**Nuclear Data Section**

**International Atomic Energy Agency**

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

**Memo 4C-3/417**

**Date:** 31 January 2020

**To:** Distribution

**From:** N. Otsuka

**Subject: Neutron inelastic scattering gamma data in Baghdad Atlas (EXFOR 31816)**

The “Atlas of gamma-ray spectra from the inelastic scattering of reactor fast neutrons” (“Baghdad Atlas”, B,GAMMAATLAS,,,1978=R,INDC(CCP)-120,1978) tabulates intensities of over 7000 gamma-rays from 76 natural and 29 enriched samples measured under the fast neutron fields of (1) Kurchatov Institute IRT-M reactor (enriched Mo, Cd and Dy samples), and (2) Nuclear Research Institute in Tuwaitha IRT-2000 reactor (other samples). Outgoing gamma-rays were detected by a Ge(Li) detector at 110 deg (for 114,116Cd) or 90 deg (for other target nuclides). The intensity of a reference gamma line is taken to be 100 for each target nuclide, and the ratio of its intensity to the 847 keV Fe gamma intensity is also reported for natural samples.

A.M. Hurst, L.A. Bernstein and S.A. Chong (UC Berkeley and LBNL) compiled the gamma intensities, and the numerical data in CSV files are distributed from their website with various tools (<https://nucleardata.berkeley.edu/> see also CP-C/456). I would like to share this excellent compilation with the EXFOR users and converted the CSV files to the EXFOR format by a program. Each CSV file is for a target nuclide, and it was converted to (maximum) four subentries – (1) ratio to the Fe 847 keV gamma intensity, (2) inelastic gamma intensities, (3) capture gamma intensities, (4) (n,p) gamma intensities, and (5) others. An example of the conversion result is appended to this memo **(Appendix 1)**.

Since a part of these data sets have been already compiled in EXFOR from preliminary or final publications, I retrieved the relevant articles in EXFOR and (manually compiled) CINDA and summarize their status in **Appendix 2**. Addition of STATUS=SPSDD is proposed for some area 3 and 4 entries.

The conversion result was checked by Marina Mikhailiukova, and the program was improved. Finally, the data measured at NRI and converted to EXFOR 31816 was transmitted in PRELIM.3194. Data for enriched Mo, Cd and Dy samples from Moscow are missing in EXFOR, and they must be compiled by CJD. The corresponding part of the EXFOR draft generated from the Berkeley CSV files was sent to CJD.

Berkeley group’s intention is to issue periodic revisions where the γ-ray and level-scheme information has been updated to match modern values in ENSDF, and they encourage users of the atlas to assist in this process by sending updated csv data to them for more general dissemination to the user community. (During preparation of Appendix 2, I also observed the level assignment has been sometimes changed within their publications. This situation explains why we code the initial level energy not under E-LVL-INI but under LVL-INI when possible.)

**Appendix 1: Sample output of conversion from Berkeley compilation**

SUBENT 31816016 20191216 3181601600001

BIB 3 5 3181601600002

REACTION ((13-AL-27(N,INL)13-AL-27,,SPC/DA,,SPA)// 3181601600003

 (26-FE-0(N,INL)26-FE-0,,SPC/DA,,SPA)) 3181601600004

SAMPLE Elemental sample. 11.0 gram. 3181601600005

METHOD Irradiated for 14.1 hours 3181601600006

 (MOMIX) Irradiation of mixture with iron 3181601600007

ENDBIB 5 0 3181601600008

COMMON 1 3 3181601600009

ANG 3181601600010

ADEG 3181601600011

 90. 3181601600012

ENDCOMMON 3 0 3181601600013

DATA 4 1 3181601600014

E-NM E-DN DATA DATA-ERR 3181601600015

KEV KEV NO-DIM NO-DIM 3181601600016

 1014. 847. 0.28 0.03 3181601600017

ENDDATA 3 0 3181601600018

ENDSUBENT 17 0 3181601699999

SUBENT 31816017 20191216 3181601700001

BIB 4 6 3181601700002

REACTION ((13-AL-27(N,INL)13-AL-27,,SPC/DA,,SPA)// 3181601700003

 (13-AL-27(N,INL)13-AL-27,,SPC/DA,,SPA)) 3181601700004

SAMPLE Elemental sample. 11.0 gram. 3181601700005

METHOD Irradiated for 14.1 hours 3181601700006

FLAG (13027.) 27Al(n,n')27Al 3181601700007

 (10013027.) 27Al(n,n')27Al. Energy from literature for 3181601700008

ENDBIB 6 0 3181601700009

COMMON 3 3 3181601700010

ANG E-DN E-DN-ERR 3181601700011

ADEG KEV KEV 3181601700012

 90. 1014.4 0.15 3181601700013

ENDCOMMON 3 0 3181601700014

DATA 6 20 3181601700015

E-NM E-NM-ERR DATA DATA-ERR LVL-INI FLAG 3181601700016

KEV KEV NO-DIM NO-DIM KEV NO-DIM 3181601700017

 170.6 0.2 0.049 0.010 1014.4 13027. 3181601700018

 793.0 0.2 0.031 0.003 3004.8 13027. 3181601700019

 843.75 0.600 0.040 843.8 10013027. 3181601700020

 1014.4 0.15 1.000 1014.4 13027. 3181601700021

 1507.3 0.7 0.003 0.001 4511.6 13027. 3181601700022

 1720.8 0.3 0.140 0.020 2735.2 13027. 3181601700023

 2211.8 0.2 0.520 0.050 2211.8 13027. 3181601700024

 2299.2 0.5 0.016 0.002 4511.6 13027. 3181601700025

 2371.7 0.6 0.008 0.002 4582.2 13027. 3181601700026

 2664.5 0.8 0.009 0.002 3679.3 13027. 3181601700027

 2735.3 0.5 0.034 0.003 2735.2 13027. 3181601700028

 2835.8 0.7 0.011 0.002 3679.3 13027. 3181601700029

 2940.6 0.8 0.008 0.003 3954.7 13027. 3181601700030

 2981.3 0.4 0.077 0.013 2981.4 13027. 3181601700031

 3004.5 0.3 0.180 0.030 3004.8 13027. 3181601700032

 3210.4 0.7 0.021 0.004 4054.3 13027. 3181601700033

 3954.9 1.1 0.006 0.003 3954.7 13027. 3181601700034

 4307.0 1.5 0.004 0.002 5151.1 13027. 3181601700035

 4413.4 0.8 0.011 0.004 4413.6 13027. 3181601700036

 4582.0 0.8 0.014 0.005 4582.2 13027. 3181601700037

ENDDATA 22 0 3181601700038

ENDSUBENT 37 0 3181601799999

SUBENT 31816178 20191216 3181617800001

BIB 4 5 3181617800002

REACTION ((13-AL-27(N,P)12-MG-27,,SPC/DA,,SPA)// 3181617800003

 (13-AL-27(N,INL)13-AL-27,,SPC/DA,,SPA)) 3181617800004

SAMPLE Elemental sample. 11.0 gram. 3181617800005

METHOD Irradiated for 14.1 hours 3181617800006

FLAG (10300.) 27Al(n,p)27Mg 3181617800007

ENDBIB 5 0 3181617800008

COMMON 3 3 3181617800009

ANG E-DN E-DN-ERR 3181617800010

ADEG KEV KEV 3181617800011

 90. 1014.4 0.15 3181617800012

ENDCOMMON 3 0 3181617800013

DATA 6 3 3181617800014

E-NM E-NM-ERR DATA DATA-ERR LVL-INI FLAG 3181617800015

KEV KEV NO-DIM NO-DIM KEV NO-DIM 3181617800016

 955.2 0.2 0.005 0.001 1939.8 10300. 3181617800017

 984.5 0.15 0.017 0.003 984.5 10300. 3181617800018

 1940.2 0.4 0.004 0.002 1939.8 10300. 3181617800019

ENDDATA 5 0 3181617800020

ENDSUBENT 19 0 3181617899999

SUBENT 31816184 20191216 3181618400001

BIB 4 5 3181618400002

REACTION ((13-AL-27(N,X)0-G-0,,SPC/DA,,SPA)// 3181618400003

 (13-AL-27(N,INL)13-AL-27,,SPC/DA,,SPA)) 3181618400004

SAMPLE Elemental sample. 11.0 gram. 3181618400005

METHOD Irradiated for 14.1 hours 3181618400006

FLAG (12024.) 27Al(n,x)24Mg 3181618400007

ENDBIB 5 0 3181618400008

COMMON 3 3 3181618400009

ANG E-DN E-DN-ERR 3181618400010

ADEG KEV KEV 3181618400011

 90. 1014.4 0.15 3181618400012

ENDCOMMON 3 0 3181618400013

DATA 6 2 3181618400014

E-NM E-NM-ERR DATA DATA-ERR LVL-INI FLAG 3181618400015

KEV KEV NO-DIM NO-DIM KEV NO-DIM 3181618400016

 1369.3 0.8 0.003 0.001 1368.6 12024. 3181618400017

 2754.0 1.5 0.002 0.001 4122.8 12024. 3181618400018

ENDDATA 4 0 3181618400019

ENDSUBENT 18 0 3181618499999

**Appendix 2: Comparison of data sets compiled in Baghdad Atlas (BA) and EXFOR/CINDA reference.**

Ref.#: Reference ID in the citation list of Baghdad Atlas.

Lab.: Location of the measurement (NRI=3IRQNRI, KUR=4RUSKUR).

Diff.: Difference between data in Baghdad and EXFOR/CINDA source articles.)

SPSDD by 31816: The subentry number of the 31816 data set which supersedes the data set identified by the subentry in the first column.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **EXFOR #** | **EXFOR/CINDA Reference** | **Ref#** | **Target** | **Lab** | **Diff.** | **Remark** | **SPSDD by 31816** |
| 30303.002 | L.I.Govor+,J,NP/A,245,13,1975 | 75Go2 | Pd-108 | NRI |  = | Same. Typo in BA at 985.3 and 1441.60 keV? | No |
| 30303.003 | L.I.Govor+,J,NP/A,245,13,1975 | 75Go2 | Pd-110 | NRI |  = | Same. Typo in BA at 208.3 keV? | No |
| 30304.002 | M.R.Ahmed+,J,NIM,117,533,1974 | 74Ah | Pd-106 | NRI |  ~ | Slightly different (e.g., 1150.2 keV, 1566.3 keV) | 079 |
| 30304.003 | M.R.Ahmed+,J,NIM,117,533,1974 | 74Ah | Al-27 | NRI |  ~ | Slightly different (e.g., 170.6 keV) | 017 |
| 30304.004 | M.R.Ahmed+,R,NRITB-PH-28,1974 |  | Nb-93 | NRI |  ~ | Slightly different (e.g., 708.2 keV) | 068 |
| 30304.005 | M.R.Ahmed+,R,NRITB-PH-28,1974 |  | Fe-0 | NRI |  ~ | Slightly different (e.g., 122.1 keV, 3601.9 keV) | 040 |
| 30334.002 | M.R.Ahmed+,R,NRITB-PH-31,1975 |  | Pd-104 | NRI |  ~ | Slightly different (e.g., 497.8 keV, 1271.69 keV) | 077 |
| 40386.002 | L.I.Govor+,P,YFI-21,8,1976 |  | Pd-104 | NRI |  ~ | Slightly different (e.g., 1028.1 keV) | 077 |
| 30522.002 | A.M.Demidov+,J,NP/A,237,125,1975 | 75De5 | W-182 | NRI |  ≠ | Difference in normalization! | 146 |
| 40313.002 | L.I.Govor+,C,75LENING,,54,1975 | 75Go | Mn-55 | NRI |  ≠ |  | 039 |
| 40314.002 | L.I.Govor+,C,75LENING,,76,1975 | 75Go3 | Pd-105 | NRI |  ≠ |  | 078 |
| 40317.002 | A.M.Demidov+,C,75LENING,,157,1975 | 75De1 | Th-232 | NRI |  ≠ |  | 168 |
| 40444.002 | V.D.Avchukhov+,C,76BAKU,,85,1976 | 76Av1 | In-115 | NRI |  ~ | Slightly different (e.g., 1173.1 keV) | 085 |
| 40445.002 | V.D.Avchukhov+,C,76BAKU,,90,1976 | 76Av2 | I-127 | NRI |  ≠ | FACILITY: 4RUSKUR -> 3IRQNRI | 102 |
| 40446.002 | V.D.Avchukhov+,C,76BAKU,,93,1976 | 76Av3 | Cs-133 | NRI |  ≠ |  | 104 |
| 40449.003+40449.004 | V.D.Avchukhov+,J,BAS,42,(9),120,1978 |  | W-184 | NRI | ~ | Slightly different (e.g., 891.4 keV, 1110.4 keV) | 147 |
| 40449.005+40449.006 | V.D.Avchukhov+,J,BAS,42,(9),124,1978 |  | W-186 | NRI | ~ | Slightly different (e.g., 615.30 keV, 807.1 keV) | 148 |
| 40454.002 | V.D.Avchukhov+,C,77TASHKENT,,9,1977 |  | Pr-141 | NRI |  ~ | Slightly different (e.g., 1580.2 keV, 2136.2 keV) | 112 |
| 40454.003 | V.D.Avchukhov+,C,77TASHKENT,,14,1977 |  | Ta-181 | NRI |  ~ | Slightly different (e.g., 359.1 keV, 383.8 keV, 686.4 keV) | 143 |
| 41552.002 | A.M.Demidov+,J,BAS,40,(1),132,1976 | 76De | Cd-110 | KUR |  ~ | Slightly different (e.g., 657.72 keV) |  |
| 41552.003 | A.M.Demidov+,J,BAS,40,(1),132,1976 | 76De | Cd-112 | KUR |  ~ | Slightly different (e.g., 617.50 keV) |  |
| 41553.002+004 | A.M.Demidov+,J,BAS,40,(6),119,1976 | 76De1 | Cd-114 | KUR | ? | (not compared at NDS) |  |
| 41553.003+005 | A.M.Demidov+,J,BAS,40,(6),119,1976 | 76De1 | Cd-116 | KUR | ? | (not compared at NDS) |  |
| (not in X4) | A.M.Demidov+,R,INDC(CCP)-111,10,1978 |  | Mo-92 | KUR |  ≠ |  |  |
| (40449.003+004) | V.D.Avchukov+,C,77TASHKENT,,11,1977 |  | W-184 | NRI |  ≠ | This reference is missing in 40449.003+004. |  |
| Missing in X4 | K.A.Baskova+,J,BAS,40,(4),88,1976 | 76Ba1 | Dy-164 | KUR | ~ | Slightly different (e.g., 585.5 keV, 673.7 keV) |  |
| Missing in X4 | K.A.Baskova+,J,BAS,40,(1),63,1976 | 76Ba | Dy-162 | KUR |  ≠ | Must be newly compiled by CJD. |  |
| Missing in X4 | A.M.Demidov+,C,75KIEV,5,34,1975 | 75De3 | Mo-92 | KUR |  | (See R,INDC(CCP)-111,10,1978) |  |
| No data in X4 | A.M.Demidov+,C,75LENING,,159,1975 | 75De2 | U-238 | NRI |  ≠ | Secondary reference of 31816? |  |

**Distribution:**

a.koning@iaea.org

abhihere@gmail.com

aloks279@gmail.com

dbrown@bnl.gov

draj@barc.gov.in

fukahori.tokio@jaea.go.jp

ganesan555@gmail.com

gezg@ciae.ac.cn

iwamoto.osamu@jaea.go.jp

j.c.sublet@iaea.org

jmwang@ciae.ac.cn

kaltchenko@kinr.kiev.ua

kenya.suyama@oecd-nea.org

kimura.atsushi04@jaea.go.jp

l.vrapcenjak@iaea.org

manuel.bossant@oecd-nea.org

masaaki@nucl.sci.hokudai.ac.jp

michael.fleming@oecd-nea.org

mmarina@ippe.ru

nicolas.soppera@oecd-nea.org

n.otsuka@iaea.org

nrdc@jcprg.org

odsurenn@gmail.com

ogritzay@kinr.kiev.ua

ogrudzevich@ippe.ru

otto.schwerer@aon.at

pikulina@expd.vniief.ru

pritychenko@bnl.gov

s.okumura@iaea.org

samaev@obninsk.ru

sbabykina@yandex.ru

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

vvvarlamov@gmail.com

v.zerkin@iaea.org

vidyathakur@yahoo.co.in

vsemkova@inrne.bas.bg

yolee@kaeri.re.kr

zholdybayev@inp.kz

**cc:**

andrew.voyles@berkeley.edu

amhurst@berkeley.edu

labernstein@lbl.gov