As previously, the corresponding Task was carried out in cooperation with the International Atomic Energy Agency (IAEA), which led to more information and thus provided a better overview on PSA worldwide. The expected readers and “end users” of this report are PSA professionals and generalists dealing with risk and safety management. The current version of the report includes information from twenty-one member and non-member countries and covers a range of topics including national PSA frameworks, numerical safety criteria, PSA standards and guidance status, scope of PSA programs, PSA methodology and data, applications results and insights from, and future development and research activities.

## 2.2. Use of OECD Data Project Products in Probabilistic Safety Assessment

The OECD/NEA joint Database Projects and information exchange programmes enable interested countries, to pursue research or the sharing of data with respect to particular areas or problems. The following Database Projects have direct relevance to PSA activities:

- International Common Cause Failure Data Exchange (ICDE),
- OECD/NEA Fire Incidents Record Exchange (FIRE) Project,
- Component Operational Experience, Degradation and Ageing Programme (CODAP) having subsumed the former OECD Piping Failure Data Exchange (OPDE), and
- OECD/NEA Computer-based System Important to Safety (COMPSIS) Project.<sup>‡</sup>

These data projects can, in principle, support the collection and analysis of data that is highly relevant to PSA, particularly in the areas of material degradation and aging, common cause failures, fire risk, and digital instrumentation and control systems. All of these projects collect qualitative information that can be useful in the development and review of PSA models. Moreover, several of these projects include specific objectives to support quantification activities. However, to date, WGRISK members, particularly those who are not members of the database projects, have made little use of the data project products (principally reports). To address this challenge, and based on needs expressed by a number of member countries, the CSNI WGRISK initiated a Task on “Use of OECD Data Project Products in Probabilistic Safety Assessment” in NEA member countries in 2011. This task was coordinated with representatives from ICDE, FIRE, OPDE/CODAP, and COMPSIS and benefitted greatly from the perspectives offered by the data project members.

The major objectives of this data project task were the following:

- Identification and characterization of the current uses of OECD/NEA data project products and data in support of PSA. In this context, the term ‘products’ refers to data analysis results, technical reports, and other project outputs.
- Identification and characterization of technical and programmatic characteristics that either support or impede use of data project products in PSA. This includes an assessment of which PSA parameters could be potentially estimated from the various data project products and gaps between available product information and PSA data needs.
- Identification of recommendations for enhancing the usefulness of data project products and the coordination between WGRISK and the data projects.

An additional objective of this task was to strengthen the relationships between the data project and PSA communities.

The data project task included three main activities:

- **Questionnaire/Survey** – A survey instrument was developed in collaboration with representatives from WGRISK and each of the data projects. Two surveys were developed, one that was distributed to members of the PSA community, and a second that was distributed to each of the data projects. The surveys focused on the task objectives and requested information pertaining to project participation, data access, uses of data project products for PSA, challenges in data collection and use, and best practices in use of data project products. The surveys were distributed in the spring of 2012. Good participation completing the survey was noted, with 22 organizations representing 14 member countries providing survey responses. Survey responses were also obtained from the ICDE, FIRE, OPDE/CODAP, and COMPSIS data project representatives.
- **Task Meeting** – After the survey responses were analysed, a two day task meeting was held in October 2012 at OECD headquarters in Paris, France. Fourteen participants attended the task

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<sup>‡</sup> The COMPSIS project ended in December 2011 but was an active project when this task was initiated.

meeting, representing eight NEA member countries, the NEA secretariat, and the FIRE, ICDE, and CODAP projects<sup>§</sup>. The task meeting agenda included a review of survey results from each data project, open discussions on enhancing participation in data project activities and identification of new data needs, and identification of conclusions and recommendations.

- **Final task report** – The final task report [5] provides the survey responses and associated analysis, along with a detailed description of the key attributes of each of the data projects. The report also includes recommendations for strengthening collaboration between the PSA community and the joint data projects. Best practices for the use of data project products for PSA are identified, along with a summary of success factors for data project activities. The final report was coordinated with representatives from ICDE, FIRE, OPDE/CODAP, COMPSIS, and WGRISK and is intended to represent a consensus view among each of these organizations.

In general, the OECD/NEA joint data projects represent mature data collection efforts and have enjoyed substantial support from the NEA membership. These projects have endeavoured to ensure that data collection activities have a high level of completeness and quality. This commitment to quality has resulted in the development of project-specific programmatic requirements intended to ensure quality. However, there remain some challenges when attempting to apply data project products to PSA activities (e.g., data completeness and exposure information needed to calculate PSA parameters). As such, data applicability and completeness should be fully assessed prior to applying data project products to a specific application. Despite these challenges, experience has been developed by a number of NEA members in applying ICDE, FIRE, and ODPE/CODAP data to PSA initiatives. Examples include CCF parameter estimation, fire frequency calculation, and estimation of piping rupture frequencies. Overall, the data projects are an important OECD/NEA activity, particularly for member states with a small number of nuclear installations and limited national databases.

This task identified a number of challenges and opportunities for further improvement:

- Enhancing participation in data project activities
- Striving for continual improvement in operating experience data collection efforts
- Increased sharing of data with national organizations including industry and standards organizations (as appropriate)
- Consideration of new data collection needs (e.g., new and advanced reactors, human reliability analysis, external hazards)
- Consideration of success factors for application of data project products to PSA when developing new activities

In order to support wider dissemination of the lessons learned from this activity, a summary of the task and results were presented at the recent American Nuclear Society PSA 2013 topical meeting [6].

### 3. RESULTS OF ONGOING OR RECENTLY STARTED TASKS

WGRISK has a number of ongoing tasks that are nearing completion, including comparisons of human reliability analysis (HRA) methods to desirable attributes<sup>\*\*</sup> and identification of failure taxonomies to support the digital instrumentation and control (I&C) PSA. In addition to these more traditional PSA-related activities, recent nuclear power plant operating experience and the insights from the post-Fukushima stress tests have highlighted new challenges for PSA. WGRISK has identified several new activities to address these challenges, including conducting international workshops on PSA for naturally occurring external hazards and fire, and using PSA as a tool to identify insights related to electrical power sources.

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<sup>§</sup> At the time the workshop was held (October 15-16, 2012), both the COMPSIS and ODPE Projects had ended.

<sup>\*\*</sup> This HRA-related task is being performed in collaboration with the CSNI Working Group on Human and Organizational Factors (WGHOFF).

### **3.1. International Workshop on PSA of Natural External Hazards including Earthquakes**

Motivation for the task of an international workshop on PSA for natural hazards was that the 2011 reactor accidents of Fukushima Dai-ichi triggered discussions about the significance of external hazards and their treatment in probabilistic safety analyses and assessment. In addition, the results of the stress tests performed as a result of these accidents have shown vulnerabilities and potential cliff-edge effects in plant responses to external hazards resulting in identifying possibilities of and priorities for improvements and safety measures' implementation at specific sites and for particular designs.

In order to address these issues and provide relevant conclusions and recommendations to CSNI and CNRA, the WGRISK directed, together with the CSNI Working Group WGIAGE, an "International Workshop on PSA of Natural External Hazards Including Earthquakes". The workshop was hosted by UJV Rez and took place in Prague, Czech Republic in June 2013.

Key objectives of this workshop were to collect information from OECD member states on methods and approaches being used and experience gained in PSA for natural external hazards. In addition, the workshop was used to identify new potential topics, such as improving the PSA treatment of the different levels of defense-in-depth, for further WGRISK and WGIAGE activities.

The focus of the workshop was on external hazards PSA for nuclear power plants (NPP), including all modes of plant operation. The workshop scope was limited to natural external hazards including those ones for which the distinction between natural and man-made hazards is not sharp (e.g., external floods caused by dam failures). The participation was open to experts from regulatory authorities and their technical support organizations, research organizations, operators, NPP designers and vendors, industry associations and observers.

The following conclusions have been drawn based on workshop presentations, discussions during particular sessions and two facilitated discussions.

#### Regulatory framework

Lessons learned from the Fukushima Dai-ichi reactor accidents and related actions at national, European and global level have emphasized the importance to assess risks associated with external hazards (including combinations of these hazards) and their impacts on a plant site (possibly with several units).

Regulators in most countries have taken actions to include seismic and flooding risk, and, to some extent, some other specific external hazards in national PSA practices and safety regulations. The development of systematic approaches for addressing external hazards completely in PSA practices is still ongoing.

The current role of external hazards PSA in the regulatory framework varies from country to country depending on the local conditions, operating experiences and the type of relevant hazards. In some countries adequate deterministic requirements for protection against earthquakes or other external hazards did not exist when the operating reactors were built and the external hazards have been later analyzed in the PSA framework. In other countries the emphasis has been on deterministic design requirements.

#### Models, methods, tools and data

Useful hazard estimates can be determined with current methods and used in applications in the processes of risk oriented decision making.

Development of methods and preparation of studies aiming to obtain realistic risk assessments, neither too optimistic nor too much conservative, is a key issue. These more realistic evaluations would

provide a better view on the real problems and also a better view on the interest of safety improvements.

### Standards and guidance

Recently developed methods and guides are available for seismic hazard determination, identification of external hazards and screening of external hazards for detailed consequent analysis. Several lists of screening criteria are available. The methods of Probabilistic Seismic Hazards Assessment (PSHA) have been developed and used in practice for several decades and they have been well documented and described in relevant Standards.

### Good practices and applications

The following good practices in external hazards PSA were demonstrated by the presentations made during the workshop (and are applicable to PSA in general, not just for external hazards PSA):

- challenging assumptions,
- calibrating models,
- accounting for underlying physical processes,
- treating dependencies ,
- involving multidisciplinary teams, and
- disseminating information promptly and broadly.

Methods for external hazards analysis have been recently used to evaluate operating NPP units and to identify needs for modification of plant systems and procedures as well as to support new plant designs. The risk contribution (at least for some external hazards) has included events occurring during shutdown and low power operation and examples of plant reactor (and non-reactor) improvements following the results of the analyses were given.

### Challenges and opportunities for further enhancements

The task on PSA for Natural External Hazards including earthquakes identified a number of challenges and opportunities for further enhancements.

In general, there are a number of significant technical challenges for external hazards PSA covering various areas of PSA, which include, for example:

- multi-unit impacts,
- combinations of external hazards,
- fragility analysis of non-seismic external hazards,
- correlation effects and consequent damage scenarios,
- HRA for external hazards PSA, including organizational and managerial aspects,
- mission times for long-term scenarios,
- effects of climate change on the derivation of hazard frequencies and magnitudes.

Data analysis, particularly estimation of the initiating event frequency and identification of correlations between external hazards represents another significant challenge.

The broad scope and organizational challenges appear to be:

- increasing the scope of external hazards PSA to match internal events (recognizing resource limitations);
- ensuring appropriate interactions with the appropriate scientific/technical communities;

- ensuring appropriate use in safety-related decision making, including challenges related to quality and acceptance of external hazards PSA.

The workshop provided valuable input for strengthening the role of WGRISK in supporting the development and application of probabilistic safety assessment and risk-oriented decision making methods in the area of external hazards.

Recognizing the impetus for action provided by actual operational events, it has appeared that WGRISK can provide stronger (and better-focused) cases for action by increasing its use of operating experience feedback. Among others, this could imply strengthening ties with associated international working groups, particularly the NEA Committee of Nuclear Regulatory Authorities (CNRA) Working Group on Operating Experience (WGOE).

An additional action for WGRISK suggested by this task concerns the tracking of recommendations from completed tasks. Increased efforts by the WGRISK leadership to systematically track, prioritize, and appropriately resolve past recommendations would improve the group's strategic planning process. Specifically, such tracking would help ensure that each task performed by the group more strongly supports the group's overall objectives and ensure that timely action is taken on risk-significant recommendations.

In general, due to high importance of external hazards risk analysis, WGRISK should consider initiating further activities in this area. For example, a future task to cover (partly or completely) the area of man-induced external hazards, which has been shown in some plant specific studies to be an important contributor to risk, could be considered.

Moreover, in the CSNI framework, WGRISK could provide a contribution to the newly created CSNI Task Group on Natural External Events for including a risk aspect.

### **3.2. International Workshop on Fire PRA**

Another ongoing WGRISK activity is the second follow-up workshop on "Fire PRA" addressing the most recent challenges for Fire PRA, which typically provides a non-negligible contribution to the overall core or fuel damage frequency. The aim of the workshop, to be held in April 2014, is development of recommendations regarding a potential future update of the State-of-the-art Report on fire risk analysis (NEA/CSNI/R(99)27 [7]). This includes providing insights in probabilistic fire risk analysis and the corresponding methods, the collection of operating experience and processing of data to be used in Fire PRA applications.

More specifically, the workshop will cover the following objectives:

- to support assessment of current state of probabilistic analyses of fire hazards for nuclear installations at the design stage and during all plant operational states from start of operation up to the longer lasting post-commercial operating phases,
- to support re-evaluation of Fire PSA, in particular as a tool to address the lessons learned from the post-Fukushima investigations and stress tests with respect to fire events,
- to share methods and good practices and experiences among member states on probabilistic risk assessment of fire hazards and event combinations with fires, and
- to identify new potential topics for further WGRISK activities in this area, including potential update of the State-of-the-Art Report (SOAR) on fire risk analysis.

The workshop builds upon previous, relevant WGRISK work in the field of fire probabilistic risk analysis. In addition, ongoing activities at the OECD/NEA in the field of fire risk analysis in the frame of the OECD FIRE Database project, the PRISME and PRISME2 experimental fire research projects, and the fire related OECD High Energy Arcing Fault (HEAF) experimental program are intended to form a sound basis for discussions in the frame of this workshop.

The workshop will include plenary and technical sessions in addition to facilitated discussion sessions. It has also been organized to encourage active participation of the attendees in the discussions, as well as in the formulation of conclusions and recommendations. Information obtained as a result of the workshop should provide better understanding and interpretations of subjects, topics and issues connected with fire risk analysis. A report covering workshop proceedings with summarized results and some conclusions and recommendations for follow-on activities on good practices and experiences in member states, including lessons learned from operating experience, experimental research and actual applications of probabilistic analyses in the frame of regulatory activities will be prepared based on material presented at the at the workshop.

### **3.3. Probabilistic Safety Assessment Insights Relating to the Loss of Electrical Sources**

Most recently, the activities and related WGRISK tasks focus on insights from probabilistic safety assessment related to the loss of electrical sources. This task aims on collecting good examples of PSA insights related to a loss of electrical sources identified as a result of several activities after the Fukushima Dai-ichi reactor accidents. While in the analysis of the robustness of safety functions the emphasis is generally on the causes of potential functional failures, particularly when using operating experience, PSA is a tool for providing insights related to the potential consequences of the loss of a safety function, such as damage frequencies or frequencies of radioactive releases, and relating to the provisions aiming to avoid such inadmissible consequences of the loss of the safety function. The use of PSA results may provide a measure of defense-in-depth in case of loss of a safety function.

The task intends to illustrate the PSA capabilities with an outstanding practical example. Two types of insights will be gained:

- Insights for plant safety related to results and applications of risk calculations: overall risk as well as relative results relating to dominant contributions, potentially weak points in the defenses, balance between core damage prevention and mitigation, comparison between the contributions of internal initiating events and internal or external hazards, key sources of uncertainty (where available), safety benefits brought by modifications already implemented or planned (including possible post-Fukushima modifications).
- Insights on PSA methodology: identification of good practices, potential gaps, differences in the methodologies used or developed. Potential interesting points are the treatment of common cause failures (CCF) and the treatment of long-lasting scenarios which are not currently introduced in the PSAs.

## **4. INTENDED FUTURE ACTIVITIES**

WGRISK has developed and maintained a comprehensive integrated plan that describes the working group's vision, technical goals, and working methods. The operating plan is reviewed updated annually in order to help ensure that WGRISK remains well aligned with CSNI priorities and is focused on topics of current interest to its members. The operating plan provides a systematic approach of reviewing WGRISK's progress in addressing main CSNI challenges and evolving needs of the membership. Emerging issues of interest to members include human reliability analysis for seismic and other external events and multi-unit integrated risk assessment. WGRISK is currently evaluating proposals for new tasks in both of these areas. A future activity to enhance the tracking and prioritization of past WGRISK recommendations is expected to better inform future task planning.

## **5. CONCLUSION**

WGRISK strives to provide timely, high-quality work products addressing, to the extent practical, the broad range of risk assessment and management needs identified by CSNI and the working group members. In addition, WGRISK serve as an internationally recognized, authoritative source on risk-related matters and as an important resource for risk-related knowledge management activities. It is expected that recently completed and ongoing task activities associated with HRA, digital I&C,



External Hazards PSA, Fire PSA, and electrical power source risk insights will serve to enhance the state of knowledge in the broad PSA community. Finally, it should be noted that WGRISK reports are generally available to the public (including non-members of NEA) and can be found on the OECD/NEA website (e.g., <http://www.oecd-nea.org/nsd/docs/indexcsni.html>).

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