Oak Ridge National Laboratory
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Subject: Report on Foreign Travel to Vienna

Date: 12/28/2020

To: Dr. Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-511

From: Marco T. Pigni

Meeting Title: Technical Meeting of the International Nuclear Data Evaluation Network (INDEN) on Actinide Evaluations in the Resonance Region

Meeting Location: Vienna (Virtual)

Meeting Date: 17-19 November 2020

Attendees on behalf of NCSP:

Meeting Purpose:

The R-matrix evaluations of the reaction cross section for fissile actinides such as233,235U and 239Pu are in progress. Several updates to the resonance parametersincluding thermal constants as well as neutron multiplicities are implemented werepresented.

Meeting Benefits to the NCSP:

These evaluations are currently included in the APPENDIX B and pivotal for criticality applications.

Purpose of Travel:

see attached file

Persons Contacted at Meeting:

Presentations, Chair Responsibilities, Etc.

Distribution:

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The preliminary Agenda is given below, suggestions/comments are welcome:

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Tuesday 17 November starting at 2pm (open since 1:45pm Vienna time)

2:00-2:05 Opening of the meeting

2:05-2:15 Election of Chair and Rapporteur(s), discussion of the Agenda

2:15-2:50 (10min disc) Introduction, R. Capote

2:50-3:30 (10min disc) Oscar Cabellos (UPM, Spain)
"Indications from integral benchmarks on U-235 and Pu-
239 evaluations"

3:30-3:40 short break

3:40-4:20 (10min disc) Gilles Noguere (CEA-Cadarache, France)
"Status of the U-235 evaluation in the RR for JEFF"

4:20-5:00 (10min disc) Daniel Cano-Ott (CIEMAT, Spain)
"A new measurement of the Pu-239 alpha ratio,
capture and fission cross sections at n_TOF"

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Wednesday 18 November starting at 2pm (open since 1:45pm Vienna time)

2:00-2:40 (10min disc) Marco Pigni (ORNL, USA)
"New U-233 evaluation and updates to the U-235 RR evaluations"

2:40-3:20 (10 min disc) Andrej Trkov (JSI, Slovenia)
"Integral performance and data feedback: U-235, U-233, O-16"

3:20-4:00 Ignacio Duran (USC, Spain)
"to be announced"

4:00-4:15 short break

4:15-5:00 Discussions

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Thursday 19 November starting at 2pm (open since 1:45pm Vienna time)

2:00-3:00 Discussions

3:00-3:45 (15min disc) Denise Neudecker (LANL, USA)
"New n+Pu-239 PFNS evaluation using Chi-Nu and CEA latest data"

3:45-4:00 Short break

4:00-5:00 Wrap-up of discussions. List of actions.

Status of the RRR evaluations for ^{233,235}U, ^{239}Pu

Marco T. Pigni

The R-matrix evaluations of the reaction cross section for fissile actinides such as ^{233,235}U and ^{239}Pu are in progress. Several updates to the resonance parameters including thermal constants as well as neutron multiplicities are implemented were presented.

- **^{233}U**
  - Particular focus is devoted to resolve the strong negative gradient in the critical assemblies (as pointed out in Nuclear Data Sheets 148, 1, 2018)
  - The *(n,f)* cross sections were increased and fitted to the ORELA measured data. In previous evaluations only the shape of these data was used
  - Exclusive updates to the thermal values recommended by the Standards evaluations together with the Prompt Fission Neutron Spectra were implemented
  - The impact of these updates on the benchmark calculations were tested (parabolic fit of the thermal solutions for increasing Above Thermal Fission Fraction shown in Trkov's presentation)
  - The presented results were based on a RRR evaluation up to 600 eV. Additional work is in progress to extend the RRR evaluation up to about 2.5 keV with proper statistical constraints (slides 5 and 6) and average resonance parameters to define the URR evaluation up to 40 keV. As discussed in previous INDEN meetings, the work to extend the RRR is devoted in identifying the need of including fluctuating excitation functions where self-shielding corrections are important
- **^{235}U**
  - Updates to the RRR evaluation in the thermal and resonance region up to a few ten of eVs was presented. This was motivated by improving the fit of newly measured RPI capture and fission data with particular focus in the 0.1—1 eV
  - The absorption rate below 1 eV was particularly important to understand the sensitivity of the capture cross section to the VERA depletion benchmark results and the related negative gradient of the Δk_{eff} related to ENDF/B-VII.1
  - After achieving an improved agreement to RPI measured data, almost no difference (about 50 pcm at the beginning of the depletion) was observed (slide 9)
- **^{239}Pu**
  - Results focusing on coupling the thermal and the resolved resonance region to the newly evaluated prompt neutron fission spectra (PFNS) were

presented. The recently released ENDF/B-VIII.0 was based on evaluations performed within the international collaboration CIELO aiming to improve nuclei of fundamental importance such as ^{235}U and ^{239}Pu. The ^{235}U R-matrix evaluation (ORNL) was updated with the latest thermal constants and PFNS improving the benchmark performance of the thermal solutions. However, for ^{239}Pu evaluation the focus was in the high energy range and the prediction on the thermal solution benchmarks was underpredicted. Within IAEA coordinated research activities, newly evaluated PFNS showed a reduction of 1.8% on the average energy: PFNS(⟨Eav⟩=2.08 MeV). These changes were combined to recent work on ^{239}Pu R-matrix evaluation (ORNL) aimed to update the thermal constants. This led to improved benchmark performance in the thermal solutions

- Negative slope as a function of the temperature is not understood yet (bias over 2s lower than measured)