**Nuclear Data Section**

**International Atomic Energy Agency**

**P.O.Box 100, A-1400 Vienna, Austria**

**Memo CP-D/1085**

**Date:** 2023-05-31

**To:** Distribution

**From:** N. Otsuka

**Subject: NRDC2023 – Conclusions & Actions, EXFOR Protocol, meeting summary**

Drafts of Conclusions & Actions (including revised EXFOR Protocol), Meeting Summary of the 2023 NRDC meeting are appended to this memo. Changes from the version reviewed in the meeting are in red. Please send me your comments (e.g., actions fulfilled after the meeting) by the end of June 2023 if any.

**Major changes to Conclusions & Actions:**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Version reviewed in the meeting** | **Revised** |
| C6 |  | (new) | The NDS open and backup areas require authentication and must be accessible to the NRDC participants only. |
| C7 |  | (new) | The preliminary tape will not be deleted but kept on the NDS open area even after its finalization. |
| A2 | Marian | Obtain DOI and data license for EXFOR Master file(s) and associated documents and files. As recommended above, we recommend CC-BY-4.0. | Follow-up on the effort of the IAEA to mint DOIs. When this becomes available at the IAEA, facilitate the set-up of a procedure to obtain DOIs for the EXFOR Master versions, in line with the IAEA workflows |
| A3 | Marian | Follow up with the IAEA Legal department the NRDC's decision of releasing all the NRDC products under the CC-BY-4.0 license. |
| A73 | Zerkin | (Continuing action) Continue development of the EXFOR upload web tool. | (Continuing action) Continue development of the EXFOR upload web tool MyExfor. Prepare standalone version of Web EXFOR CINDA-ENDF-IBANDL retrieval system with MyExfor working without Internet (c.f. Conclusion X) |
| A93 | Zerkin | (new) | Prepare software package producing Dictionaries in MS-Access used in EXFOR Editor for Sarov group |
| A94 | Zerkin, Pikulina Taova | (new) | Setup software package (A93) in Sarov and start producing Dictionaries in MS-Access used in EXFOR Editor. |

**Conclusions**

|  |  |
| --- | --- |
| **General** | |
| C1 | The next technical NRDC meeting will be held in Vienna, Austria from 14 to 17 May 2024. |
| C2 | The next full NRDC meeting will be held in Paris, France in the second quarter of 2025. |
| C3 | The next EXFOR compilation workshop will be held in Vienna, Austria in the fourth quarter of 2024. |
| C4 | The NRDC supports reviewing and updating the ~~guiding~~ Network Document (INDC(NDS)-0401). |
| **EXFOR General** | |
| C5 | The NRDC supports releasing the EXFOR Master Files, ~~documentation, and~~ Dictionaries and their documentation as Open Data, with Document Object Identifiers (DOI) and an acceptable open data license (CC-BY-4.0 or similar). Each released Master File would then require its own DOI and internet landing page. This distribution should be made retroactively ~~from 2005~~ ca. 2015 onward and should not include NRDC working materials such as preliminary and final trans tapes, and backup files. |
| C6 | The NDS open and backup areas require authentication and must be accessible to the NRDC participants only. |
| C7 | The preliminary tape will not be deleted but kept on the NDS open area even after its finalization. |
| C8 | The NRDC supports releasing all EXFOR codes~~,~~ and their documentation~~, etc.~~ as Open Source necessary to support the use of EXFOR data (especially the EXFOR Master Files) by the broader community. |
| C9 | Regarding staff changes in NDS, NRDC recommends sharing ~~basic~~ EXFOR software source codes and their documentation developed by Zerkin between NRDC centres. |
| C10 | The basic compilation responsibility (Appendix C of NRDC Protocol) of JAEA will be compilation of the neutron data measured at JAEA or measured in Japan in cooperation with JAEA Nuclear Data Center. They will be compiled in area 2 and submitted through NEA DB. |
| **EXFOR Statistics and Coverage** | |
| C11 | The Network finalized 351 new entries since the NRDC 2022 meeting (11 months). |
| C12 | The originating centre should (1) update the N2 field of TRANS (date of transmission) just before submission to the NDS open area, and (2) announce release of a new final tape without delay. |
| **Manuals and Dictionary** | |
| C13 | The revised NRDC Protocol Appendix B (Scanning responsibility) proposed in CP-D/1078 = WP2023-07 was approved. |
| C14 | The revised LEXFOR “Scattering” proposed in 4C-3/0421 = WP2023-08 was approved. |
| C15 | The new format of Dictionary 227 (Nuclides) proposed in CP-D/1067 = WP2023-09 was approved. |
| C16 | Addition and deletion of the institute codes proposed in CP-D/1080 = WP2023-10 was approved. |
| C17 | Revised EXFOR/CINDA Dictionary Manual proposed in CP-D/1081 = WP2023-11 was approved. |
| C18 | The reference type code K (abstract of journal) should not be used since it may introduce inconsistency with the entries which data were compiled from journal abstracts with the reference type code J. |
| **EXFOR Quality Control** | |
| C19 | The keyword ERR-ANALYS must be present with coded information when error fields associated to the dependent variable (e.g., DATA-ERR, ERR-S, ERR-1) are given. Otherwise, presence is optional as proposed in CP-D/1082 = WP2023-22. |
| **EXFOR Coding Rule** | |
| C20 | The revised EXFOR Formats Manual and LEXFOR for the keyword STATUS proposed in CP-D/1053 and CP-D/1055 (Rev.) = WP2023-23 were approved. Use of the reference code field is optional. |
| C21 | The headings ERR-HL and ERR-IDD may be used only when they are propagated to the total uncertainty (ERR-T) and their propagated partial %-uncertainties are not available for coding under ERR-1 etc. as proposed in CP-D/1038 = WP2023-24. |
| C22 | Use of the multiple reaction formalism is not limited to the quantities having the same independent variables. The vector common formalism is no longer necessary, and it will be abolished. The cumulative and chain fission product yields may be compiled together in the same subentry by using the formalism as proposed in CP-D/1056 = WP2023-25. The use of the multiple reaction formalism is limited to the cases listed in LEXFOR “Multiple Reaction Formalism”. |
| C23 | The coding rules of REACTION SF4-SF7 for the cascade gammas not following quasi-metastable state production (,PAR/L-,DA,G) and for the cascade gammas following quasi-metastable state production (-L,PAR,DA,DG) proposed in CP-D/1057 (Rev.) = WP2023-26 were approved. |
| C24 | Use of fixed decimal point numbers other than integers under the heading FLAG and DECAY-FLAG proposed in CP-D/1069 = WP2023-27 was not approved. |
| C25 | The data type field (SF9) is always omitted under the keyword MONITOR and ASSUMED as proposed in CP-D/1071 = WP2023-28. |
| C26 | Cross sections for reactions induced by secondary particles are not for compilation as proposed in CP-D/1072 = WP2023-29. |
| C27 | Revision of LEXFOR “Activation” (restriction for use of the method code ACTIV) proposed in CP-D/1076 = WP2023-30 was approved. |
| C28 | Legendre coefficients of 0th order and higher orders must be compiled together as a single dataset as proposed in 4C-3/0233 (Rev.) = WP2023-31. |
| **Tools for Compilation and Dissemination** | |
| C29 | NRDC supports proposal of Zerkin to distribute X4Pro database with X5 as a product of NRDC recommended for users’ community. Implementing must include sharing NDS source code and documentation producing X4Pro within NRDC. |
| C30 | NRDC recommends continuing the functioning of Web EXFOR-CINDA-ENDF-IBANDL Retrieval system including MyExfor on NDS and Mirror sites. Standalone version of this system would be also useful. |
| C31 | NRDC recommends continuing maintenance and extension of EXFOR-NSR PDF database at NDS. |
| C32 | NRDC encourages development of other software systems which interact with the EXFOR data. |

## Actions

|  |  |  |
| --- | --- | --- |
| **General** | | |
| A1 | Centre Heads | Send to Otsuka revised description of the centre in the Network Document (INDC(NDS)-0401) by end of 2023. |
| **EXFOR General** | | |
| A2 | Marian | Follow-up on the effort of the IAEA to mint DOIs. When this becomes available at the IAEA, facilitate the set-up of a procedure to obtain DOIs for the EXFOR Master versions, in line with the IAEA workflows |
| A3 | Marian | Follow up with the IAEA Legal department the NRDC's decision of releasing all the NRDC products under the CC-BY-4.0 license. |
| A4 | Koning | Inform centre heads of final license proposed by the IAEA for distribution of files. |
| **EXFOR Statistics and Coverage** | | |
| A5 | All | (Standing action) Give the highest priority to compilation of new articles. |
| A6 | All | (Standing action) Correct erroneous entries listed on the EXFOR Feedback List according to the indicated priorities. All urgent corrections must be done by the next meeting. |
| **Manuals and Dictionaries** | | |
| A7 | Otsuka | (Continuing action) Update Dictionaries every six months. |
| A8 | Zerkin Otsuka | (Continuing action) Propose a numbering scheme for compound codes defined in Dictionary 209. |
| A9 | Otsuka | Revise NRDC Protocol Appendix B according to CP-D/1078 = WP2023-07 and Appendix C according to Conclusion X (neutron data by JAEA). |
| A10 | Otsuka | Revise EXFOR Formats Manual for   1. CP-D/1053 = WP2023-23 (STATUS) 2. CP-D/1056 = WP2023-25 (Multiple reaction formalism) 3. CP-D/1069 = WP2023-27 (DECAY-DATA and FLAG) 4. CP-D/1071 = WP2023-28 (ASSUMED and MONITOR) |
| A11 | Otsuka | Revise LEXFOR for   1. 4C-3/0421 = WP2023-08 (Scattering) 2. 4C-4/0233 = WP2023-31 (Fitting coefficients) 3. CP-D/1038 = WP2023-24 (Error) 4. CP-D/1055(Rev.) = WP2023-23 (Status) 5. CP-D/1072 = WP2023-29 (Production and emission cross sections) 6. CP-D/1076 = WP2023-30 (Activation) |
| A12 | Otsuka | Revise EXFOR/CINDA Dictionary Manual according to   1. CP-D/1067 = WP2023-09 (Dictionary 227) 2. CP-D/1081 = WP2023-11 (full review) |
| A13 | Otsuka | Revise Dictionary 3 according to CP-D/1080 = WP2023-10. |
| A14 | Otsuka | Delete the code K (abstract of journal) in Dictionary 4 (reference type). |
| A15 | Otsuka | Add the codes L- and PAR/L-,DA,G to Dictionary 31 (branches) and 236 (quantities), respectively. |
| A16 | Devi | Summarize the coding suggested in CP-D/1073 = WP2023-26 for LEXFOR “Partial reactions”. |
| **CINDA** | | |
| A17 | Zerkin | (Continuing action) Export EXFOR to CINDA, and distribute it to other Centres ~~every month~~. |
| A18 | BNL | Create meta schema for bibliographic data encompassing CINDA, EXFOR, NSR, Atlas and ENSDF. Report to NRDC for next actions. |
| **EXFOR Compilation Needs**  **(**Underlined items are registered inthe Article Allocation List.) | | |
| A19 | Foligno Pritychenko | Compile with priority the articles listed in WP2023-16 to respond to the requests from EXFOR users. |
| A20 | Pritychenko | (Continuing action) Compile with priority the neutron source spectra listed in CP-D/0700 (Rev.3). |
| A21 | Pritychenko | (Continuing action) Compile with priority R.G.Lanier+,R,UCAR-10062-89,71,1989 listed in CP-D/0725 Rev. (~WP2012-19). |
| A22 | Pritychenko Nomura Taova | (Continuing action) Compile with priority the light charged-particle induced isotope production cross sections listed in CP-D/0757 = WP2013-12. |
| A23 | Pritychenko | (Continuing action) Compile with priority T.Mo+,J,NP/A,198,153,1972 listed in CP-D/0832 Rev. |
| A24 | Pritychenko | (Continuing action) Compile with priority W.G. Alberts+,R,NUREG/CP-0029,433,1982 in CP-D/0838 = WP2014-21. |
| A25 | Pritychenko | (Continuing action) Compile the thermal neutron-induced reaction data cited in Mughabghab’s “Atlas of Neutron Resonances” and listed in 4C-3/0395 = WP2014-19. |
| A26 | Pritychenko | (Continuing action) Compile F. Bischoff,R,RPI-328-87,146,1966 listed in 4C-3/0404 = WP2016-19. |
| A27 | Pritychenko | (Continuing action) Compile P.L.Reeder+,J,PR/C,15,2108,1977 listed in 4C-3/0410 = WP2018-20. |
| A28 | Pritychenko | (Continuing action) Compile deuteron-induced reaction data compiled by the Frascati group and listed in CP-D/0758. |
| A29 | Foligno Pritychenko Nomura Varlamov | (Continuing action) Compile articles reporting experimental fission product yields and listed in CP-C/464, 465, 466 and CP-D/0979. Inform Devi if an article in the lists is not for EXFOR compilation. Transmit EXFOR entries relevant to these lists separately from other EXFOR entries. |
| A30 | Gritzay | (Continuing action) Compile data measured with filtered neutrons measured at the KINR research reactor with numerical neutron spectra. |
| A31 | Pritychenko | (Continuing action) Monitor availability of P.E. Koehler’s time-of-flight spectra on DVDs received from ORELA in 2015 for EXFOR compilation. |
| A32 | Pritychenko  Brown | (Continuing action) Perform EXFOR completeness checking for the list of articles (4C-3/0401, articles cited in S. Mughabghab’s “Atlas of Neutron Resonances”) to identify articles missing in EXFOR, and assign responsibility of compilation of the identified articles to centres by a memo. |
| **EXFOR Quality Control**  (Underlined items are registered in the EXFOR Feedback List.) | | |
| A33 | Pritychenko Nomura Taova | Resolve the duplications listed in WP2023-18. |
| A34 | Pritychenko | Revise the datasets of neutron elastic scattering including inelastic scattering contribution as proposed in 4C-3/0420(Rev2). |
| A35 | Pritychenko | (Continuing action) Replace REACTION SF3=A with EL in C0753.002 (CP-D/0960 = WP2019-31). |
| A36 | Pritychenko | (Continuing action) Revise entries involving several variable atomic and/or mass numbers listed in CP-D/0984 in WP2021-31. |
| A37 | Pritychenko | (Continuing action) Revise DECAY-DATA and DECAY-MON records including EC (electron capture) listed in CP-D/0989 = WP2021-07. |
| A38 | Pritychenko | (Continuing action) Replace EL and INL in REACTION SF3 of 12373.008 with SCT (Memo CP-D/0991 = WP2021-26). |
| A39 | Pritychenko | (Continuing action) Revise entries relevant to 511 keV gamma emission listed in CP-D/1005 = WP2021-33. |
| A40 | Nomura | (Continuing action) Revise entries involving isomers of Nb-102, Tc-102, Rh-108, Sb-128 and Sb-132 according to Appendix of Memo CP-D/1009 (Rev.) = WP2021-28. |
| A41 | Pritychenko Nomura | (Continuing action) Revise REACTION SF3 and SF7 listed in Appendices 1, 2 and 3 of CP-D/1014 = WP2021-10 (Combination of particle codes and their order in REACTION SF7). |
| A42 | Pritychenko | (Continuing action) Replace X with an appropriate code or code combination REACTION SF3 of entries listed in CP-D/1017 = WP2022-24. |
| A43 | Nomura | (Continuing action) Replace the extra heading DATA with an appropriate one as listed in CP-D/1027 = WP2022-28. |
| A44 | Nomura | (Continuing action) Replace ,INT,,BRA with ,INT,,BRS in K2191.007-010 as listed in CP-D/1037 = WP2022-16. |
| A45 | Pritychenko | (Continuing action) Replace TABLE with SCSRS or update the free text unless the numerical data are published in source articles as listed in CP-D/1041 = WP2022-27. |
| A46 | Pritychenko Nomura | (Continuing action) Revise entries relevant to assessment of suspicious E-LVL values as listed in CP-D/1043 = WP2022-26. |
| A47 | Devi Pritychenko Nomura Taova Varlamov | Correct the isomeric flags in REACTION and DECAY-DATA listed in CP-D/1052Rev. = WP2023-19. |
| A48 | Devi Foligno Mikhailiukova Pritychenko Nomura Taova Varlamov | Resolve with priority the repetition of data headings listed in CP-D/1070 = WP2023-20. |
| A49 | Foligno Mikhailiukova Pritychenko | Replace NO-DIM with the correct unit for the absolute eta values listed in CP-D/1082(Rev.) = WP2023-22. |
| A50 | Foligno Pritychenko | (Continuing action) Consider addition of numerical data which are not superseded (SPSDD) and suitable for digitization, but still unobtainable (UNOBT) for neutron-induced reaction data published in old literature. |
| A51 | Foligno | (Continuing action) Provide a report on mistakes in bibliographies and spells on each preliminary tape. |
| A52 | Pritychenko | (Continuing action) Revise EXFOR entries compiling data sets from ORELA 40 m flight station listed in the Appendix of 4C-3/407 = WP2017-30 by addition of   1. the corrigendum under REFERENCE of the common subentry, 2. STATUS=OUTDT to each data subentry with the correction factor in free text. |
| A53 | Soppera | (Continuing action) Provide JANIS Import Log created from the EXFOR Master File to Otsuka on a regular basis. |
| A54 | Otsuka | (Continuing action) Assess the JANIS Import Log provided by Soppera as above and register important errors to the EXFOR Feedback System. |
| A55 | Otsuka | (Continuing action) Review the neutron quasi-elastic scattering cross sections for natural target nuclides and total scattering cross sections similar to the review summarized in Memo 4C-3/0420=WP2022-29. |
| **EXFOR Coding Rule** | | |
| A56 | Takács Otsuka | (Continuing action) Check presence of the cross sections compiled as total (=ground state plus metastable state) independent production cross sections but deviation of the measured values from the actual total cross sections may be non-negligible. |
| A57 | Varlamov Otsuka | (Continuing action) Review the usage of (G,TOT), (G,ABS), (G,SCT) and (G,N) for the cross sections declared as “absorption cross sections” or “total cross sections” by the authors. |
| A58 | Zerkin | Provide a list of subentries coded with the Vector Common Formalism. |
| A59 | Otsuka Pritychenko | Propose how to keep the 209Bi(p,x)211At cross sections in EXFOR listed in CP-D/1072=WP2023-29. |
| **Tools for Compilation and Dissemination** | | |
| A60 | Foligno | (Continuing action) Make available on the NEA Data Bank web site the EANDC and NEANDC reports compiled in EXFOR and not available as INDC reports. |
| A61 | Pikulina | (Continuing action) Continue development and testing of the EXFOR-Editor and InpGraph in cooperation with NDS and other data Centres. |
| A62 | All | (Continuing action) Provide Pikulina feedback on EXFOR-Editor and InpGraph. |
| A63 | Suzuki | (Continuing action) Continue development and testing of GSYS in cooperation with NDS and other centres. |
| A64 | All | (Continuing action) Provide Suzuki feedback on GSYS. |
| A65 | Soppera | (Continuing action) Continue development and testing of the JANIS TRANS Checker in cooperation with NDS and the other centres. |
| A66 | All | (Continuing action) Provide Soppera feedback on JANIS TRANS Checker. |
| A67 | Otsuka | (Continuing action) Provide EXFOR News every month and consider updates to the IAEA NDS website. |
| A68 | Otsuka | (Continuing action) Support update of the Japanese editor (HENDEL) as time permits. |
| A69 | Zerkin | (Continuing action) Update ZCHEX based on comments from compilers. |
| A70 | All | (Continuing action) Provide feedback to NDS on the existing ZCHEX version (on bugs as well as desired additions.). Bugs must be reported with sample entries which are checked and not checked properly by ZCHEX. |
| A71 | Zerkin | (Continuing action) Develop and distribute the program package including a standalone platform independent program to generate X4+ from a standalone EXFOR entry. |
| A72 | All | (Continuing action) Consider using the X4+ format for author approval, and also send feedback to Zerkin. |
| A73 | Zerkin | (Continuing action) Continue development of the EXFOR upload web tool MyExfor. Prepare standalone version of Web EXFOR CINDA-ENDF-IBANDL retrieval system with MyExfor working without Internet (c.f. Conclusion X) |
| A74 | Zerkin | (Continuing action) Produce: (a) EXFOR Master File with Dictionary-236 and X4Map after every database update, and (b) Dictionaries in MS Access after every Dictionaries update (see also A4). |
| A75 | Zerkin | (Continuing action) Continue development of the additional database encompassing correction factors and relevant comments for suspect/erroneous data (X4-evaluated) presented in WP2010-19; keep NRDC informed about results, impact and usage statistics of the database. |
| A76 | Zerkin | To start public distribution of X4Pro database and package. |
| A77 | Zerkin Pritychenko | (Continuing action) Continue joint development of the EXFOR and NSR databases. |
| A78 | Jin Suzuki Pikulina Zerkin | (Continuing action) Study problems in 2D calibration of original pictures, and process of approval of results of digitizing using plotting facilities. |
| A79 | Foligno Pritychenko | (Continuing action) Finalize and submit EXFOR entries including covariance data provided by Zerkin (WP2017-Z3). |
| A80 | Pritychenko | (Standing action) Provide NSR database to Zerkin with the name aliases to improve the search of EXFOR entries by the author name (WP2014-53). |
| A81 | Pritychenko Zerkin Otsuka | (Continuing action) Investigate assignment of Digital Object Identifiers (DOI) for EXFOR data sets using DataCite and one of EXFOR formats. Start a pilot project and produce several DOI for EXFOR data sets. Report results at the next NRDC meeting in 2022. |
| A82 | Zerkin Pritychenko | (Continuing action) Collaborate with the IAEA INIS Unit for technical matching of the pdf databases maintained by NDS and the Unit. |
| A83 | Zerkin Mikhailiukova | (Continuing action) Arrange a letter to IPPE for opening public access from the NDS web retrieval system to IPPE reports. |
| A84 | Zerkin | (Continuing action) Prepare a manual describing the EXFOR database related tools available on the NDS web site. |
| A85 | Pritychenko | (Continuing action) To investigate NNDC library for missing private communication relevant to EXFOR compilation. |
| A86 | Zerkin Vrapcenjak | Maintain and extend (as needed) the EXFOR-NSR PDF database. |
| A87 | Vrapcenjak | (Continuing action) Collect articles coded under REFERNECE of newly submitted preliminary tapes but missing in the NDS article collection. |
| A88 | All | (Continuing action) Collaborate with Vrapcenjak for collection of articles coded under REFERENCE of newly submitted preliminary tapes but missing in the NDS article collection. |
| A89 | All | Analyze X5 structure/hierarchy and contents, contact Zerkin with questions and proposals. |
| A90 | Zerkin | Take into account proposals on structure of X4Pro and X4+1(=X5). |
| A91 | Otsuka Zerkin | Prepare distribution EXFOR-Master File and Dictionaries (from 2005 onward). Prepare and distribute among NRDC members a software generating next Master File using previous Master File and TRANS file providing possibility for every NRDC Data Centre to maintain and reproduce Master File locally. |
| A92 | Otsuka | Prepare EXFOR Master landing page(s). Landing page should include data license, corresponding EXFOR Dictionaries and links to documentation. |
| A93 | Zerkin | Prepare software package producing Dictionaries in MS-Access used in EXFOR Editor for Sarov group |
| A94 | Zerkin, Pikulina Taova | Setup software package (A93) in Sarov and start producing Dictionaries in MS-Access used in EXFOR Editor |
| A95 | Marian Otsuka Zerkin | Implement authentication of the NDS open and backup areas and provide access to the NDS participants. |

**Revision on the EXFOR Protocol  
(revision from IAEA-NDS-0215 Rev.2018/06)**

|  |  |
| --- | --- |
| **Current description** | **Revision** |
| Data compilation responsibility | |
| Removal of “NDS shall keep an archival copy of the latest version of each of the EXFOR entries and shall be ready to provide the data to any Centre should it be required.” | (Delete.) |
| Procedure for transmitting new exchange files | |
| Request NDS to delete the preliminary version from the NDS open area | Request NDS to move delete the preliminary version to subdirectory TRANS.PRELIM.ARCHIVE from the NDS open area. |
| (New) | NDS will maintain preliminary and final versions of exchange files, dictionaries, and the source codes of the official programs to create updated EXFOR Master File. The NDS open area is for distribution of these materials to the Network and should not be accessible for the public. |
| EXFOR Master File (new section) | |
| (New) | The EXFOR Master File is the continuously updated file generated from the common Master File of DD, MM, YYYY and all exchange files finalized since that date. The Network has responsibility for ensuring reproducibility of the EXFOR Master File including the maintenance of an official program that creates the EXFOR Master File. NDS shall make available on a publicly accessible and referenced website the EXFOR Master File. |

# Meeting Summary

## 1. Introduction

This report summarizes the IAEA Technical Meeting on the International Network of Nuclear Reaction Data Centres held at the IAEA Headquarters in Vienna, Austria from 9 to 12 May 2023. The meeting was attended by 24 participants representing 12 cooperative Centres from seven Member States (China, Hungary, Japan, Korea, Russia, Ukraine and USA) and two International Organisations (NEA, IAEA) as well as a participant from Kazakhstan. (see **Appendix A**). Meetings of this network are held annually, with full meetings involving Centre Heads and technical staff every two years. (The last full meeting was planned to be held in May 2020 at the IAEA Headquarters, but it has been postponed due to COVID-19.)

Main topics of the present meeting were various statistics, manuals and dictionaries, compilation needs, quality control, coding rules as well as software and dissemination (see **Appendix B**). The participants summarized the results of the discussions in XX conclusions and YY actions (see **Appendix C**).

## 2. Brief Summary

**2.1 Opening**

**R. Capote**, Deputy Head of the IAEA Nuclear Data Section welcomed the participants. He emphasized importance to receive recommendations from the participants to ensure both accessibility and quality of EXFOR.

**D. Brown** was elected as the chairperson, and the agenda was adopted.

**2.2 Progress Reports**

Progress reports from 12 attending Centres were presented by **R. Capote**, **V. Varlamov, S. Taova**, **M. Mikhailiukova**, **O. Grizay**, **N C. Shu**, **D.H. Kim**, **M. Kimura, S. Takács**, **O. Iwamoto, M. Fleming** and **D. Brown**, who highlighted the staffing, compilation, dissemination and other nuclear data related activities of interest to the network. See progress reports P2023-01 to P2023-10 (**Appendix F**) for further details.

**2.3 EXFOR General**

**V. Devi** presented the statistics of transmissions, journal scanning and preliminary tape checking. She reported that 351 new entries and 1284 revised entries have been newly finalized since the last (2022) NRDC meeting. She also reported NDS takes maximum one week to review a preliminary tape while NEA DB takes two to three months for it.

**V. Devi** reported that the NDS shares responsibility for scanning of 54 journals with CJD, CNDC, CNPD, NNDC and UkrNDC. She mentioned three journals (AE/T, CNPR and JET) were scanned more than three months since no new issues have been published since their last issues.

**2.4 Manuals and Dictionaries**

**N. Otsuka** informed that JAEA managed compilation of neutron-induced reaction data measured at J-PARC or measured by a researcher from JAEA Nuclear Data Center. He proposed their compilation activity to the NRDC Protocol Appendix C as an official responsibility, and it was approved.

**N. Otsuka** reported his attempt to modernize process for production of the EXFOR/CINDA dictionary by replacing the old Fortran code (DAN2X4) with a new Python script. He implemented not only creation of the DANIEL Backup dictionary and TRANS dictionary from the Archive dictionary but also detection of format errors (via the dictionary converted to JSON) and found about 840 errors (though many of them are very minor errors). He plans to release the dictionary produced by this new Python script for testing in parallel with those produced by DAN2X4.

**2.5 CINDA**

**V. Zerkin** reported that (1) regular automatic updates using the EXFOR and NSR databases have been frozen since December 2018 because NSR database is no longer available; and (2) import from EXFOR was performed once (2023-04-26). He also informed that the number of CINDA search on the NDS web server in 2022 increased by 125% compared to 2021.

**2.6 EXFOR Compilation Needs**

**N. Otsuka** reported CNPD, JCPRG and NNDC still have to compile a few articles related with applications (dosimetry, isotope production, ion-beam analysis, accelerator driven neutron source). He also reported there are still fission product yield articles listed in 2019 by NNDC and NDS, and still waiting compilation by CDFE (3 articles), JCPRG (1 article), NEADB (16 articles) and NNDC (57 articles).

**2.7 EXFOR Quality Control**

**N. Otsuka** presented some remarks from his comparison of the isomeric flags (e.g., -G, -M) in EXFOR with NUBASE2020 by using the Dictionary 227 produced with the new procedure from NUBASE2020. He found 306 nuclides with isomeric flags in REACTION SF4 are not seen in NUBASE 2020 and proposed the centres their corrections with priority. He also reported that half-lives in the 309 datasets are coded not under DECAY-DATA but under the heading HL etc. and argued that this must be moved to DECAY-DATA for the quantities other than the data partial for a half-life group (e.g., partial delayed fission neutron multiplicity).

**V. Devi** presented her analysis of EXFOR outliers. She is continuing review of plots made by A. Koning for production cross sections for γ, p, d, t, 3He and α induced reactions compiled in the EXFOR and TENDL-2021 libraries. As a continuation of her report on γ, d and α induced reactions presented in the last NRDC meeting, she presented some typical errors found in proton-induced reaction data in EXFOR (incorrect reaction product in SF4 such as 159Ho instead of 159Dy, wrong copying from the article table such as 48.0 mb instead of 4.8 mb, compilation of same datasets twice, wrong interpretation of uncertainty values such as compilation of “18.0(19) mb” as 18.0±19 mb instead of 18.0±1.9 mb.

**2.8 EXFOR Coding Rule**

**S. Dunaeva** reported heading ERR-HL (uncertainty in half-life) and ERR-IDD (uncertainty in intensity) are sometimes coded even when the partial uncertainties due to the half-life and/or intensity are coded separately under ERR-1 etc. She proposed to allow use of ERR-HL and ERR-IDD only when they are propagated to the total uncertainty (ERR-T) and not coded as fractional (%) partial uncertainties of the quantity, and her proposal was accepted by the participants.

**N. Otsuka** proposed (1) use of a pointer to an independent variable in the multiple reaction formalism, (2) abolishment of the vector common formalism, and (3) use of the multiple reaction formalism to accommodate the cumulative and chain fission product yields together. These proposals were approved.

**V. Devi** introduced presence of gamma production angular differential cross sections separated to two components: gammas following a cascade (1) bypassing quasi-metastable state production (“prompt component”) and (2) following production of a quasi-metastable state (“delayed component”), and proposed to compile them with ,PAR/L-,DA,G and -L,PAR,DA,DG, respectively in REACTION SF5-SF7. The proposal was approved.

**V. Devi** also proposed use of non-integers as a flag coded under FLAG and DECAY-FLAG. **V. Zerkin** commented that flagging by a non-integer may not work properly since it could be processed by a computer program not as intended by the compiler (e.g., 11.099999 instead of 11.1). The participants concluded to keep the current restriction (integers only).

**N. Otsuka** reported some production cross section datasets are compiled with REACTION codes violating mass conservation though the reaction is properly taken from the source articles with 209Bi(p,x)211At as a typical example. The participants agreed that EXFOR should not include production cross sections of nuclides which can be produced only by interaction with secondary particles (e.g., 209Bi(p,α)206Pb then 209Bi(α,2n)211At). Considering the high interest of 211At production, the participants agreed that an exception could be made for the “209Bi(p,x)211At cross section” already compiled in EXFOR.

**M. Mikhailiukova** argued that the 0th and higher order Legendre coefficients must be compiled together as a single dataset without separation, and the participants agreed with it.

**2.10 Evaluated Data Libraries**

**O. Iwamoto** introduced to the JENDL-5 library released in December 2021. He explained it integrates JENDL special purpose libraries for activation and high energies, and also it is the first JENDL library including the original evaluation of neutron thermal scattering law. **J.-C. Sublet** asked the half-life limit for the target and product nuclides. **Iwamoto** answered that it is one day for the target nuclide and depends evaluator’s decision for the product nuclide. **D. Brown** asked if the experimental information from the LANL Chi-Nu experiment was utilized for evaluation of 235U prompt fission neutron spectrum. **Iwamoto** answered that it was evaluated theoretically without help of the experimental information at the fast neutron region.

**2.9 Tools for Compilation and Dissemination**

**N. Otsuka** presented compilation of experimental isomeric ratios done with his intern Alberto Rodrigo (Universidad Politécnica de Madrid). He introduced extraction of the isomer production cross sections isomeric ratios compiled in EXFOR (12,313 data points for 962 reactions) by using X4Pro. He presented a few typical problems in EXFOR identified during validation of the extracted outputs (duplication, violation of compilation rule, typos by publishers and authors). He emphasized that users still need good knowledge of EXFOR and physics for proper uses of EXFOR even if a helpful tool (e.g., SQL, JSON) becomes available for better readability of EXFOR.

**N. Otsuka** also introduced development of a new tool helping selection of INSTITUTE codes to accelerate compilation of articles having many affiliations (e.g., publications from n\_TOF collaboration). Once the list of affiliations from an article website is copied, the tool proposes candidates of the institute code for each affiliation. He also reported suggestion by the tool was improved by applying the Naïve Bayes classifier.

**S. Okumura** reported development of “Data Explorer”, which displays cross sections for various processes and productions as well as fission product yields in EXFOR and evaluated data libraries. Her code systems are open to the public and it was well received by the participants. She made several proposals to EXFOR: (1) addition of the relation between the author and institute, (2) addition of DOI as coded information, (3) reduction of free text, (4) compilation without COMMON section, (5) removal of pointers. **M. Mikhailiukova** asked what purpose of the project and difference with existing Web Retrieval system is and suggested to study logic of EXFOR deeper. **S. Dunaeva** commented that presence of the COMMON section is essential to minimize redundancy in EXFOR. **N Otsuka** reminded the participants that the EXFOR format is designed for compilation and exchange of experimental data and should not be confused with a centre-to-user format.

**V. Zerkin** presented progress in databases, retrieval systems, tools and software for access to EXFOR, ENDF, IBANDL and pdf files. His presentation included reports on (1) plotting of covariance in angular differential cross section and fission neutron multiplicity in ENDF-6 format (MF34 and 31), (2) connection to INIS, (3) CSV output from the EXFOR web retrieval system, (4) X4Pro as a universal and fully relational EXFOR database, (5) EE-View (a new viewer for data in EXFOR and ENDF formats) and (6) X5 (EXFOR in JSON).He mentioned that the X4Pro database and X5-json could be treated as NRDC products. The participants supported his idea to distribute X4Pro with X5 if the source code and documentation for X4Pro production are shared within the Network.

**V. Zerkin** reviewed existing distribution of the full EXFOR contents (e.g., standalone database, download of full EXFOR in a computational format, exchange files), and proposed the participants to discuss the NRDC policy for off-line EXFOR distribution considering the purpose, users, contents and formats, frequency, and media/storage. The participants recommended release of the EXFOR Master File, dictionaries, and their documentations as Open Data with Document Object Identifiers (DOI) and an open data license (CC-BY-4.0 or similar). The participants also concluded that the working materials such as preliminary and final trans tapes and backup files should not be included in the Open Data distribution and must be closed to the NRDC participants.

**V. Zerkin** also reviewed the software packages used in the NDS EXFOR system. He categorized his packages to three types (1) standalone tools (e.g., database maintenance tool for conversion of EXFOR/ENDF/CINDA to relational databases), (2) standalone/online tools (e.g., interpreters to generate X4+, C5 etc.), and (3) online tools (e.g., retrieval systems, MyExfor). The participants recommended NDS to share the software source codes and their documentation within the Network.

**2.10 Other Business**

**T. Zholdybayev** informed that the Central Asian group (Kazakhstan and Uzbekistan) compiled seven articles since the last NRCD meeting (EXFOR D8059 which was finally merged into D0924, D8053, D8055-D8057, D8061-D8062) and 13 articles from Kazakhstan are still waiting compilation. He also reported that he found a laboratory logbook recording double differential cross sections of charged particle emission from 56Fe, 60Ni, 59Co and 116Sn irradiated by deuterons at 25 MeV and from 208Pb irradiated by alpha particles at 50 MeV, and made these numerical data computer readable for inclusion in an EXFOR entry.

**2.11 Closing**

**N. Otsuka** proposed the dates and places for the next technical NRDC meeting (Vienna, Austria, 14 to 17 May 2024) and for the next full NRDC meeting (Paris, 2nd quarter of 2025), and they were approved.

**M. Fleming** presented possible revisions of the “EXFOR Protocol” to reflect the conclusions on distribution policy of the EXFOR Master File and working materials.

**D. Brown** presented a draft of the Conclusions and Actions for review by the participants.

**M. Fleming** expressed his thanks to Zerkin for his outstanding services to the Network since 1999. **N. Otsuka** thanked for chairmanship taken by Brown.

**R. Capote** called an adjournment of the meeting.

**Distribution:**

a.koning@iaea.org

abhihere@gmail.com

aloks279@gmail.com

daniela.foligno@oecd-nea.org

dbrown@bnl.gov

dgremyachkin@ippe.ru

draj@barc.gov.in

exfor@oecd-nea.org

fukahori.tokio@jaea.go.jp

ganesan555@gmail.com

gezg@ciae.ac.cn

iwamoto.osamu@jaea.go.jp

jmwang@ciae.ac.cn

kaltchen@ukr.net

kimdh@kaeri.re.kr

kimura.atsushi04@jaea.go.jp

l.vrapcenjak@iaea.org

manuel.bossant@oecd-nea.org

marina-03-08@yandex.ru

michael.fleming@oecd-nea.org

mvmikhaylyukova@ippe.ru

nicolas.soppera@oecd-nea.org

nomura@nucl.sci.hokudai.ac.jp

n.otsuka@iaea.org

nrdc@jcprg.org

nshu@ciae.ac.cn

odsurenn@gmail.com

ogritzay@ukr.net

otto.schwerer@aon.at

pikulina@expd.vniief.ru

pritychenko@bnl.gov

scyang@kaeri.re.kr

selyankina@expd.vniief.ru

sonzogni@bnl.gov

stakacs@atomki.mta.hu

stanislav.hlavac@savba.sk

sv.dunaeva@gmail.com

tada@nucl.sci.hokudai.ac.jp

taova@expd.vniief.ru

tarkanyi@atomki.hu

v.devi@iaea.org

v.zerkin@iaea.org

vidyathakur@yahoo.co.in

vsemkova@inrne.bas.bg

vvvarlamov@gmail.com

yolee@kaeri.re.kr

zholdybayev@inp.kz

**cc:**

l.marian@iaea.org

r.capotenoy@iaea.org