

Trip Report for the Working Party on Nuclear Criticality Safety (WPNCs) and Associated Expert Group Meetings

Trip Package Information

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Traveler Information

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Trip Purpose

RES - Attend the annual meeting of the OECD/NEA Working Party on Nuclear Criticality Safety (WPNCs). RES has a user need to develop the appropriate cross sections using SCALE for calculations to audit licensee spent fuel package designs. (Supports NMSS-2005-003)

NRR - Participate in NEA annual meeting of its Working Party on Nuclear Criticality Safety. WPNCs has expert groups on burnup credit and uncertainty analysis. Key areas in NRR Action Plan 'On Site Spent Fuel Criticality Analyses.' See attached sheets with description of NEA WPNCs and expert groups. NRR staff will gain international perspective on these topics which will inform future guidance. Participation is included in the NRR Action Plan.

NRO - The purpose is to attend various expert group meetings (including burnup credit, advanced Monte Carlo techniques, criticality excursions, and uncertainty analysis) related to criticality safety. The discussions held by the expert groups are of interest to NRO as they relate to the ongoing staff review of design certification applications for spent fuel pool licensing.

Dates of Travel and Countries/Organizations Visited

Travel occurred between 9/4/2010 and 9/11/2010 with meetings at the Nuclear Energy Agency headquarters in Issy-les-Moulineaux, France occurring between 9/6/2010 through 9/10/2010.

Desired Outcome

RES - Identify the benefits that were realized from recent improvements of the burnup credit analysis methodologies; Discuss and evaluate the implications of applying improved burnup credit methodologies.

NRR - Acquire knowledge on international activities and perspective on the nuclear criticality safety (NCS) analysis, particularly in regard to burnup credit (BUC) and uncertainty analysis. NRR is developing durable guidance with respect to NCS analysis of spent nuclear fuel. Knowledge gained at these meetings will impact that guidance.

NRO - The desired outcome is an increased understanding and awareness of current international activities and viewpoints relating to criticality safety issues pertaining to the licensing of spent fuel pools. The intent is to gain knowledge that can be applied to ongoing licensing tasks. This knowledge is to be gained by listening to presentations and discussions from experts in the various groups listed in the NRO purpose statement. A secondary desired outcome is to come away with an understanding of any current expert group benchmarking problem so that appropriate calculations can be performed within NRO to further develop staff skills and familiarization with the codes that are used for spent fuel pool licensing and also to compare results with the international criticality safety community's results at a future meeting for validation purposes.

Results Achieved

NRC participants achieved their respective desired outcomes by attending the following meetings:

- Working Party on Nuclear Criticality Safety (WPNCS) – deals with technical and scientific issues relevant to criticality safety. Specific areas of interest include (but are not limited to) investigations of static and transient configurations encountered in the nuclear fuel cycle. These include fuel fabrication, transport and storage. The WPNCS oversees six expert groups and the International Criticality Safety Benchmark Evaluation Project (ICSBEP) Working Group.
- Expert Group on Advanced Monte Carlo Techniques for Criticality Safety Assessment (EGAMCT) – Participants discussed methods that will be useful for practitioners of Monte Carlo neutral-particle transport codes. Discussions included source convergence for spent fuel applications, Monte Carlo depletion, and perturbation theory concepts. These discussions are directly applicable to analyses performed by various NRC offices.
- Expert Group on Burnup Credit Criticality (EGBUC) – held two meetings. The first discussed progress on the Lessons Learned from International Investigations of Burnup Credit Criticality report. The second included discussions of member country activities in the area of burnup credit where presentations on current modeling activities were given and discussed, and a new benchmark was proposed. Information from this meeting was helpful to understand where the international community stands on burnup credit research and also to better understand what current state-of-the-art tools and resources are available to reviewers of burnup credit licensing applications.

- Expert Group on Uncertainty Analysis for Criticality Safety Assessment (EGUACSA) – This group is dedicated to evolving technology and guidance related to estimation of bias and its uncertainty for validation of criticality safety calculations and the assessment of manufacturing/operational (including depletion when applicable) uncertainties. It is understood that a large part of the uncertainty comes from the nuclear data that are used in criticality safety calculations and the ability to quantify this uncertainty is important.

Summary of Trip

On Monday September 6, 2010 the EGBUC met to discuss a lessons learned report it has been drafting for several years. The report will contain sections on pressurized water reactors and boiling water reactors. The report will also contain sections on mixed oxide fuel and the Russian VVER fuel designs. In addition the report will contain sections on validation, accident/abnormal conditions, and a broad section currently titled “Scientific and Technical Contributors to Assessing Risk and Uncertainty. Kent Wood (NRR/DSS) was invited to contribute to the this section. During this meeting NRC participants were also invited to review the structure and contents of the final report which will serve as a tool to provide guidance for practitioners performing or analyzing burnup credit calculations.

On Tuesday September 7, 2010 the EGAMCT met. Discussion on the future of the EGAMCT was held to determine the future path of research activities as this is a newly formed expert group and a mandate was agreed upon. Topics for study and evaluation were proposed and settled upon with a focus on Monte Carlo perturbation theory and Monte Carlo depletion. The area of perturbation theory as it relates to sensitivity and uncertainty analyses is becoming increasingly important in the area of burnup credit. The progress of calculational tools will be important for review work in several NRC offices in the future including NRR and NRO with respect to spent fuel pool analysis, and including NMSS with respect to cask storage and transport. Several presentations were also given which included important discussions on spatial source convergence in spent fuel applications, an area that requires special treatment when modeling spent fuel.

On Wednesday September 8, 2010 the EGBUC met again. The meeting included a revision to the existing EGBUC mandate. The meeting included a brief discussion of burnup credit activities among all of the member countries in attendance. The French regulatory agency, IRSN, has updated their burnup credit code, VESTA, to use MCNPX/ORIGEN2.2 in version 2.0, MCNPX/PHOENIX in version 2.1, and MORET/PHOENIX in version 2.2. The capability to use different combinations of codes within VESTA is a unique feature which will allow useful code comparisons for a given case as these codes are widely used in the criticality safety community. VESTA will be available through RSICC in the U.S. Finland announced that they will be doing BWR commercial reactor critical (CRC) research work which will complement the proposed EPRI/Studsvik initiative with PWR CRC research work. The methodology will be based on 2-D lattice physics codes. The Japanese representatives announced the release of the JENDL-4.0

cross-section library which aims to evaluate minor actinides and fission products. This work will be valuable to the assessment of uncertainties in the nuclear data.

A new calculational benchmark problem was proposed to the group relating to the analysis of small-sample reactivity experiments. The NRC was invited to participate in the benchmark and Amrit Patel of NRO agreed to perform the calculations. The value of the benchmark to the NRC is for validation of the codes used to perform sensitivity and uncertainty analysis which are currently being used to support development of guidance for NRR in the area of burnup credit for the licensing of spent fuel pools in the U.S. This guidance will also be used by NRO in the future.

On Thursday September 9, 2010 the EGUACSA met. The meeting included a revision to the existing EGUACSA mandate. Several methods are proposed that attempt to propagate quantifiable uncertainties and estimate the true calculational bias in order to establish an appropriate system neutron multiplication factor for various criticality safety scenarios. This area is of significant importance to the NRC, as was previously mentioned, due to the ongoing development of regulatory guidance for the review of spent fuel pool applications that incorporate sensitivity/uncertainty methods. It is therefore important for regulators and practitioners to understand how these tools are being applied to criticality safety practices.

Several presentations were given relating to developing technology in the field of uncertainty analysis. A benchmark was proposed in order to help the international community gain confidence in their computer codes that perform sensitivity/uncertainty calculations. Oak Ridge National laboratory (ORNL) in the U.S. volunteered to participate.

Additionally, the chairman of the ICSBEP Working Group gave a presentation of the ongoing work with the database for the International Handbook of Evaluated Criticality Safety Benchmark Experiments (DICE). DICE is a relational database with a user interface which allows users to query it. The ongoing work is adding overall correlation data between experiments which will aid in further increasing the accuracy of code bias estimation. Future activities include expanding the overall correlation data into categories to allow more advanced statistical application of the correlation data to bias and uncertainty assessment.

On Friday September 10, 2010 the WPNCS met. The meeting included a brief discussion of country reports from all of the member countries in attendance. Of particular note was a discussion about increasing the maximum enrichment for LWR fuel above 5.0 weight percent U235. The representative from Slovakia stated they have fuel with peak enrichment above 4.9 weight percent U235 with an assembly average enrichment of approximately 4.87 weight percent U235. The Japanese representative made a presentation concerning Japan's plans to pursue increasing the maximum enrichment for LWR fuel above 5.0 weight percent U235. As increasing the maximum enrichment for LWR fuel above 5.0 weight percent U235 would impact virtually every aspect of the nuclear fuel cycle it was determined that the WPNCS Chairman would bring this item to the attention of the Nuclear Science Committee for consideration.

The chairman of each expert group in attendance and the Chairman of the ICSBEP Working Group provided a brief of the previous year's accomplishments and intended future actions. Those actions are included in the mandate for each expert group. The WPNCS approved the revised mandates for EGBUC and EGUACSA. As it is, the initial mandate for EGAMCT was recommended for approval and will be forwarded to the Nuclear Science Committee for consideration.

NRC participation in the various expert groups above is of value to the NRC and should be continued to understand the direction of research in various international efforts and also to better understand the science behind criticality safety practices. The meetings of the expert groups allow open discussion and highlight important criticality safety practices and guidance, especially in areas where characterization of spent fuel is important, as in spent fuel storage and transportation. The guidance provided by the expert groups is specifically tailored for criticality safety practitioners, and in that regard, the guidance provided is highly useful for regulatory agencies.

Additional Information/Discussion

The following webpage has information on the WPNCS and the associated expert groups.

<http://www.nea.fr/science/wpncs/index.html>

The following webpage has links available under the "Publications and Reports" section that provide an extensive compilation of burnup credit references in addition to NEA reports available online. The link to the references is currently being updated to include publications after 2005.

<http://www.nea.fr/science/wpncs/buc/index.html>

Pending Actions/Planned Next Steps for NRC

Kent Wood is to provide input on the Burnup Credit Lessons Learned Report and Amrit Patel is to provide benchmark problem results to the EGBUC for the next meeting.

Points for Commission Consideration/Interest

The content of this report is not likely to be of interest to the Commission. No Commission action is required.