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**ORNL
FOREIGN TRIP REPORT
TA 353017**

DATE: January 28, 2014

SUBJECT: Report of Foreign Travel to Vienna, Austria and Geel, Belgium – Klaus H. Guber, Reactor and Nuclear Systems Division

TO: Jerry N. McKamy, Director, Office of Environment, Safety, and Health, National Nuclear Security Administration / NA-00-10/GTN, 1000 Independence Ave., SW, Washington, DC 20585-1290

FROM: Klaus H. Guber

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 cerium (Ce) neutron capture cross-section measurements performed at IRMM. In addition, Klaus Guber was invited by the International Atomic Energy Agency (IAEA) to participate in a Consultants' meeting concerning the international storage format and dissemination procedures of measured differential data, and the meeting titled "EXFOR Data in Resonance Region and Spectrometer Response Function" was held at the IAEA Headquarters in Vienna, Austria October 8-10, 2013. All of these 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.

SITES VISITED: IAEA Headquarters in Vienna, Austria and Institute for Reference Materials and Measurements at the Joint Research Institute of the European Community, Geel, Belgium

ABSTRACT: The traveler participated in the Consultants' meeting titled "EXFOR Data in Resonance Region and Spectrometer Response Function" at the IAEA Headquarters in Vienna, Austria October 8-10, 2013. Following the IAEA meeting, 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) at the IRMM Geel Electron Linear Accelerator (GELINA). During the visit, the traveler also performed data reduction tasks for Ce neutron capture data obtained with the thin sample for the 800 Hz experiments that were completed during the previous travel to IRMM.

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REPORT OF FOREIGN TRAVEL

**Klaus Guber
Vienna, Austria and Geel, Belgium
October 6–November 21, 2013**

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 includes data reduction tasks for previous cerium (Ce) neutron capture cross-section measurements performed at IRMM. In addition, Klaus Guber was invited by the International Atomic Energy Agency (IAEA) to participate in a Consultants' meeting concerning the international storage format and dissemination procedures of measured differential data, and the meeting titled "EXFOR Data in Resonance Region and Spectrometer Response Function" was held at the IAEA Headquarters in Vienna, Austria October 8-10, 2013. All of these 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

The IAEA Nuclear Data Section is collecting experimental neutron-induced reaction data for the EXFOR library, and EXFOR is the international, standardized database that is used to store and transmit measured cross-section data between organizations. As a result, the EXFOR database is of importance to the NCSP because the EXFOR format governs the process for disseminating and obtaining measured nuclear data for isotopes/nuclides of interest to the NCSP. In particular, measured nuclear data for neutron-induced reactions in the resonance energy region are an essential part of the EXFOR database; however, there are many EXFOR entries where resonance parameters are compiled without energy dependent data (cross sections, time-of-flight spectra). To make optimum use of the results of such experiments for a cross-section evaluation, it is important to have the experimental observables available in a form that can be used to extract the required parameters needed for an evaluation. Therefore, Guber's participation in this meeting is essential to ensure that NCSP nuclear data needs are addressed within the EXFOR data format.

During the EXFOR working group meeting, the spectrometer response function of the different, international neutron cross-section measurements facilities were presented, and the working group discussed how to implement the facility-dependent spectrometer response data into EXFOR. Ideas were developed for how the requisite information could be included in the experimental data files so that EXFOR users will be able to utilize the data in the correct way to support the subsequent nuclear data evaluation effort. Currently, much of the stored experimental data lack essential information about the experiment. Because of the paucity of key data in EXFOR, the user must make too many assumption and corrections while using the data for producing cross-section evaluations. Overall, the EXFOR meeting at the IAEA was very productive, and Klaus Guber had the opportunity to represent the NCSP nuclear data measurement needs for the EXFOR database.

Following the EXFOR meeting at the IAEA, 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 sample and neutron capture at 60 meters using a 80 mm diameter and 10 mm thick Ce sample. Due to unforeseen circumstances while refurbishing several flight stations at GELINA, accelerator operation did not start as planned during Guber's visit to IRMM. As a result, no experiments could be performed during this visit; however, previous measurements have been performed at GELINA, and the trip provided an excellent opportunity to perform data analysis tasks with the IRMM staff while using the IRMM data analysis software.

During the visit to IRMM, data reduction tasks for the neutron capture measurement of the thin natural Ce sample were completed. 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 Guber's analysis of the Ce 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, 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 data will be provided to the ORNL evaluators who will prepare new Ce resonance evaluations per the schedule in the NCSP Five-Year Plan.

In addition, the traveler had discussions with A. Trkov, G. Nougere, P. Schillebeeckx and S. Kopecky about recent experiments and evaluation results for manganese (Mn) and tungsten (W). Currently, ORNL is working to complete a new set of resonance evaluations for the stable tungsten isotopes (i.e., ^{182}W , ^{183}W , ^{184}W , and ^{186}W) for the NCSP in FY14, and the discussions were very helpful to support the cross-section evaluation work at ORNL. In addition, ORNL has previously completed a new ^{55}Mn resonance evaluation, and the discussions were important to obtain feedback on the performance of the new resonance evaluation.

During the travel, Guber had discussions with P. Siegler, A. Plompen and S. Kopecky at IRMM about establishing an experimental capability measure neutron scattering cross-section data in the resonance range. 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 the IAEA and IRMM was very important to completing NCSP measurement and evaluation tasks as defined in the NCSP Five Year Plan.

Meeting participants at IAEA

V. Semkova, Host
Y. Danon
F. Gunsing
A. Kimura
G. Noguere
P. Schillebeeckx
G. Zerovnnik
N. Otsuka
V. Zerkin

Persons Contacted at IRMM

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

Itinerary

10/06/13 - 10/07/13	Travel from Knoxville to Vienna, Austria
10/08/13 - 10/10/13	Meeting at IAEA
10/11/13 - 10/20/13	Personal time, stay in Vienna, Austria and Karlsruhe, Germany
10/20/13	Travel to Geel, Belgium
10/20/13 - 11/20/13	IRMM-GELINA, Geel, Belgium
11/21/13	Travel from Geel, Belgium to Knoxville, TN (USA)

DISTRIBUTION

1. Nichole Ellis (ellis_9899@msn.com)
2. M. E. Dunn (dunme@ornl.gov)
3. L. C. Leal (leallc@ornl.gov)
4. Jerry N. McKamy (Jerry.McKamy@nnsa.doe.gov)
5. Lori Scott (Lorisc0tt@aol.com)
6. Gladys Udentia (gladys.udenta@nnsa.doe.gov)