

# **INDC International Nuclear Data Committee**

## **DECAY DATA FOR MONITORING APPLICATIONS**

Summary Report of the Technical Meeting

IAEA Headquarters, Vienna, Austria  
23-25 October 2023

Prepared by

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April 2024

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## 1. Introduction

The fourth Technical Meeting on Decay Data for Monitoring Applications was held from 23 to 25 October 2023 at the IAEA Headquarters, Vienna, with a virtual component. Tibor Kibedi (Australia), Filip Kondev (USA), Jun Chen (USA), Alexandru Negret (Romania), and Stefan Lalkovski (Bulgaria), together with two IAEA staff, Paraskevi (Vivian) Dimitriou and Marco VerPELLI, participated in person, while Jagdish Tuli (USA) and Alan Nichols (UK) joined the meeting remotely.

The purpose of the meeting was to review the progress made since the previous meeting in July 2022 in the evaluation and review of the decay data identified as priority radionuclides for monitoring applications. The list of priority radionuclides and the assignments undertaken by the members of the project [1] were reviewed, and those radionuclides previously assigned to the late Balraj Singh were re-assigned. A timeline for the completion of all evaluations and reviews, and for the determination of beta-decay parameters using the BetaShape code [2, 3] and atomic radiation data using the NS\_RadList code [4] was agreed upon.

The meeting was opened by Arjan Koning, Head of the Nuclear Data Section, who welcomed the participants to the meeting and emphasized the importance of the project and its deliverables for a range of monitoring activities of both the CTBTO and the IAEA. The project officer, Paraskevi Dimitriou (IAEA), outlined the goals of the meeting, Filip Kondev (ANL) and Jun Chen (MSU) were elected Chair and Rapporteur of the meeting, respectively. The meeting agenda was adopted without changes.

A summary of the status of evaluations and reviews as reported by participants is given in Section 2 while Section 3 includes the summary of the technical discussions. The meeting agenda and list of participants are given in Appendix 1 and 2, respectively.

## 2. Status reports, assignments, and actions

The status of the evaluations was reported by evaluators and the assignment spreadsheet was updated based on new time estimates for the submission of the remaining evaluations and reviews. Due to the sudden passing away of our colleague Balraj Singh prior to the meeting, all pending evaluations and reviews in his responsibility have been re-assigned to the other evaluators of the project.

TABLE 1. RE-ASSIGNMENTS OF RADIONUCLIDES PREVIOUSLY ASSIGNED TO B. SINGH (unless otherwise stated)

Name	Assignments
F. Kondev	<ul style="list-style-type: none"> <li>• Final check of <math>^{132}\text{Te}</math> post-review</li> <li>• Final check of <math>^{144}\text{Ce}</math> post-review</li> <li>• Review <math>^{147}\text{Nd}</math> – contact experimental groups (NPL, LLNL) for final results</li> <li>• Re-evaluate <math>T_{1/2}</math> of <math>^{95}\text{Nb}</math> after discarding <math>T_{1/2}</math> value of 1980HO17</li> </ul>
A.L. Nichols	<ul style="list-style-type: none"> <li>• Review <math>^{131}\text{I}</math>, <math>^{144}\text{Pr}</math></li> </ul>
T. Kibedi	<ul style="list-style-type: none"> <li>• Evaluate <math>^{131}\text{I}</math></li> <li>• Review <math>^{99}\text{Mo}</math> and <math>^{99\text{m}}\text{Tc}</math></li> </ul>
A. Negret	<ul style="list-style-type: none"> <li>• Review <math>^{143}\text{Ce}</math></li> </ul>
J. Chen	<ul style="list-style-type: none"> <li>• Finalize post-reviews of <math>^{135}\text{Xe}</math> and <math>^{143}\text{Ce}</math></li> <li>• Evaluate <math>^{132}\text{I}</math></li> <li>• Review <math>^{106}\text{Rh}</math></li> </ul>
S. Lalkovski	<ul style="list-style-type: none"> <li>• Evaluate <math>^{106}\text{Rh}</math></li> <li>• Review <math>^{136}\text{Cs}</math> (not previously assigned)</li> </ul>

### 3. Technical discussions

The project is well into the final stage with a few remaining evaluations and reviews. Most of the discussions involved details of the evaluation and review process, as well as setting up the mechanism to generate the derived beta decay and atomic radiation data using the codes BetaShape and NS\_RadList, respectively.

The evaluation of the  $\beta$ -decay of  $^{137}\text{Cs}$ , one of the most important long-lived radio nuclei, was discussed extensively, mainly due to the fairly large number of measurements that exist (about 70) on the half life.  $^{137}\text{Cs}$  decays to  $^{137}\text{Ba}$  with a new recommended half life of 30.019(22) yr. The last ENSDF evaluation, published in 2007, reported a significantly longer value of  $T_{1/2}=30.08(9)$  yr. The intensity of the most intensive  $\gamma$ -ray transition at 661.657(3) keV is now 84.89(14)%, compared to the previous value of 85.1(2)%. In parallel to the evaluation of T. Kibedi, the DDEP network also prepared a new evaluation. Although they used a different evaluation methodology, the key decay parameters are in good agreement with those of Kibedi. The new evaluation has been reviewed and approved for the final stage of the pipeline.

A summary of the remaining issues that were discussed is given in the following.

- Evaluation
  - Evaluators agreed to omit the  $T_{1/2}$  values from 1980HO17 as the article did not provide any suitable justification for the rather low uncertainty assigned to the half life or any information on the statistical and systematic uncertainty budgets.
- Evaluation policy
  - Evaluators should ensure that realistic estimates of the statistical and systematic uncertainties are considered when performing a weighted average and should implement the following guideline from the Guidelines for ENSDF evaluators



([5], page 21): **“Where systematics uncertainties dominate, or where their contribution is unknown, the adopted uncertainty should be no smaller than the smallest of the input uncertainties.”**

- Literature
  - The final evaluations should be checked for the latest references before being submitted to the pipeline to calculate beta decay parameters and atomic radiation data: Action on F. Kondev.
  - Reference 1980VYZZ contains valuable information and a copy should be obtained and included in the IAEA PDF database: Action on F. Kondev and P. Dimitriou.
- Organisation of datafiles
  - Include two columns in assignments spreadsheet to check the status of BetaShape and NS\_RadList operations on each datafile: Action on P. Dimitriou;
  - Rename final decay datafiles to indicate the stage in the pipeline: Action on M. Verpelli;
    - a) “Zn95-decay-2023-10-26.ens” for the file agreed by the evaluator/reviewer and submitted to technical coordinator (F. Kondev) for final approval;
    - b) “Zn95-decay-approved.ens” for the file approved by technical coordinator (F. Kondev) and submitted as input to the BetaShape and NS\_RadList codes- these files should be stored in a read-only folder;
  - All previous versions of the evaluated decay datafiles will be moved into a folder “previous”.
- BetaShape code  
Action on M. Verpelli (by end of 2023):
  - Run all “approved” ENSDF decay datafiles through BetaShape;
  - Run output ENSDF datafiles through FormatCheck code;
  - Store beta and anti-neutrino spectra in separate folder.
- NS\_RadList code – atomic radiation data  
Action on T. Kibedi (by end of 2023):
  - Run NS\_Radlist code on all output ENSDF datafiles from BetaShape – after they have been checked for format compliance;
  - Run FormatCheck code on output ENSDF datafiles from NS\_RadList;
  - Store all atomic spectra in a separate folder.
- Final product - library format  
The new atomic radiation data are incorporated in the ENSDF decay datafiles in an agreed format that was adopted by the NSDD network. The format and tools to parse this data will have to be provided to the end users of the final library. Action on M. Verpelli: to communicate the new format and parser tools required to parse the new ENSDF datafiles to CTBTO group.

- Final publication  
Participants agreed to submit the final technical report for publication in a peer-reviewed scientific journal. For that purpose, the following actions were adopted:
  - o Contact the editors of Atomic Data and Nuclear Data Tables, EPJA, and Nuclear Data Sheets (in this order) for their consideration to publish the technical report. Action on P. Dimitriou;
  - o Prepare a draft template of the article and circulate by March 2024. Action on F. Kondev.

#### 4. Summary

The fourth and last IAEA Technical Meeting of the project Decay Data for Monitoring Applications was held in a hybrid format from 23 to 25 October 2023. As the project is in completion stage, final details of the evaluation, review and data production processes were discussed. The timeline for submission of the remaining evaluations and reviews and for running the codes to determine the final beta decay and atomic radiation data, was agreed. Additionally, the final publication and the timeline for preparing the report was discussed and agreed.

The deliverables of the project, an adopted decay data library, will be finalized for release in 2024.

#### References

- [1] IAEA Report INDC(NDS)-0859, International Atomic Energy Agency, Vienna, 2022, <https://int-nds.iaea.org/publications/indc/indc-nds-0859.pdf>
- [2] X. Mougeot, Appl. Radiat. Isotopes **201** (2023) 111018, <https://www.sciencedirect.com/science/article/pii/S0969804323003718?via%3Dihub>
- [3] X. Mougeot, Appl. Radiat. Isotopes **154** (2019) 108884, <https://www.sciencedirect.com/science/article/pii/S0969804319303793?via%3Dihub>
- [4] B.P. Tee, T. Kibedi, B.Q. Lee, M. Vos, R. du Rietz, and A. Stuchbery, EPJ Web of Conferences **232** (2020) 01006, <https://doi.org/10.1051/epjconf/202023201006>
- [5] M.J. Martin, Guidelines for Nuclear Structure Evaluators, Report ORNL/TM-2022/1835, Oak Ridge National Laboratory, 2022, [https://www-nds.iaea.org/nsdd/docs/Evaluators\\_Guidelines\\_2021\\_V2.pdf](https://www-nds.iaea.org/nsdd/docs/Evaluators_Guidelines_2021_V2.pdf)

## Appendix 1: Adopted Agenda

### IAEA Technical Meeting on Decay Data for Monitoring Applications

23 – 25 October 2023

IAEA, Vienna

MOE10 (virtual component)

#### ADOPTED AGENDA

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##### Monday, 23 October

- 9:45 – 12:30     **Opening of the meeting**, Arjan Koning / NDS Section Head  
**Welcome and Introduction**, Paraskevi (Vivian) Dimitriou / Scientific Secretary  
**Election of Chair and Rapporteur(s), Adoption of Agenda**  
**Participants' Reports** *Coffee Breaks as needed*
- F.G. Kondev
  - A.L. Nichols
  - T. Kibedi
  - J. Chen
  - S. Lalkovski
  - P. Dimitriou
- 12:30 - 14:00     **Lunch Break**
- 14:00 - 17:00     **Roundtable discussion**
- Remaining assignments
  - Balraj's assignments – status and re-assignment
  - Running BetaShape and BrIccEmis
  - Publication

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##### Tuesday, 24 October

- 10:00 –12:30     **Roundtable discussion cont'd** *Coffee Breaks as needed*
- 12:30 - 14:00     **Lunch Break**
- 14:00 - 17:00     **Roundtable discussion cont'd**

**18:30 Dinner at a restaurant (separate information)**

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##### Wednesday, 25 October

- 10:00 –12:30     **Roundtable discussion cont'd** *Coffee Break as needed*  
**Drafting of report**  
**Closing**
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## Appendix 2: Participants' List

### IAEA Technical Meeting on Improved Decay Data for Monitoring Applications

23-25 October 2023

Vienna, Austria

### PARTICIPANTS

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