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**ORNL
FOREIGN TRIP REPORT
TA 361288**

DATE: August 27, 2014

SUBJECT: Report of Foreign Travel Paris, France – Luiz C. Leal, 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: Luiz C. Leal

**MEETING:
TITLE** 1) Collaboration meeting with the Institut de Radioprotection et de Sûreté (IRSN) and 2) Working Party on International Nuclear Data Evaluation Co-operation (WPEC)

**MEETING:
LOCATION** IRSN Headquarters and NEA Headquarters, Paris, France

**MEETING:
DATES** 1) IRSN: May 5-14, 2014 and May 17-31, 2014 and 2) WPEC: May 15-16, 2014

**ATTENDEES:
ON BEHALF
OF NCSP** Luiz Leal and Michael Dunn (WPEC and 1-day meeting at IRSN)

**MEETING:
BENEFIT TO
NCSP** Dr. Leal is developing new ^{235}U and ^{56}Fe nuclear data evaluations for the U.S. Nuclear Criticality Safety Program (NCSP), and as part of the travel, Leal had the opportunity to work with IRSN to access proprietary benchmark data and expertise to test and improve the new NCSP nuclear data evaluations. As a benefit from the travel, ORNL has been able to expedite the progress on completing new ^{235}U and ^{56}Fe nuclear data evaluations for the NCSP. Further, the collaborative work with IRSN provided the opportunity to improve the accuracy of the nuclear data evaluations through extensive testing with IRSN. With regard to the WPEC meeting, there is an ongoing effort to generate an evaluated nuclear data library by consolidating the evaluation work performed at various laboratories throughout the world. This effort is being performed as part of the WPEC subgroup named the Collaborative International Evaluated Library Organization (CIELO) project. The NCSP resonance evaluation work for ^{16}O , ^{56}Fe , ^{235}U and ^{239}Pu has been identified as important contributions for the CIELO project. Participation in the WPEC meeting is of benefit to the NCSP

because the CIELO resonance evaluation work aligns with the NCSP Five Year Plan. By developing these priority NCSP evaluations as part of the CIELO project, there is an opportunity to develop and test these evaluations within an international framework thereby shortening the evaluation time while improving the overall quality of the nuclear data evaluations.

PURPOSE: The purpose of the travel to France is to perform nuclear cross-section evaluation work in accordance with the NCSP Five Year Plan. The travel provided the opportunity for Leal to work with IRSN staff to test and improve the ^{235}U and ^{56}Fe evaluations, respectively. These work tasks have been performed in accordance with the NCSP Five Year Plan. In addition, Leal participated in the WPEC CIELO meeting and presented the ORNL nuclear data evaluation work performed for the NCSP.

**SITES:
VISITED** IRSN Headquarters and OECD/NEA Headquarters

ABSTRACT: During the first three weeks of travel, Leal worked at IRSN to generate a cross-section library with the updated ORNL ^{56}Fe resonance evaluation in order to test the evaluation with benchmark experiments. In addition, Leal worked with IRSN to develop a collaborative paper for the special NCSP session at the Winter Meeting of the American Nuclear Society November 9-13, 2014. After visiting IRSN, Leal attended the WPEC meeting at OECD/NEA Headquarters, May 12-15. Leal participated in the WPEC subgroup meetings to discuss ORNL accomplishments for the ^{16}O , ^{56}Fe , and ^{235}U resonance evaluations. Leal gave two presentations during the WPEC meeting, namely, "Resonance Region of ^{56}Fe for the CIELO Project," and "Resonance Region of ^{235}U for the CIELO Project." At the WPEC meeting, Leal also presented a proposal for a new WPEC subgroup to provide nuclear data evaluation improvements for thermal neutron scattering data. The WPEC subgroup proposal is titled "Thermal Scattering Kernel S(a,b): Measurement, Evaluation and Application." The development of new thermal neutron scattering measurement and evaluation capabilities is identified as a nuclear data task in the NCSP Five Year Plan.

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REPORT OF FOREIGN TRAVEL

**Luiz C. Leal
Paris, France
May 5–31, 2014**

PURPOSE OF TRAVEL

The purpose of the travel to France is to perform nuclear cross-section evaluation work in accordance with the NCSP Five Year Plan. The travel provided the opportunity for Leal to work with IRSN staff to test and improve the ^{235}U and ^{56}Fe evaluations, respectively. These work tasks have been performed in accordance with the NCSP Five Year Plan. In addition, Leal participated in the WPEC CIELO meeting and presented the ORNL nuclear data evaluation work performed for the NCSP.

Report

Benchmark calculations of criticality safety benchmarks and shielding benchmark experiments with ^{56}Fe were performed in collaboration with IRSN. IRSN staff members selected a series of benchmark problems sensitive to the ^{56}Fe energy-angle dependent scattering cross section. The benchmark experiments provided a rigorous test for the new ORNL ^{56}Fe evaluation.

With regard to the ^{56}Fe evaluation, ORNL has developed a new approach to extend the ^{56}Fe resolved resonance range from 850 keV in the present evaluation to as high as the experimental energy resolution of the data permit. High-resolution transmission data for ^{56}Fe have been measured at Rensselaer Polytechnic Institute (RPI). The measurements were performed on a 250-m flight-path with a neutron burst of 1.5 ns providing that results in excellent neutron energy resolution. These data were used to extend the present ENDF/B-VII.1 ^{56}Fe resolved resonance evaluation up to 2 MeV. The energy range above 850 keV includes an inelastic channel. Therefore, the representation of the inelastic cross section with resonance parameters must be addressed. New inelastic cross-section measurements have been performed using the Geel Electron Linear Accelerator (GELINA) at the Institute for Reference Materials and Measurements (IRMM) in Belgium. The IRMM data were also used in the SAMMY resonance evaluation effort for ^{56}Fe . In addition, ORNL has championed a new approach for generating angular-dependent cross-section data produced from the resonance parameters with the objective of improving the calculation of neutron leakage in criticality safety benchmarks for systems with small dimensions. IRSN has proprietary integral benchmark experiment data in the thermal energy region that were used to test and improve the ^{56}Fe resonance evaluation. In addition to the critical benchmark data, fixed-source benchmark experiments consisting of iron spheres with dimensions ranging from 20 cm to 70 cm radius were also used in the evaluation testing effort. The results of calculations performed for three iron spheres of diameters 20 cm, 40cm and 70 cm are shown in Fig. 1. The solid line is the calculated results obtained with SAMMY and the new ORNL ^{56}Fe resonance evaluation whereas the symbols are the experiments. Overall the results are very encouraging. A ^{56}Fe cross-section library has been submitted for further testing by members of the CIELO project.

In addition to the work on ^{56}Fe , ORNL has developed a new ^{235}U resonance region evaluation based on new measurements and as part of a collaborative evaluation effort with the Commissariat à l'Énergie Atomique (CEA) / Cadarache. The visit to IRSN provided an opportunity to test the new ^{235}U resonance evaluation with IRSN. During the visit, a radiation transport cross-section library was generated using the new ^{235}U evaluation. The ^{235}U evaluation was tested by modeling a select set of benchmarks that are

sensitive to the resolved and unresolved resonance regions of ^{235}U . Based on the analyses, the ^{235}U evaluation performed well for systems that are sensitive to the resonance region; however, the benchmark testing also showed that evaluation improvements are needed at energies above the resonance region (i.e., “high-energy” region). Follow-on work is planned with CEA/Bruyeres le Chatel in order to improve the high-energy portion of the cross-section evaluation. Once the high-energy evaluation is updated, additional benchmark testing will be performed with the new ^{235}U evaluation.

Overall, Leal’s foreign travel to IRSN has been important to completing nuclear data evaluation work tasks as defined in the NCSP Five Year Plan. Furthermore, the travel has accelerated the cross-section evaluation and testing effort for ^{235}U and ^{56}Fe thereby enabling ORNL to perform work toward completing the NCSP Five Year Plan tasks for these key evaluations.

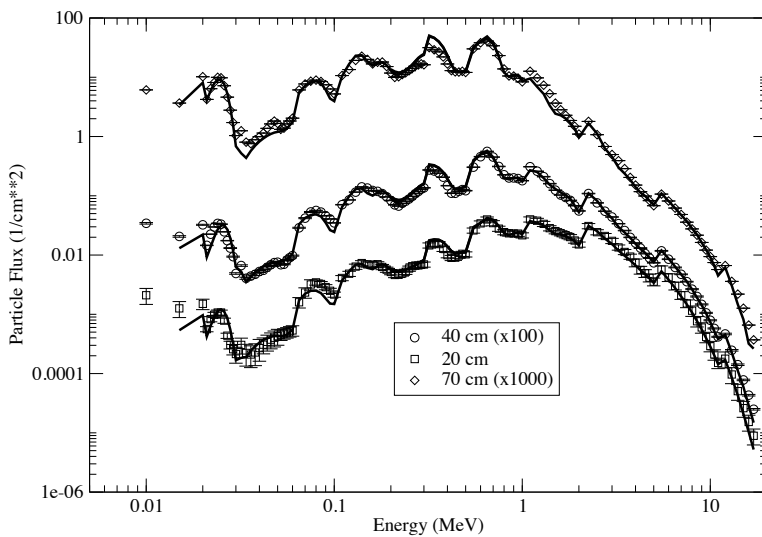


Fig. 1. Comparison of ^{56}Fe ORNL evaluation with experimental data identified by IRSN staff member sensitive to the ^{56}Fe cross sections.

Itinerary

5/04/14 - 5/05/14	Travel from Knoxville, TN, USA to Paris, France
5/05/14 - 5/09/14	Work at IRSN
5/12/14 – 5/16/14	Attend WPEC
5/19/14 - 5/30/14	Work at IRSN
5/31/14	Travel from Paris, France to Knoxville, TN, USA

DISTRIBUTION

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