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**ORNL  
FOREIGN TRIP REPORT  
TA 378296**

**DATE:** January 16, 2015

**SUBJECT:** Report of Foreign Travel Paris, France – William J. Marshall, Reactor and Nuclear Systems Division

**TO:** Jerry N. McKamy, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-00-10/GTN, 1000 Independence Ave., SW, Washington, DC 20585-1290

**FROM:** William J. Marshall

**MEETING:  
TITLE** Working Party on Nuclear Criticality Safety (WPNCSS) Expert Groups on Advanced Monte Carlo Techniques (AMCT) and Uncertainty Analysis for Criticality Safety Assessment (UACSA)

**MEETING:  
LOCATION** OECD/NEA Headquarters, Paris, France

**MEETING:  
DATES** July 6-9, 2015

**ATTENDEES:  
ON BEHALF  
OF NCSP** William J. Marshall

**MEETING:  
BENEFIT TO  
NCSP** Mr. Marshall is an expert on applications of the SCALE S/U analysis capabilities, and has been leading efforts to develop and use these capabilities to determine correlations among critical experiments. As a member of the WPNCSS Expert Group on uncertainty analysis, Marshall presented recent SCALE results for the benchmarking work tasks for these experiment correlations. By participating in the WPNCSS meeting, the NCSP continued to demonstrate leadership in S/U analysis methods. As an added benefit, the NCSP obtain valuable feedback and information exchange through the latest benchmarking analyses with the SCALE S/U tools. As a result, ORNL obtained important information needed to test and improve the NCSP S/U capabilities that are in SCALE by vetting these S/U capabilities with the international community.

**PURPOSE:** The primary purpose of the travel to Paris is to participate in the Organization for Economic Cooperation and Development (OECD) Working Party on Nuclear Criticality Safety (WPNCS) Expert groups on Advanced Monte Carlo Techniques (AMCT) and Uncertainty Analysis for Criticality Safety Assessment (UACSA).

**SITES:  
VISITED** OECD/NEA Headquarters

**ABSTRACT:** The OECD/WPNCS UACSA expert group is working to apply advanced uncertainty analysis tools to improve confidence in criticality safety validation, and the AMCT expert group is working to establish best practices for the application of advanced Monte Carlo simulations for criticality safety analysis. Both of these expert groups align well the NCSP Analytical Methods tasks, and William Marshall is contributing in both of these expert groups, particularly with key results related to critical experiment correlations as part of the UACSA Phase IV benchmark. The SCALE tools developed with NCSP Analytical Methods support help provide enabling capabilities that advance the state-of-the-art within the NCSP and OECD expert groups where new approaches are presented and reviewed in collaboration with the international community.

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## **REPORT OF FOREIGN TRAVEL**

**William J. Marshall  
Paris, France  
July 6-9, 2015**

### **PURPOSE OF TRAVEL**

The primary purpose of the travel to Paris is to participate in the Organization for Economic Cooperation and Development (OECD) Working Party on Nuclear Criticality Safety (WPNCS) Expert groups on Advanced Monte Carlo Techniques (AMCT) and Uncertainty Analysis for Criticality Safety Assessment (UACSA).

### **Report**

The UACSA expert group is working to apply advanced uncertainty analysis tools to improve confidence in criticality safety validation. In this meeting, a review of the current benchmark exercises that focus on the determination of correlations in uncertainties between criticality safety benchmark experiments was conducted. Where correlations between experiments are high, the effective number of independent data points is reduced, and subcritical margins could be impacted. This meeting attracted a wide range of participants from the U.S., U.K., Sweden, France, Germany, Japan, Korea, Slovakia, and others. Four teams presented preliminary results for the benchmark, with three participants using SCALE in their work. Marshall provided a presentation of the use of the Sampler code of SCALE to quantify the correlation in uncertainties in benchmark experiments. The latest results reinforced the conclusion obtained during the 2014 meeting that the primary source of experimental uncertainty for low-enriched uranium fuel-rod lattice experiments is derived from uncertainty in the fuel rod pitch, especially where all pitch uncertainties within a single experiment are treated as fully correlated. With this assumption all of the pins move systematically closer together or farther apart with each sample within the provided uncertainty. With this first assumption, correlations between benchmark cases can exceed 0.99. However, when the fuel rod positions are varied randomly within the tolerances, the overall correlation is drastically reduced. With this second assumption, correlations between benchmarks are generally on the order of 0.25. A justification for pin pitch uncertainty assumptions that will meet regulatory requirements needs to be established.

Additional topics were also discussed at the UACSA meeting. Dr. Santamaria (CEA) proposed a blind validation benchmark for MOX powder. This exercise has clear potential benefits for efficient operations for MOX fuel fabrication, but it is less evident what the benefits would be for US domestic participation at this time. Brad Rearden also presented updates on the sensitivity/uncertainty (S/U) tools and capabilities planned for release in SCALE 6.2. The primary features discussed were continuous-energy sensitivity capabilities and updates to the cross-section covariance library. The covariance library discussion updated preliminary results presented at last year's UACSA meeting, and there was, in general, improved confidence in the covariance library improvements that have been made over the last 10 months since the prior UACSA meeting.

The UACSA expert group has been chaired by Brad Rearden since September 2014. Dr. Rearden will continue as the chair at least until the July 2016 meeting.

The OECD/WPNCS AMCT expert group is working to establish best practices for the application of advanced Monte Carlo simulations for criticality safety analysis. At this meeting, many code teams are

represented, and this venue provides an excellent opportunity to share novel ideas and best practices. In addition to SCALE, this meeting included representatives from the MORET team at IRSN, the TRIPOLI team from CEA, the MONK/ANSWERS team from the UK, and the MCNP team from Los Alamos. Dr. Chris Perfetti is assisting Dr. Rearden in leading an exercise to examine errors in Monte Carlo flux tallies, which are needed for reaction rate analysis as well as sensitivity analysis. Results compiled from several participants reveal that errors in the values of the tallies that exceed their reported uncertainties by an order of magnitude are possible in some regions of large fissile systems. Preliminary tally convergence metrics were presented that could provide insight into the quality of the flux and reaction rate calculations performed using Monte Carlo. All code teams agreed that some type of metric should be implemented in all of the codes.

Additional topics were presented, though they were mostly devoted to somewhat esoteric problems that can be encountered in Monte Carlo simulations involving very small sample sizes. Many of these discussions were centered on Monte Carlo theory and code development. Ultimately, these are important aspects of confirming the correct functioning and application of these tools for criticality safety assessments.

Overall, Marshall's participation in these meetings, coupled with the participation of Dr. Rearden and Dr. Perfetti (both sponsored by other work), provided the opportunity to ensure that NCSP Analytical Methods interests are represented in the international community. In addition, the technical information exchange will be used to improve the NCSP SCALE analytical methods to support nuclear criticality safety analyses.

### **Itinerary**

07/04/2015 – 07/05/2015	Travel from Knoxville, TN, USA to Paris, France
07/06/2015 – 07/09/2015	Attend OECD/WPNCS AMCT and UACSA Meetings
07/10/2014	Travel from Paris, France to Knoxville, TN, USA

## DISTRIBUTION

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ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT  
Nuclear Energy Agency  
Nuclear Science Committee  
Working Party on Nuclear Criticality Safety

9th Meeting of the Expert Group on  
Uncertainty Analysis for Criticality Safety Assessment (EGUACSA)

Wednesday July 8<sup>th</sup> 2015  
NEA Headquarters, Issy-les-Moulineaux,  
France

AGENDA

Meeting venue : NEA Headquarters, Room B

*Proposed Meeting Schedule:*  
9h00 – 18h00

- 1) Welcome (*B. Rearden*)
- 2) Administrative items *Secretariat / All*
  - a) Approval of the agenda
  - b) Approval of the summary record from the previous meeting
- 3) Status of Benchmark Phase IV on the Role of Integral Experiment Covariance Data for C.S. validation
  - a) *Proposed Changes to Benchmark Phase IV*, O. Buss (Areva)
  - b) *Results of Benchmark Phase IV*, M. Stuke, (GRS)
  - c) *Results of Benchmark Phase IV*, G.S. Lee (KINS)
  - d) *Results for Critical Experiment Correlations Benchmark*, W. Marshall (ORNL)
  - e) *Results and preliminary conclusions from Benchmark Phase IV*, D. Mennerdahl (EMS)
- 4) Status of Benchmark Phase V Blind Benchmark proposal
  - a) *MOX powder benchmark*, A. Santamarina (CEA)
- 5) General presentations (20' + 5')
  - a) *A New OECD-NEA Tool for Nuclear Data Sensitivity Analyses in Criticality Safety Benchmarks (NDaST)*, J. Dyrda, (NEA)
  - b) *Advances in Sensitivity and Uncertainty Analysis Tools and Data for SCALE 6.2*, B. Rearden (ORNL)
  - c) *Preliminary Results on a benchmark proposal*, A. Jinaphanh (IRSN)
- 6) Any other business
  - a) Proposal for Mandate Extension
    - i) Revision of Scope (if any)
    - ii) Revision of Deliverables and their timeline
    - iii) Date and Place of the next meeting : 4-7 July 2016?

Adjourn

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT  
Nuclear Energy Agency  
Nuclear Science Committee  
Working Party on Nuclear Criticality Safety  
4<sup>th</sup> Meeting of the Expert Group on  
Advanced Monte Carlo Techniques for Criticality Safety Assessment (EGAMCT)

Tuesday July 7, 2015  
NEA Headquarters, Issy-les-Moulineaux  
France

**PRELIMINARY**  
**AGENDA**  
Meeting venue : NEA Room A

*Proposed Meeting Schedule: 9h00 – 18h00*

1. Welcome – *J. Miss*
2. Approval of the agenda, review of actions from past meeting and approval of summary record - *Secretariat*
3. Benchmark Phase I
  - a. *Status of Benchmark Phase I and Results* – J. Miss (IRSN)
  - b. *IRSN results for Phase I with MORET* – A. Onillon (IRSN)
4. Other Presentations
  - a. *Diagnosis of spatial correlations* – E. Dumonteil, M. Nowak (CEA)
  - b. *Statistical methods for predicting M.C. undersampling biases* – C. Perfetti (ORNL)
  - c. *The Critical Catastrophe Revisited* – A. Zoia (CEA)
  - d. *MCNP Status* – F. Brown (LANL)
5. Request for an extension of Mandate NEA Secretariat / All
  - a. *Revision of scope (if any)*
  - b. *Revision of deliverables list and timeline*
6. Any other business
7. Date and place of the next meeting
  - 4-7 July 2015 ?
8. Adjourn