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**ORNL
FOREIGN TRIP REPORT
TA 362943**

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** 6/27/2014 – 7/25/2014

**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. The measurement campaign is follow-on work to the measurements performed at IRMM in March-May 2014. Furthermore, additional work includes data reduction tasks for previous calcium (Ca) and 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 finalize neutron transmission and capture cross-section measurements for natural Ca and natural Ce using the GELINA facility. During the visit, the traveler also continued 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
June 26–July 27, 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. The measurement campaign is follow-on work to the measurements performed at IRMM in March-May 2014. Furthermore, additional work included data reduction tasks for previous and new Ca/Ce neutron transmission and 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 performed at GELINA: transmission experiments to determine the total cross section for the thick Ca and Ce samples as well as the transmission of the thin Ce sample. Neutron capture at 60 meters with different filter combinations using a thick Ca and an 80 mm diameter and 10 mm thick Ce sample were performed on Flight Path (FP) 14. The data were obtained during the course of a 4-week measurement campaign and are needed to finalize the calcium neutron capture runs for the thick sample and natural cerium.

During this visit to IRMM, data reduction tasks continued for the previous neutron capture measurements of the thick natural Ce and Ca samples. 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. The

transmission factors for the thick Ca and thin Ce samples were obtained. At this stage, the data are ready for analysis.

Based on preliminary analysis of the Ce and Ca data, the measured cross-section data 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 important to 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

06/27/14 - 06/28/14	Travel from Knoxville to Frankfurt, Germany
06/28/14 - 06/29/14	Personal day in Germany
06/29/14 - 06/29/14	Travel to Geel, Belgium
06/29/14 - 07/25/14	IRMM-GELINA, Geel, Belgium
07/26/14 - 08/08/14	Personal time in Germany
08/09/14	Travel from Germany to Knoxville, TN (USA)

DISTRIBUTION

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