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Abstract: The current work program of WGRISK, the Nuclear Energy Agency (NEA)/Committee for the Safety of Nuclear Installations' (CSNI) Working Group on Risk Assessment, involves a broad range of topics. WGRISK task groups are addressing human reliability analysis data needs, probabilistic safety assessment (PSA) methods for non-seismic external events, probabilistic risk criteria, methods for analyzing digital instrumentation and control systems, and low power and shutdown PSA. Most of these tasks are expected to be completed in 2008. To support the identification and management of future activities, the working group, along with other CSNI working groups, has updated its integrated plan. The updated plan directly addresses future challenges and associated issues identified by the CSNI, thereby ensuring that the WGRISK program appropriately addresses user needs.

Keywords: PSA, OECD, international cooperation, planning.

1. INTRODUCTION

WGRISK, the Nuclear Energy Agency (NEA)/Committee for the Safety of Nuclear Installations' (CSNI) Working Group on Risk Assessment, is a working group tasked with supporting the improved use of Probabilistic Safety Assessment (PSA) in risk informed regulation and safety management through the analysis of results and the development of perspectives regarding potentially important risk contributors and associated risk-reduction strategies. To accomplish this mission, WGRISK, which is composed of PSA experts and leaders from member countries, holds annual meetings to exchange PSA-related information and experience; develops state of the art reports and technical opinion papers (i.e., papers which present the opinion of the working group); publishes technical notes (i.e., papers which represent the opinion of the authors); and supports international specialist meetings and workshops [1, 2].

The WGRISK work program covers a wide range of PSA and PSA-related topics. Recently, the working group had produced a number of reports and papers on such subjects as the use and development of PSA, Level 2 PSA, and software reliability. The current work program includes activities addressing human reliability analysis (HRA) data needs, PSA methods for non-seismic external events, probabilistic risk criteria, methods for analyzing digital instrumentation and control systems, and low power and shutdown PSA. Regarding future activities, the working group has updated its integrated plan. The updated plan directly addresses future challenges and associated issues identified by the CSNI, thereby ensuring that the WGRISK program appropriately addresses user needs. The remainder of this paper provides additional details on the above activities.

2. RECENT ACTIVITIES

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Since its formation in 2000 as a successor to the former Principal Working Group 5 (PWG-5) of CSNI, WGRISK has performed or co-sponsored activities addressing PSA methods (e.g., approaches to treat errors of commission), tools (e.g., risk monitors), areas of analysis (e.g., fire risk), and applications (e.g., emergency planning). In 2007, WGRISK publications addressed the international use and development of PSA, Level 2 PSA and severe accident management, seismic PSA, software-based system reliability, and the role of PSA in plant safety.

2.1. International Use and Development of PSA

In 2002, to support the exchange of information on the current status of PSA programs in member countries, WGRISK produced a report describing member country PSA guidelines, applications, study results, associated plant modifications, and research and development topics (with a focus on reactor applications). In 2007, WGRISK issued an updated report [3], developed from a country survey and subsequent discussions. The updated report covers the respondents' PSA framework and environment, numerical safety criteria, standards and guidance, program status and scope, methodology and data, applications, results and insights, and future developments. The report provides evidence of the widespread use of PSA in the responding countries. In most of these countries, PSA is encouraged by the regulatory system; in some countries, PSAs are required (e.g., as part of the periodic safety review process). Level 1 PSAs have been performed for all of the respondents' operating plants; several of these PSAs address low power and shutdown events, internal fires, and external events. Many PSAs have been extended to Level 2, but only a few Level 3 studies have been performed. The report also indicates where development efforts are ongoing, both with respect to the performance of PSA (e.g., research addressing key uncertainties) and the application of PSA (e.g., the development of numerical safety criteria).

2.2. Level 2 PSA and Severe Accident Management

In 2007, WGRISK also issued a Technical Opinion Paper (TOP) on Level 2 PSA [4] and a related technical report [5]. The TOP provides an overview of the elements of Level 2 PSA and a concise summary of practices and trends. The report, which addresses severe accident management as well as Level 2 PSA, updates a 1997 report on that subject. This report was developed based on the results of two CSNI workshops, a limited literature review, and input from a number of Level 2 PSA specialists. The report addresses Level 2 PSA methods, models, results and insights; key severe accident issues; severe accident management; severe accident analysis codes; and risk-informed decision making. Both the TOP and the report observe that international severe accident research has led to a significantly improved understanding of accident progression, containment performance, and radionuclide release and transport and to improvements in the integrated severe accident analysis codes used to support Level 2 PSA. They also recognize the implementation of severe accident management mitigation measures for existing plants and new designs, the more widespread performance and use of Level 2 PSA, and efforts to assess the risk impact of some mitigation measures. Finally, both documents also identify a number of remaining challenges, involving both methods (e.g., for integrated treatment of dynamics and uncertainty) and models (e.g., for treating the Level 1/Level 2 PSA interface).

2.3. Seismic PSA

In late 2006, WGRISK, in conjunction with the CSNI Working Group on the Integrity of Components and Structures (IAGE) and the cooperation of the International Atomic Energy Agency (IAEA), sponsored a specialists meeting on seismic PSA in Jeju, Korea. The meeting, which was hosted by the Korea Atomic Energy Research Institute (KAERI) and the Korea Institute of Nuclear Safety (KINS), covered recent advances in analysis methodology since a 1999 NEA workshop on seismic PSA, practical applications, the current state of the art, and methodological issues where further research would be beneficial. The meeting proceedings [6] indicate the wider use of seismic PSA

since the 1999 NEA workshop and a broader range of applications (including support for new plant designs, early site permitting, post-earthquake emergency planning, and the development of PSA standards). The proceedings also summarize a full-scale probabilistic seismic hazard analysis study for Swiss plants (the PEGASOS project), identify continuing areas of uncertainty (HRA for post-event responses and the treatment of correlations between failure events), and indicate an urgent need for the comparison of probabilistic seismic hazard analysis results to help countries with plants in low- and medium-seismicity regions. This latter need will be addressed by a Spring, 2008 IAGE workshop.

2.4. Software-Based System Reliability

There currently is no consensus regarding how digital instrumentation and control (I&C) systems should be addressed in a PSA, due to the difficulty in addressing the contribution of software to system reliability. To provide some useful information on the topic, WGRISK issued a technical note discussing the characteristics and differences of software and hardware reliability, methods of software reliability assessment, the results of a WGRISK survey, and recent research activities [7]. The note points out that the basic question: "What is the probability that a [software-based] safety system or a function fails when demanded" is well formed, that WGRISK member countries have a clear interest in addressing such systems in their PSAs, and that there are a number of software reliability methods that have been used by the member countries. The note also recognizes the lack of maturity of these methods, the weakness in available reliability data, and the need for concerted research and international cooperation (e.g., in the form of benchmark exercises).

2.5. Role of PSA in Nuclear Power Plant Safety

In parallel with the survey-based report on the use and development of PSA discussed in Section 2.1, WGRISK also issued a technical note on the role of PSA in nuclear power plant safety [8]. This note updates an earlier (1992) PWG-5 statement on the role of quantitative PSA results in safety decision making. The 2007 note provides an overview of nuclear power plant PSA and discusses the following important PSA topics: standards and guidance, results and insights, numerical safety goals, applications, uncertainties and limitations, current trends, and suggestions for good practice. The note provides a very positive view on the increasing role of PSA (especially with respect to the status in 1992), referring to the increasing quality of the models and the increasing use of these models in various decision support applications.

3. CURRENT PROGRAM

The current program of WGRISK includes tasks identified by working group members and by CSNI. These tasks are summarized below. Most of the task groups are currently scheduled to complete their work in 2008.

3.1. HRA Data Needs

For both established and developing HRA methods, the lack of operational data for human failure events relevant to scenarios of interest in PSAs has led to extensive reliance on expert judgment and contributed to uncertainties in PSA results. Other sources of data (e.g., training simulators, research simulators, controlled psychological studies) are potentially available, but each has its drawbacks as well as benefits. To develop recommendations for future international collaboration, WGRISK has established a task group to review HRA data needs and relevant developments in the field. The task group's report will reflect, among other things, lessons learned from the HRA empirical study underway at the OECD Halden Reactor Project [9].

3.2. Non-Seismic External Events

Past PSA analyses have shown that non-seismic external events (e.g., high winds, external flooding, offsite chemical releases) can, for some plants, be non-negligible contributors to risk. Recent extreme weather events and concerns regarding the potential effects of global warming raise the question as to whether such events might be even more significant, and whether available PSA methods and models appropriately reflect current understanding. To develop a common understanding of the current state of the art and to provide a basis for potential future work, WGRISK has established a task group on non-seismic external events. Based on the results of a questionnaire distributed to national safety authorities or their technical support organizations and subsequent discussions, the task group will develop a report addressing regulatory requirements and guidance, analysis scope, analytical methods, and study results and insights.

3.3. Probabilistic Risk Criteria

As discussed in the recent report on the use and development of PSA [3] (see Section 2.1 above), a number of WGRISK members have established numerical risk or risk-related goals, guidance values, and criteria (referred to subsequently as "criteria" for brevity) to support their decision making processes. These differ in their regulatory status, level (e.g., public health risk, radiological release frequency, core damage frequency, system reliability), and definitions (e.g., for "large early release"). To address the working group members' interest in the basis for the criteria and to share experiences that may be helpful to working group members contemplating the development or revision of criteria, WGRISK has established a task group to develop a report. The report will be based on the results of a questionnaire survey of utilities as well as regulatory organizations. The questionnaire addresses, for each criterion reported, a number of topics, including: level, scope (e.g., plant, site), purpose, technical definition, supporting documentation, quantitative expression (e.g., as a single value or a range of values), consideration (e.g., regulatory limit, indicator, orientation value), scope of associated PSA (e.g., internal events only or internal and external events), treatment of uncertainty, actions taken if the criterion is exceeded, and application experience.

3.4. Low Power and Shutdown (LPSD) PSA

In 2005, WGRISK, in conjunction with the since-discontinued Cooperative Probabilistic Risk Assessment Research Program (COOPRA), published a report presenting the results of two surveys "designed to gather relevant LPSD PSA information in the pursuit of improving safety at nuclear power plants when using risk-information in decision-making" [10]. Based on the recommendations of that report, WGRISK established a task group with the following three objectives: (1) create an information base for LPSD initiating events to support the sharing of operational data in a form suitable for use in PSA; (2) collect and share information on analytical issues encountered in LPSD PSAs performed by member countries (e.g., the definition and consideration of LPSD states in Level 2 PSA, the collection of experimental results to support realistic LPSD analyses, and the treatment of special issues such as cold overpressurization and boron dilution); and (3) collect and share information on how inadvertent human actions that result in initiating events are taken into consideration in LPSD PSAs, and how dependencies between the initiating event and recovery actions are addressed.

3.5. Digital I&C Reliability

As a continuation of the effort discussed in Section 2.4 above, and in response to direction from CSNI (stemming from the importance of the topic with respect to the acceptance of proposed plant upgrades and new plant designs), WGRISK has established a task group on digital I&C reliability. The objective of this task group is to make recommendations regarding current methods and information sources used for quantitative evaluation of digital system reliability for PSA applications, and to

identify, where appropriate, the near and long-term developments that would be needed in order to improve reliability assessments. To accomplish these objectives, the task group will hold a technical specialists meeting to discuss current experiences with reliability modeling and quantification of digital I&C systems in the context of PSA applications. The specific topics to be discussed at the meeting are: probabilistic models of digital I&C systems, identification of failure modes of the components of these systems, quantification of the probabilistic models, application of the resulting risk information for decision making, and identification of technical fields for further research and development. The task group will develop a report based upon the outcome of that meeting and subsequent discussions among the group members.

4. FUTURE DIRECTIONS

In order to help ensure that the working group's future activities are aligned with its objectives and responsive to CSNI's strategic directions (see Table 1), WGRISK has updated its initial integrated plan. The initial plan, which was completed in 2003, provided an extensive discussion of WGRISK's strategic goals, work processes, current status, and program of work. It also provided an in-depth review of PSA topics, including an assessment of the importance and priority of the topic [1].

Table 1: CSNI Main Challenges and Safety Issues and Topics (SITs)

- Shrinking nuclear infrastructure
  - Knowledge management
  - Experimental facility loss
- Increased public expectation on safety in use of nuclear energy
  - Use of risk-informed methods
  - Transparent technical basis for safety assessment
- Industry initiatives to improve economics and safety performance
  - Management strategies
  - Maintaining safety margins
  - Fuel and fuel cycle safety
  - Maintaining safety culture
- Necessity to ensure safety over plant lifecycle
  - Ageing management
  - New risk perspective and safety requirements
  - Upgrades in digital technology
  - Risk management across operating modes
- New reactors and new technology
  - Digital technology
  - New materials and fabrication techniques
  - New concepts of operation
  - New methods and tools

The updated plan is considerably less detailed, being aimed at providing higher-level for CSNI oversight and decision support. In addition to the working group's mandate, it provides a brief vision statement regarding how the working group will strive for excellence, a listing of the main challenges and associated SITs, a brief overview of the working group's current activities (including objective, status, and schedule), a description of interactions with other working groups, and a listing of recent products. The updated plan introduces a new programmatic element not included in the 2003 integrated plan: an activity to identify, develop, test, and implement appropriate feedback mechanisms to more formally assess the value of its activities and products to users. It is expected that the first steps to define and implement such an activity will be taken in early 2008.

5. CONCLUSION

WGRISK has, and will continue to provide, a forum for the exchange of information useful to member countries in their efforts to make improved use of PSA in risk-informed regulation and safety management. In order to strengthen the basis for future success, the working group is planning to develop a feedback program aimed at assessing the value of its activities and products.

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