

**OAK RIDGE NATIONAL LABORATORY  
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**ORNL  
FOREIGN TRIP REPORT  
TA 414861**

**DATE:** October 16, 2017

**SUBJECT:** Report of Foreign Travel: Aix En Provence– Goran Arbanas, Reactor and Nuclear Systems Division

**TO:** Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-511/GTN, 1000 Independence Ave., SW, Washington, DC 20585-1290

**FROM:** Goran Arbanas

**MEETING:  
TITLE** 4<sup>th</sup> International Workshop on Nuclear Data Covariances (cw2017.com)

**MEETING:  
LOCATION** Aix En Provence, France

**MEETING:  
DATES** 10/2/2017 – 10/6/2017

**ATTENDEES:  
ON BEHALF  
OF NCSP** Goran Arbanas

**MEETING:  
BENEFIT TO  
NCSP** Goran Arbanas was invited to participate in the 4<sup>th</sup> International Workshop on Nuclear Data Covariances, October 2-6, 2017, to present a cutting edge covariance methodology developed at the Oak Ridge National Laboratory. This meeting provided an opportunity to introduce this novel method to nuclear data community, and to exchange technical information with experts and practitioners in uncertainty and covariance generation methods to benefit NCSP nuclear data work efforts. Arbanas' participation in conference was needed to ensure that most accurate methods for covariance generation be introduced to nuclear data evaluation community and employed in the modernized version of the SAMMY code.

**PURPOSE:** Invited to participate in the 4<sup>th</sup> International Workshop on Nuclear Data Covariances, to represent NCSP nuclear data methods and needs, and to discuss ongoing modernization of ORNL's nuclear data evaluation code SAMMY. Furthermore, the purpose of the travel is to cultivate and sustain collaborations with multiple international partners who may help the NCSP accomplish nuclear data work tasks as

defined in the FY18-22 NCSP Five Year Plan. Collaborations were initiated with:

- 1) Roberto Capote (IAEA, Austria) to compare our new method with the Universal Monte Carlo method,
- 2) Gilles Noguere (CEA, France) and Luiz Leal (IRSN, France) for upcoming measurements and evaluations of thermal neutron scattering kernels, and
- 3) Georg Schnabel (CEA, France) and his recent academic adviser Helmut Leeb (TTU, Vienna, Austria) on covariance generation methods.

**SITES:  
VISITED**

Aix En Provence, France

**ABSTRACT:**

Arbanas was invited to present a talk titled “Bayesian Generalized Data Covariance Method” at the 4<sup>th</sup> International Workshop on Nuclear Data Covariances, Aix En Provence, France, October 2-6, 2017. Arbanas presented this novel application of Bayes’ theorem to generalized data for simultaneous and consistent evaluation of both differential and integral benchmark experiments that would yield most accurate covariance data and obviate the need for data adjustment methods presently in use. Furthermore, our framework is the first one to formally accommodate inclusion of model defects into the evaluation methodology, and it has established a roadmap for understanding and judging various approximate evaluation methods currently in use. Participation at this event was essential in order to advocate our new evaluation method to the broader nuclear data evaluation community and to dispel any misconceptions that were raised. This activity has paved a way toward acceptance of this method by the nuclear data evaluation community, and toward its implementation in the modernized SAMMY code for future evaluations.

## **Itinerary**

9/30/17 - 10/1/17      Travel from Knoxville, TN, USA to Aix En Provence, France

10/2/17 – 10/6/17      Participate in the 4<sup>th</sup> International Workshop on Nuclear Data Covariances (CW2017.com), Aix En Provence, France.

10/7/17                  Travel from Aix En Provence, France, to Knoxville, TN, USA



**APPENDIX B**



## DISTRIBUTION

1. D. G. Bowen ([bowendg@ornl.gov](mailto:bowendg@ornl.gov))
2. Angela Chambers ([Angela.Chambers@mnsa.doe.gov](mailto:Angela.Chambers@mnsa.doe.gov))
3. Lori Scott ([Lorisc0tt@aol.com](mailto:Lorisc0tt@aol.com))

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**ORNL  
FOREIGN TRIP REPORT  
TA 412968**

**DATE:** October 16, 2017

**SUBJECT:** Report of Foreign Travel to Aix en Provence and Fontenay aux Roses, France – Vladimir Sobes, Reactor and Nuclear Systems Division

**TO:** Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-511/GTN, Pantex Plant, PO Box 30020, Amarillo, TX 79120-0020

**FROM:** Vladimir Sobes

**MEETING:  
TITLE** 4<sup>th</sup> edition of the International Workshop on Nuclear Data Covariances and NCSP Nuclear Data Collaboration Meeting with IRSN

**MEETING:  
LOCATION** Aix en Provence, France; Institute of Radiological protection and Nuclear Safety (IRSN), Fontenay Aux Roses, France

**MEETING:  
DATES** 10/02/2017 – 10/13/2017

**ATTENDEES:  
ON BEHALF  
OF NCSP** Vladimir Sobes

**MEETING:  
BENEFIT TO  
NCSP** The US DOE Nuclear Data Advisory Group (NDAG) maintains and constantly updates lists of materials that are considered important for applications in nuclear criticality safety. The NDAG has identified gadolinium to be an important element for an updated nuclear data evaluation in the near future. The US DOE Nuclear Criticality Safety Program (NCSP), following the advice of the NDAG committee, added the evaluation of gadolinium to the list of isotopes considered as important for measurement and evaluation in the next five years to its published Five-Year Execution Plan for the Mission and Vision of the program. The nuclear data evaluation of gadolinium has been identified as a joint effort between Oak Ridge National Laboratory (ORNL) and the Institute of Radiological protection and Nuclear Safety (IRSN) in France under the existing NCSP/IRSN memorandum of understanding and Appendix E of the NCSP 5-year plan. Dr. Sobes, the traveler, and Dr. Leal were identified as the two Principle Investigators (PIs) for the evaluation of gadolinium respectively for their institutions. This trip helps to accomplish the

execution plan laid out by the US DOE NCSP and in particular supports the goal of improving the differential data evaluations for isotopes of interest for nuclear criticality safety in the US. Therefore, this visit will help ensure that DOE and ORNL maintain a leadership position in the nuclear data analysis area while also cultivating international partnerships that could provide further data and information to support the US NCSP.

During the travel to France, Dr. Sobes will also be participating in the 4th edition of the International Workshop on Nuclear Data Covariances, 2017 to be held in Aix en Provence, France, in October 2-6, 2017. Dr. Sobes is one of the founders and the group coordinator of the OECD/NEA Working Party on International Nuclear Data Evaluation Co-operation (WPEC) Subgroup 44 (SG44) on the "Investigation of Covariance Data in General Purpose Nuclear Data Libraries." Nuclear data covariance is fundamentally important to the US DOE NCSP as it influences safety margins derived from modeling and simulation of existing and proposed criticality safety systems. Dr. Sobes has been selected to represent the interests of ORNL and serve as the chair of this international expert group. Overall, the objective of the WPEC meeting is to coordinate the international nuclear data measurement and evaluation work activities among the international nuclear data projects, and participation in the WPEC meeting is important for the NCSP as the meeting provides an opportunity to exchange information about nuclear data work efforts and help influence work activities that can benefit NCSP nuclear data work efforts. During the International Workshop on Nuclear Data Covariances, Dr. Sobes will be chairing an intermediate meeting of SG44 focused on the influence of integral experimental data on nuclear data covariance evaluations for general purpose nuclear data libraries as well as promoting active participation of the conference attendees in future SG44 meetings.

**PURPOSE:** Dr. Sobes is the principle investigator (PI) for the task of performing the nuclear data evaluation in the resonance region for three of the isotopes of gadolinium,  $^{156}\text{Gd}$ ,  $^{158}\text{Gd}$ , and  $^{160}\text{Gd}$ , that have been identified as important for evaluation in the next five years in the Five Year Plan of the Mission and Vision of the NCSP. Dr. Leal is the PI for performing the nuclear data evaluation for the two other major isotopes of gadolinium,  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$ , from IRSN. The primary purpose of this trip was for Dr. Sobes to collaborate with Dr. Luiz Leal at IRSN on the joint evaluation of the isotopes of gadolinium and allow the two researchers to synchronize the on-going evaluation of all five isotopes. Further, Dr. Sobes and Dr. Leal collaborated methods of experimental data analysis, jointly studied historical cross section measurements that can serve to improve the nuclear data evaluation for gadolinium and discussed coordinated strategies for generating covariance data.

**SITES:** IRSN, Fontenay aux Roses, France  
**VISITED** NEA OECD Conference Centre, Paris, France

**ABSTRACT:** The traveler made a trip to the Institute of Radiological protection and Nuclear Safety (IRSN) to work collaboratively with the IRSN nuclear data team on cross section evaluations in the resolved resonance region for isotopes of interest to NCSP and IRSN. The traveler also participated in the 4<sup>th</sup> edition of the International Workshop on Nuclear Data Covariances where he chaired an intermediate meeting of the WPEC Subgroup 44 on the “Investigation of Covariance Data in General Purpose Nuclear Data Libraries.”

**Access to the information in this report is limited to those indicated  
on the distribution list and to U.S. Government Agencies and their Contractors.**

## **REPORT OF FOREIGN TRAVEL**

**Vladimir Sobes  
Fontenay aux Roses, France  
May 14, 2017 – June 3, 2017**

### **PURPOSE OF TRAVEL**

The US DOE Nuclear Data Advisory Group (NDAG) maintains and constantly updates lists of materials that are considered important for applications in nuclear criticality safety. This is documented in the NCSP 5-year plan, Appendix B. The NDAG has identified gadolinium to be an important element for an updated nuclear data evaluation in the near future. The US DOE Nuclear Criticality Safety Program (NCSP), following the advice of the NDAG committee, added the evaluation of gadolinium to the list of isotopes considered as important for measurement and evaluation in the next five years to its published Five-Year Execution Plan for the Mission and Vision of the program. The nuclear data evaluation of gadolinium has been identified as a joint effort between Oak Ridge National Laboratory (ORNL) and the Institute of Radiological protection and Nuclear Safety (IRSN) in France by NCSP 5 Year Plan via prioritization from the NDAG committee. Dr. Sobes, the traveler, and Dr. Leal were identified as the two Principle Investigators (PIs) for the evaluation of gadolinium respectively for their institutions. This trip helped to accomplish the execution plan laid out by the US DOE NCSP and in particular supported the goal of improving the differential data evaluations for isotopes of interest for nuclear criticality safety in the US. Also, this visit helped ensure that DOE and ORNL maintain a leadership position in the nuclear data analysis area while also cultivating international partnerships that could provide further data and information to support the US NCSP.

Dr. Sobes is the principle investigator (PI) for the task of performing the nuclear data evaluation in the resonance region for three of the isotopes of gadolinium,  $^{156}\text{Gd}$ ,  $^{158}\text{Gd}$ , and  $^{160}\text{Gd}$ , that have been identified as important for evaluation in the next five years in Five Year Plan of the Mission and Vision of the NCSP. Dr. Leal is the PI for performing the nuclear data evaluation for the two other major isotopes of gadolinium,  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$ , from IRSN. The primary purpose of this trip was for Dr. Sobes to collaborate with Dr. Luiz Leal at IRSN on the joint evaluation of the isotopes of gadolinium, ( $^{155}\text{Gd}$ ,  $^{156}\text{Gd}$ ,  $^{157}\text{Gd}$ ,  $^{158}\text{Gd}$  and  $^{160}\text{Gd}$ ) and allow the two researchers to synchronize the on-going evaluation of all five isotopes. Further, Dr. Sobes and Dr. Leal collaborated methods of experimental data analysis, jointly studied historical cross section measurements that can serve to improve the nuclear data evaluation for gadolinium and discussed coordinated strategies for generating covariance data.

Dr. Sobes also participated in the 4th edition of the International Workshop on Nuclear Data Covariances. Dr. Sobes is one of the founders and the group coordinator of the OECD/NEA Working Party on International Nuclear Data Evaluation Co-operation (WPEC) Subgroup 44 (SG44) on the “Investigation of Covariance Data in General Purpose Nuclear Data Libraries.” Nuclear data covariance is fundamentally important to the US DOE NCSP as it influences safety margins derived from modeling and simulation of existing and proposed criticality safety systems. Dr. Sobes has been selected to represent the interests of ORNL and serve as the chair of this international expert group. Overall, the objective of the WPEC meeting is to coordinate the international nuclear data measurement and evaluation work activities among the international nuclear data projects, and participation in the WPEC meeting is important for the NCSP as the meeting provides an opportunity to exchange information about nuclear data work efforts and help influence work activities that can benefit NCSP nuclear data work efforts.

During the International Workshop on Nuclear Data Covariances, Dr. Sobes acted as chairman of an intermediate meeting of SG44 focused on the influence of integral experimental data on nuclear data covariance evaluations for general purpose nuclear data libraries.

Overall, Dr. Sobes' foreign travel to IRSN was successful and essential to enable ORNL to make progress on the planned NCSP nuclear data evaluation tasks (2.4.2.4 ORNL ND1) as defined in the NCSP Five-Year Plan Execution Plan FY2017-2021. The complete resonance region evaluations of the isotopes of  $^{155}\text{Gd}$ ,  $^{156}\text{Gd}$ ,  $^{157}\text{Gd}$ ,  $^{158}\text{Gd}$  and  $^{160}\text{Gd}$  are currently estimated to be delivered at the end of Q2 of FY2019.

### **Persons Contacted at IRSN**

Luiz Leal, Host  
Raphaëlle Ichou  
Stephan Ivo

### **Itinerary**

09/30/17 – 10/01/17	Travel from Knoxville, USA to Aix en Provence, France
10/02/17 – 10/06/17	Aix en Provence, France (conference agenda attached)
10/09/17 – 10/13/17	IRSN, Fontenay aux Roses, France (detailed agenda follow)
10/14/17	Travel from Paris, France to Knoxville, USA

IRSN, Fontenay aux Roses, France (day-by-day agenda)

10/09/17	Synchronization of evaluated resonance parameters between $^{156}\text{Gd}$ , $^{158}\text{Gd}$ , and $^{160}\text{Gd}$ (ORNL) and $^{155}\text{Gd}$ and $^{157}\text{Gd}$ (IRSN). Review of performance improvements and differences.
10/10/17	Joint incorporation of ZED-II integral experiments into evaluation of all five isotopes. Development of a path forward for the adjustment of the parameters of the unresolved resonance region based on integral experiments.
10/11/17 – 10/12/17	Development of a trial version of a methodology for adjusting parameters of the unresolved resonance region based on available information in integral benchmarks. Discussion of the impact on covariance evaluation in the unresolved resonance region through the inclusion of integral benchmark information.
10/13/17	Testing of the developed methodology to adjust parameters of the unresolved resonance region based on integral benchmarks. Planning of further course of action for collaborative evaluation based on differential and integral data.

## DISTRIBUTION

1. Doug G. Bowen ([bowendg@ornl.gov](mailto:bowendg@ornl.gov))
2. Angela Chambers ([angela.chambers@mnsa.doe.gov](mailto:angela.chambers@mnsa.doe.gov))
3. Lori Scott ([Lorisc0tt@aol.com](mailto:Lorisc0tt@aol.com))
4. Jamie Sweers ([jsweers@lanl.gov](mailto:jsweers@lanl.gov))