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**ORNL
FOREIGN TRIP REPORT
TA 366452**

DATE: October 24, 2014

SUBJECT: Report of Foreign Travel Paris, France – Bradley T. Rearden, 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: Bradley T. Rearden

**MEETING:
TITLE** Working Party on Nuclear Criticality Safety (WPNCS) 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** September 15-19, 2014

**ATTENDEES:
ON BEHALF
OF NCSP** Bradley T. Rearden

**MEETING:
BENEFIT TO
NCSP** Dr. Rearden is the SCALE Project Manager and developer of the SCALE S/U analysis capabilities. As a member of the WPNCS Expert Groups, Rearden has leadership roles in the AMCT and UACSA EGs. The AMCT is working to establish best practices for the application of advanced Monte Carlo simulations for criticality safety analysis. The results of the AMCT EG will lead to improved Monte Carlo capabilities for NCS calculations with SCALE. During the UACSA EG, Rearden presented recent SCALE results for the benchmarking work tasks for uncertainty analyses. Through Rearden’s participation in the WPNCS EG meetings, the NCSP continues to demonstrate leadership in key analytical methods capabilities. As an added benefit, the NCSP obtained feedback through the latest EG benchmarking and testing work using SCALE. The feedback will certainly lead to improved NCSP/SCALE S/U capabilities by continued vetting of the SCALE AM capabilities with the international community.

PURPOSE: The primary purpose of the travel to Paris was 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 Brad Rearden is leading activities and contributing key results in both of these expert groups. The SCALE tools developed under Rearden's leadership with NCSP Analytical Methods support provide enabling capabilities that advance the state-of-the-art within the OECD expert groups where new approaches are presented and reviewed in collaboration with the international community.

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REPORT OF FOREIGN TRAVEL

**Bradley T. Rearden
Paris, France
September 13–21, 2014**

PURPOSE OF TRAVEL

The primary purpose of the travel to Paris was 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 point 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. Several teams presented preliminary results for the benchmark, with several participants using SCALE in their work. Rearden provided a presentation of the use of the Sampler code of SCALE to quantify the correlation in uncertainties in benchmark experiments. The interesting result found by many teams is 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 further 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. Justification some combination of the two approaches needs to be found. The consensus of the group is to explore different levels of systematic versus random uncertainty in the fuel rod placement and make a final revision to the benchmark before concluding this phase of study.

Rearden also presented the latest ORNL neutron cross-section covariance library, including data from ENDF/B-VII.1. ORNL has proactively corrected several errors in the ENDF/B-VII.1 data distributed by the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory, and provided feedback to the NNDC on these corrections. A significant update in the SCALE covariance library is the update of the ²³⁹Pu nubar uncertainty. The currently release SCALE library uses data from ENDF/B-V, which was the best available at the time the library was created. Replacing the ENDF/B-V with the latest ENDF/B-VII.1 data results in a reduction in the nubar uncertainty from approximately 1% to approximately 0.2%. This uncertainty reduction can impact c_k values computed with TSUNAMI as well as data adjustments computed with TSURFER. Further review of the impact of this change is recommended.

At the end of the UACSA meeting, Rearden was elected to chair the group, replacing Tatiana Ivanova from IRSN, who has chaired the group for 7 years. During this time, interest in the activities of this group has continued to grow, attracting over 40 participants at this 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 representative 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. Rearden is leading an exercise to examine errors in Monte Carlo flux tallies, which are needed for reaction rate analysis as well as sensitivity analysis. Preliminary results 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.

Overall, Rearden's participation in these meetings provided the opportunity to ensure that NCSP Analytical Methods interests are represented in the international community.

Itinerary

09/13/2014 - 09/14/2014	Travel from Knoxville, TN, USA to Paris, France
09/15/2014 – 09/19/2014	Attend OECD/WPNCS AMCT and UACSA Meetings
09/20/2014	Personal Day
09/21/2014	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

**8th Meeting of the Expert Group on
Uncertainty Analysis for Criticality Safety Assessment (EGUACSA)**

Monday-Tuesday September 15-16 2014
NEA Headquarters, Issy-les-Moulineaux,
France

AGENDA

Meeting venue : NEA Headquarters, Room B

Proposed Meeting Schedule:

Monday September 15 2014, 9h00 – 18h00

Tuesday September 16 2014, 9h00 – 13h00

1. Welcome (*NEA / T. Ivanova*)
2. Approval of the Agenda: *Secretariat / All*
3. Approval of the summary record from the previous meeting and review of actions:
Secretariat / All
4. Status of **Phase II Benchmark**: *J.C. Neuber*
5. Benchmark **Phase III** on calculation of *keff* sensitivities to nuclear data
 - 5.1 Uncertainty Analysis using an IFP-based Method in TRIPOLI-4, *G. Truchet*
 - 5.2 Benchmark on sensitivity calculations proposed by WPEC/Sg. 39 and summary results: *E. Ivanov*
 - 5.3 Discussion of the preliminary Draft Report: *Ivanova T. / All*
6. Benchmark **Phase IV** on the Role of Integral Experiment Covariance Data for C.S. validation
 - 6.1 New Benchmark Specifications : *A. Hoefler / T. Ivanova*
 - 6.2 Contribution to Phase IV benchmark, *C. Riffard*
 - 6.3 Role of Integral Experiment Covariance Data for Criticality Safety Validation,
J. Dyrda
 - 6.4 Latest ORNL Studies on Experimental Correlations, *B. Rearden.*
 - 6.5 Correlation of error sources and associated reactivity influences,
D. Mennerdahl
7. New Benchmark proposal on criticality safety validation for fuel cycle configurations with MOX fuel : *I. Duhamel*
8. General presentations
 - 8.1 PSI UACSA-related studies, *M. Pecchia*
 - 8.2 Propagation of Rod Positioning Uncertainty in a Lattice, *N. Leclaire*
 - 8.3 Cross Section Covariance Data for SCALE 6.2, *B. Rearden*

- 8.4 Recent Advances in SCALE Sensitivity Methods, *C. Perfetti*
 - 8.5 Generation of sensitivity correlations for ICSBEP configurations, *I. Hill*
 - 8.6 Status of **Phase V** blind benchmark (*MOX wet powders*) CEA ? (TBC)
9. Any other business
- 9.1 Change of Chairmanship of EG-UACSA
 - 9.2 Proposal for new Mandate (present mandate ending June 2015)
 - 9.3 Date and place of next meeting
10. Adjourn

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

Thursday September 18, 2014
NEA Headquarters, Issy-les-Moulineaux
France

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
 - 3.1. *New Specifications of Benchmark Phase I and Results – J. Miss*
 - 3.2. *First global comparisons– Joachim Miss*
 - 3.3. *EMS detailed results – Dennis Mennerdahl*
 - 3.4. *IRSN detailed results – Anthony Onillon*
 - 3.5. *KFKI results – G. Hordosy*
 - 3.6. *GRS detailed results – (TBD)*
 - 3.7. *ORNL detailed results – (TBD)*
 - 3.8. *Results from other participants*
4. Presentations
 - 4.1. *Symmetry in Monte Carlo simulation, Dennis Mennerdahl*
 - 4.2. *New hash-based Energy Lookup Algorithm for Monte Carlo, Forrest Brown*
 - 4.3. *TBD - P. Smith*
 - 4.4. *TBD - A. Onillon*
 - 4.5. *Other presentations*
5. Identification of other activities/studies (Note: Current Mandate of EGAMCT ends in June 2015)
6. Any other business (next meeting): *All*
7. Adjourn