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**ORNL  
FOREIGN TRIP REPORT  
TA 358805**

**DATE:** August 27, 2014

**SUBJECT:** Report of Foreign Travel Geel, Belgium – Klaus H. Guber, 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:** Klaus H. Guber

**MEETING:  
TITLE** N/A

**MEETING:  
LOCATION** Institute for Reference Materials and Measurements (IRMM), Geel, Belgium

**MEETING:  
DATES** 3/27/2014 – 05/06/2014

**ATTENDEES:  
ON BEHALF  
OF NCSP** Klaus H. Guber

**MEETING:  
BENEFIT TO  
NCSP** Dr. Guber is a nuclear data specialist who has experience in nuclear data measurements, and he traveled to Geel, Belgium to perform neutron cross-section measurements using the Geel Electron Linear Accelerator (GELINA) at IRMM. The measurements have been performed in accordance with the Nuclear Criticality Safety Program (NCSP) Five Year Plan, and the measurements provide needed nuclear data for the NCSP.

**PURPOSE:** The primary purpose of the travel is to perform nuclear cross-section measurements at the Institute for Reference Materials and Measurements (IRMM) in Geel, Belgium. Furthermore, additional work includes data reduction tasks for previous and new cerium (Ce) neutron capture cross-section measurements performed at IRMM. All of these work tasks have been performed for the NCSP, and the nuclear data measurement work is performed in collaboration with IRMM of the Joint Research Institute of the European Community.

**SITES:  
VISITED** IRMM at the Joint Research Institute of the European Community, Geel, Belgium

**ABSTRACT:** The traveler visited IRMM in Geel, Belgium. At IRMM, the objective of the visit is to continue neutron transmission and capture cross-section measurements for natural calcium (Ca) and cerium (Ce) using the GELINA facility. During the visit, the traveler also initiated data reduction tasks for Ce and Ca neutron capture data obtained through measurements with “thick” samples.

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## **REPORT OF FOREIGN TRAVEL**

**Klaus Guber  
Geel, Belgium  
March 26–May 07, 2014**

### **PURPOSE OF TRAVEL**

The primary purpose of the travel is to perform nuclear cross-section measurements at the Institute for Reference Materials and Measurements (IRMM) in Geel, Belgium. Furthermore, additional work included data reduction tasks for previous and new cerium (Ce) neutron capture cross-section measurements performed at IRMM. Supplementary calcium transmission and capture measurements have been accomplished. All work tasks have been performed for the U.S. Nuclear Criticality Safety Program (NCSP), and the nuclear data measurement work is performed in collaboration with IRMM of the Joint Research Institute of the European Community.

### **Report**

Klaus Guber traveled to IRMM to perform nuclear data measurement and analysis work for the NCSP. At IRMM, the GELINA (Geel Electron Linear Accelerator) neutron facility can be used to perform neutron-induced cross-section measurements in the neutron energy range from thermal up to ~20 MeV that includes the resonance region for many isotopes/nuclides of interest to the NCSP. GELINA is similar in capability to the Oak Ridge Electron Linear Accelerator (ORELA) in the U.S.; however, ORELA is no longer available for performing neutron cross-section measurements. GELINA is a neutron source driven by a pulsed electron beam, which produces neutrons via Bremsstrahlung from a uranium target. Due to a special compression system, the accelerated electron pulse of GELINA can be compressed to one nsec pulse width at full power. In combination with a long flight path, the GELINA facility provides excellent time-of-flight (TOF) resolution, which determines the neutron energy. Therefore individual resonances of the cross section can be resolved at much higher neutron energies, and this neutron energy-resolution capability is essential for determining the detailed neutron cross-section structure for nuclides of importance to criticality safety applications.

During this trip, two types of experiments were planned at GELINA: transmission experiments to determine the total cross section for the “thick” Ca and Ce samples and neutron capture measurements at 60 meters using a 80 mm diameter and 10 mm thick Ce samples. Data were obtained during the course of a 6-week run and additional measurements to complete the calcium neutron capture runs for the thick sample were also performed. The experimental equipment for transmission experiments was set up with the emphases on extending the neutron energy range to higher energies. Calcium transmission measurements were initiated to test the equipment.

During the visit to IRMM, data reduction tasks for the neutron capture measurement of the thick natural Ce and Ca sample were initiated. For this task, the GELINA specific software packages AGL and AGS were used. In the first step, all list mode data were converted into TOF spectra. This data conversion was completed for the sample, sample holder, open beam and different background filter configurations. With AGS, the data can be converted to cross-section data or transmission data. The GELINA data-reduction software enables the experimentalist to process all experimental uncertainties in a consistent way to

produce a covariance matrix describing all experimental effects, and the experimental covariance data are essential for supporting the cross-section covariance evaluation effort.

Based on preliminary analysis of the Ce and Ca data, the experimental data obtained are useful to support subsequent resonance evaluation work at ORNL. With the high neutron flux from GELINA using a short pulse width in combination with a long flight path, it will be possible to extend the resolved resonance region for Ce beyond the existing resonance evaluation limit of 230 keV. In this energy region, the dominating part for neutron energy resolution is the neutron pulse width. It is expected that the measured Ce and Ca data will be provided to the ORNL evaluators who will prepare new resonance evaluations per the schedule in the NCSP Five-Year Plan.

During the travel, Guber continued discussions with P. Siegler, A. Plompen and S. Kopecky at IRMM about establishing an experimental capability to measure neutron scattering cross-section data in the resonance range. As part of the meeting with IRMM staff, there was some discussion about moving the ORELA scattering chamber to IRMM before the chamber is removed from ORNL. Neutron scattering measurements are identified as a NCSP measurement capability goal in the 10-year NCSP Mission and Vision document, and the meeting with IRMM staff provided an opportunity to discuss NCSP measurement capability needs at the IRMM facility.

Overall, Guber's foreign travel to IRMM was very productive toward completing NCSP measurement and evaluation tasks as defined in the NCSP Five Year Plan.

### **Persons Contacted at IRMM**

Peter Schillebeeckx, Host  
Willy Mondelaers, Section Head NP Unit  
Peter Siegler  
Stefan Kopecky  
Jan Heyse  
Arjan Plompen

### **Itinerary**

03/26/14 - 03/27/14	Travel from Knoxville to Geel, Belgium
03/27/14 - 05/07/14	IRMM-GELINA, Geel, Belgium
05/07/14	Travel from Geel, Belgium to Knoxville, TN (USA)

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