**Nuclear Data Section**

**International Atomic Energy Agency**

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**Memo 4C-3/407 (Rev.)**

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**To:** Distribution

**From:** N. Otsuka

**Subject:** **Correction of capture data from the ORELA 40 m flight station**

There was an error in the computer codes processing neutron capture yields measured at the ORELA 40 m flight station. Correction factors applied to their capture yields were published in 1981-1982 [1,2]. Though the capture kernel (resonance strength), resonance width and average capture cross section do not depend on the correction factors linearly, the authors mention that

“Our experience so far indicates that for individual resonances the percentage correction to be applied to resonance capture areas can differ by as much as one-third of the percentage correction indicated in Table I. This implies that the factors shown in Table I can be used to correct resonance capture areas and radiation widths (except for the three extreme case mentioned above) with an uncertainty of not more than ~5%” [1]

“The correction to resonance capture areas, radiation width, and average capture cross sections is in principle nonlinear because of sample thickness effects. However, an uncertainty of less than a few percent will result from the direct application of the correction factors. [2]”.

Motivated by discussion with Dr. K. Shibata on the ~7% difference in the capture kernels between Macklin’s data in EXFOR and JENDL-4.0 for 93Nb (**Appendix 2**), I checked the general situation of the affected EXFOR entries (**Appendix 1**), and observer that:

1. The corrigendum is cited in all area 3 entries, but not cited in many area 1 entries.
2. Average group-wise capture cross sections in EXFOR are revised with the correction factors in Refs.[1,2] for all cases affected by the problem. The corrections have been done by the authors for 66,68Zn, 104,105,106,108,110Pd, 165Ho and 232Th by the authors, but by the centres for the other cases.
3. Resonance widths and capture kernels are not revised except for 232Th for which the correction factor is large (1.1131) and the resonance parameters revised by the authors are in EXFOR.
4. Maxwellian spectrum averaged cross sections (MACS) are not revised except for 95,96,97,98Mo for which NNDC found in 2012 that MACS obtained by reassessment of the capture yield data sets are published in 1987, and the revised MACS were added to the EXFOR entry by NNDC and NDS. (N.B. Karlsruhe evaluation [3] applies the corrections factors in Refs.[1,2] to the MACS in the original publications.)

Macklin mentions in Ref.[1] that “We are working with the Brookhaven National Center for Neutron Cross Section Data to have all cross sections and resonance parameters reported by us since 1972 brought up to date.”, but we do not see its evidence in these EXFOR entries.

Compilation of data corrected by other than authors is allowed only when they are published in a peer-reviewed journal (NRDC2014 C30). Under this restriction, I think we should indicate the problem in the affected EXFOR entries more clearly, for example,

1. Addition of the corrigendum under REFERENCE.
2. Addition of STATUS=OUTDT to each data subentry.
3. Clear indication of the correction factors (*e.g.*, COMMENT, CRITIQUE, REL-REF) in each data subentry.

It would be useful for some users to have the correction factors in the EXFOR data correction system (see Viktor Zerkin’s slides presented in NRDC 2015) so that the users can apply the correction factors easily. Addition of the correction factors to the correction system could be a task for evaluators rather than compilers because the relation between the capture yield (for which we have the correction factor from the author) and the quantities in EXFOR (e.g., average cross section, MACS, capture kernel, capture width) is not linear, and it is not trivial for compilers to judge if the correction factor is applicable to the EXFOR data set.

**References**

[1] R.L. Macklin, R.R. Winters, Nucl. Sci. Eng. **78** (1981) 110.  
[2] B.J. Allen, J.W. Boldeman, R.L. Macklin, Nucl. Sci. Eng. **82** (1982) 230.  
[3] R.L. Mackiln, Nucl. Sci. Eng. **59** (1976) 12.

**Appendix 1: Summary of EXFOR entries compiling the ORELA data sets discussed in Refs.[1-2] (Updated 2019-12-22)**

* Factor: Correction factors in Refs.[1,2]
* Ref: Reference numbers in Refs.[1,2]
* References: References cited in Refs.[1,2]
* Cite: x means the corrigendum is under REFERENCE of the EXFOR entry
* EXFOR: C following the entry number means that the comment on the correction is in the common subentry (001).
* <σγ>: Subentry numbers of group-wise capture cross sections
* Γ, gΓnΓγ/Γ: Subentry numbers of resonance widths and capture kernels
* MACS: Subentry numbers of Maxwellian spectrum averaged cross sections
* (!: no comment about correction, c: comment given, r: corrected by NNDC or NDS, R: corrected or reanalysed by authors (or corrected but not explicitly written who corrected it), o: no correction required, d: digitized data with comment but uncertain if corrected.)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **[1] NSE,78,110,1981** | | |  |  |  |  |  |  |  |  |
| **Target** | **Factor** | **Ref** | **References** | **Cite** | **EXFOR** | **<σγ>** | **Γ, gΓnΓγ/Γ** | **MACS** | **Remark** | **TRANS** |
| 24Mg | 0.9325 | 1 | J,PR/C,14,1328,1976 |  | 10791 |  | 006!,007! | 003cd |  |  |
| 25Mg | 0.9325 | 1 | J,PR/C,14,1328,1976 |  | 10791 |  | 008! | 004cd |  |  |
| 26Mg | 0.9325 | 1 | J,PR/C,14,1328,1976 |  | 10791 |  | 009! | 005cd |  |  |
| 32S | 1.1131 | 2 | J,PR/C,21,545,1980 |  | 10455 |  | 002! |  |  |  |
| 33S | 0.9850 | 3 | J,PR/C,12,1126,1975 |  | 10534C |  | 002! |  |  |  |
| 51V | 1.0360 | 4 | J,PR/C,18,2092,1978 |  | 10813C |  | 003!,004!,005!,006! | 008! |  |  |
| 55Mn | 0.9507 | 5 | J,PR/C,18,2079,1978 |  | 10752 | 004r | 003! |  |  |  |
| 63Cu | 0.9507 | 6 | J,PR/C,15,615,1977 | x | 10726C |  | 002! |  | 002.2: SF3: EL -> G | 1436 |
| 65Cu | 0.9507 | 6 | J,PR/C,15,615,1977 | x | 10726C |  | 003! |  | 003.2: SF3: EL -> G |
| 64Zn | 0.9850 | 7 | J,PR/C,23,683,1981 |  | 10963 |  | 003!,004! |  |  |  |
| 66Zn | 0.9507 | 8 | J,PR/C,24,1922,1981 |  | 12719 | 003R | 004!,005!,007! |  |  |  |
| 68Zn | 0.9507 | 8 | J,PR/C,25,1808,1982 |  | 10982 | 005R | 002!,003! | 006! | Citation wrong in Corrigendum.  006: AV -> MXW; EN -> KT |  |
| 93Nb | 1.0737 | 9 | J,NSE,59,12,1976 |  | 10537 | 002r,003r,004r,005r | 006!,007! |  |  |  |
| 92Mo | 0.9507 | 10 | J,PR/C,7,1532,1973 |  | 10748C |  | 004!,005! |  |  |  |
| 100Mo | 0.9507 | 11 | J,PR/C,20,115,1979 |  | 10773C |  | 002! |  |  |  |
| 100Ru | 0.9850 | 12  13 | J,NSE,73,174,1980  C,79BOLOGN,,103,1979 | x | 10875 | 012r | 002! |  | Add C,79BOLOGN,,103,1979 | 1435 |
| 101Ru | 0.9850 | 12  13 | J,NSE,73,174,1980  C,79BOLOGN,,103,1979 | x | 10875 | 013r | 004! |  | Add C,79BOLOGN,,103,1979 |
| 102Ru | 0.9850 | 12  13 | J,NSE,73,174,1980  C,79BOLOGN,,103,1979 | x | 10875 | 014r | 006! |  | Add C,79BOLOGN,,103,1979 |
| 104Ru | 0.9850 | 12  13 | J,NSE,73,174,1980  C,79BOLOGN,,103,1979 | x | 10875 | 016r | 010! |  | Add C,79BOLOGN,,103,1979 |
| 103Rh | 0.9507 | 12  13 | J,NSE,73,174,1980  C,79BOLOGN,,103,1979 | x | 10875 | 015r | 008! |  | Add C,79BOLOGN,,103,1979 |
| 104Pd | 0.7999 | 13  14 | C,79BOLOGN,,103,1979  J,NSE,71,182,1979 | x | 10868 | 007R | 002c |  | Add C,79BOLOGN,,103,1979 | 1435 |
| 105Pd | 1.1131 | 13  14 | C,79BOLOGN,,103,1979  J,NSE,71,182,1979 | x | 10868 | 008R | 003c |  | Add C,79BOLOGN,,103,1979 |
| 106Pd | 0.7734 | 13  14 | C,79BOLOGN,,103,1979  J,NSE,71,182,1979 | x | 10868 | 009R | 004c |  | Add C,79BOLOGN,,103,1979 |
| 108Pd | 0.7480 | 13  14 | C,79BOLOGN,,103,1979  J,NSE,71,182,1979 | x | 10868 | 010R | 005c |  | Add C,79BOLOGN,,103,1979 |
| 110Pd | 0.7480 | 13  14 | C,79BOLOGN,,103,1979  J,NSE,71,182,1979 | x | 10868 | 011R | 006c |  | Add C,79BOLOGN,,103,1979 |
| 159Tb | 1.0737 | 15 | J,PR/C,17,522,1978 |  | 10758 |  | 003! |  |  |  |
| 165Ho | 1.1131 | 16 | J,NSE,59,231,1976 | x | 10531 | 002R | 006R |  |  |  |
| 169Tm | 1.0737 | 17 | R,LA-7479-MS,1978 | x | 10873 | 002r | 005R |  |  |  |
| 186Os | 0.8990 | 18 | J,PR/C,21,563,1980 |  | 10882 | 002r |  |  |  |  |
| 187Os | 0.9430 | 18 | J,PR/C,21,563,1980 |  | 10882 | 003r |  |  |  |  |
| 188Os | 0.9700 | 18 | J,PR/C,21,563,1980 |  | 10882 | 004r |  |  |  |  |
| 197Au | 1.0001 | 19 | J,PR/C,11,1270,1975 |  | 10432 | 002r,003r | 004! |  |  |  |
| 203Tl | 0.9507 | 20 | J,AJ,208,812,1976 |  | 10602 | 005r | 002!,003! |  |  |  |
| 206Pb | 1.0360 | 21 | J,PR/C,19,335,1979 |  | 10842C |  | 002!,004! |  |  |  |
| 207Pb | 0.9655 | 22 | J,PRL,39,598,1977 |  | 10700C |  | 002!,003! |  |  |  |
| 209Bi | 1.0360 | 23 | J,PR/C,14,1389,1976 |  | 10610 | 006r | 002!,003! | |  | | --- | |  | |  |  |
| 232Th | 1.1131 | 24 | J,NSE,64,849,1977 |  | 10554 | 002R,003R,004R | 005R,006R,009! |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| **[2] J,NSE,82,230,1982** | | |  |  |  |  |  |  |  |  |
| **Target** | **Factor** | **Ref** | **References** | **Cite** | **EXFOR** | **<σγ>** | **Γ, gΓnΓγ/Γ** | **MACS** | **Remark** |  |
| 23Na | 1.0360 | 2 | C,78HARWELL,,426,1978 | x | 30385 |  | 002! |  |  | 3191 |
| 27Al | 1.0000 | 2 | C,78HARWELL,,426,1978 | x | 30414 |  | 002o |  |  |  |
| 28Si | 1.0000 | 3  4 | J,NP/A,252,62,1975  J,NP/A,334,269,1980 | x | 30330 |  | 002o,003o |  |  |  |
| 29Si | 1.0000 | 3  4 | J,NP/A,252,62,1975  J,NP/A,334,269,1980 | x | 30330 |  | 004o |  |  |  |
| 30Si | 1.0000 | 3  4 | J,NP/A,252,62,1975  J,NP/A,334,269,1980 | x | 30330 |  | 005o |  |  |  |
| 40Ca | 1.0000 | 5 | J,NP/A,259,365,1976 | x | 30395 |  | 002o | 004o | Citation wrong in Corrigendum. |  |
| 42Ca | 1.0000 | 6 | J,NP/A,279,317,1977 | x | 30356 | 003o | 002o,004o |  |  |  |
| 43Ca | 1.0000 | 6 | J,NP/A,279,317,1977 | x | 30356 | 006o | 005o,007o |  |  |  |
| 44Ca | 1.0000 | 6 | J,NP/A,279,317,1977 | x | 30356 | 009o | 008o,010o |  |  |  |
| 45Sc | 1.0737 | 7 | J,AUJ,30,605,1977 | x | 30381 | 007r | 002!,003!,004! | 005! |  | 3191 |
| 46Ti | 0.9833 | 8  9 | R,AAEC-E-402,1977  C,77GEEL,,447,1977 | x | 30359C | 005r | 002!,006! | 003! |  | 3191 |
| 47Ti | 0.9833 | 8  9 | R,AAEC-E-402,1977  C,77GEEL,,447,1977 | x | 30359C | 010r | 007!,011! | 008! |  |
| 48Ti | 1.0360 | 8  9 | R,AAEC-E-402,1977  C,77GEEL,,447,1977 | x | 30359C | 015r | 012!,016! | 013! |  |
| 49Ti | 0.9833 | 8  9 | R,AAEC-E-402,1977  C,77GEEL,,447,1977 | x | 30359C | 020r | 017!,021! | 018! |  |
| 50Ti | 1.0000 | 8  9 | R,AAEC-E-402,1977  C,77GEEL,,447,1977 | x | 30359C | 025o | 022o,026 | 023o |  |
| 50Cr | 1.0737 | 9  10 | C,77GEEL,,447,1977  R,AAEC-E-400,1977 | x | 30393 | 006r | 002!,003!,004!,005! | 007! |  | 3191 |
| 52Cr | 1.0737 | 9  10 | C,77GEEL,,447,1977  R,AAEC-E-400,1977 | x | 30393 | 012r | 008!,009!,010!,011! | 013! |  |
| 53Cr | 1.0737 | 9  10 | C,77GEEL,,447,1977  R,AAEC-E-400,1977 | x | 30393 | 018r | 014!,015!,016!,017! | 019! |  |
| 54Cr | 1.0737 | 9  10 | C,77GEEL,,447,1977  R,AAEC-E-400,1977 | x | 30393 | 024r | 020!,021!,022!,023! | 025! |  |
| 54Fe | 1.0000 | 9  11 | C,77GEEL,,447,1977  J,NP/A,283,37,1977 | x | 30355 | 007o | 006o,010o | 008o |  |  |
| 56Fe | 1.0000 | 9  12 | C,77GEEL,,447,1977  J,NP/A,269,408,1976 | x | 30355 | 003o | 002o,005o | 004o |  |  |
| 57Fe | 1.0360 | 9  13 | C,77GEEL,,447,1977  C,77GEEL,,476,1977 | x | 30424 | 004r | 002!,003! | 005! | 005: SPA -> MXW | 3191 |
| 58Fe | 0.9655 | 14 | J,JP/G,6,381,1980 | x | 30486 | 004r | 002!,003! | 005! |  | 3191 |
| 86Sr | 1.0000 | 15 | J,AUJ,35,267,1982 | x | 30487 | 002o | 004o,008o | 003o |  |  |
| 87Sr | 1.0000 | 15 | J,AUJ,35,267,1982 | x | 30487 | 005o | 007o,009o | 006o |  |  |
| 88Sr | 1.0737 | 16 | J,NP/A,269,397,1976 | x | 30369 | 005r | 002!,003! | 004! |  | 3191 |
| 89Y | 1.0360 | 17 | J,NSE,64,744,1977 | x | 30391 | 006r | 002!,003! | 005! |  | 3191 |
| 90Zr | 0.967(16) | 18 | J,NP/A,246,1,1975 | x | 30329 | 004r | 002!,003! | 005! | STATUS of 005 incorrect | 3181 |
| 91Zr | 1.0000 | 19 | J,AUJ,30,391,1977 | x | 30423 | 005o | 002o,004o | 006o |  |  |
| 92Zr | 0.9833 | 20 | J,NP/A,269,31,1976 | x | 30358 | 007r | 002!,004! | 006! |  | 3191 |
| 94Zr | 0.9833 | 20 | J,NP/A,269,31,1976 | x | 30358 | 013r | 008!,010! | 012! |  |
| 92Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 004r | 002!,003! | 028! |  | 3181 |
| 92Mo | 0.9833 | 22 | J,PR/C,7,1532,1973 |  | 10748C |  | 004!,005! |  |  |  |
| 94Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 007r | 005!,006! | 029! |  | 3181 |
| 95Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 010r | 008!,009! | 024!,031R,035R | 031 must supersede 024. | 3181 |
| 96Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 013r | 011!,012! | 025!,032R,036R | 032 must supersede 025. | 3181 |
| 97Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 016r | 014!,015! | 026!,033R,037R | 033 must supersede 026. | 3181 |
| 98Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 019r | 017!,018! | 027!,034R,038R | 034 must supersede 027. | 3181 |
| 100Mo | 0.9833 | 21 | J,NP/A,270,108,1976 | x | 30357 | 022r | 020!,021! | 030! |  | 3181 |
| 106Cd | 0.9850 | 23 | J,JP/G,5,771,1978 | x | 30453 | 005r | 002!,003! | 004! | 004: SPA -> MXW | 3182 |
| 108Cd | 0.9850 | 23 | J,JP/G,5,771,1978 | x | 30453 | 009r | 006!,007! | 008! | 008: SPA -> MXW | 3182 |
| 110Cd | 0.9833 | 23 | J,JP/G,5,771,1978 | x | 30453 | 013r | 010!,011! | 012! | 012: SPA -> MXW | 3182 |
| 111Cd | 1.2080 | 24 | J,PR/C,7,780,1973 |  | 10746 |  | 002! |  |  |  |
| 111Cd | 1.2080 | 25 | C,78HARWEL,449,1978 | x | 30488 | 002r | 004! | 003! |  | 3191 |
| 112Cd | 1.0069 | 23 | J,JP/G,5,771,1978 | x | 30453 | 017r | 014!,015! | 016! | 016: SPA -> MXW | 3182 |
| 113Cd | 1.0187 | 24 | C,78HARWEL,449,1978 | x | 30488 | 005r | 007! | 006! |  | 3191 |
| 114Cd | 1.0187 | 23 | J,JP/G,5,771,1978 | x | 30453 | 021r | 018!,019! | 020! | 020: SPA -> MXW | 3182 |
| 116Cd | 1.0187 | 23 | J,JP/G,5,771,1978 | x | 30453 | 025r | 022!,023! | 024! | 024: SPA -> MXW | 3182 |
| 134Ba | 0.9833 | 26 | J,NP/A,256,173,1975 | x | 30328 | 013r | 002!,003! | 004! |  | 3191 |
| 135Ba | 0.9833 | 27 | R,AAEC-E-237,1974 | x | 30293 | 004r | 002!,003! | 005! |  | 3191 |
| 136Ba | 0.9833 | 26 | J,NP/A,256,173,1975 | x | 30328 | 014r | 005!,006! | 010! |  | 3191 |
| 137Ba | 0.9833 | 28 | J,AUJ,29,157,1976 | x | 30328 | 015r | 011!,012! | 017! |  |
| 138Ba | 0.9833 | 29 | J,AUJ,32,213,1979 | x | 30328 | 016r | 007!,008! | 009! |  |
| 139La | 1.0737 | 30 | J,AUJ,30,599,1977 | x | 30384 | 004r | 002!,003! | 005! |  | 3191 |
| 140Ce | 1.0000 | 29 | J,AUJ,32,213,1978 | x | 30361 | 005o | 002o,003o | 004o |  |  |
| 141Pr | 1.0737 | 31 | J,AUJ,32,551,1979 | x | 30490 | 004r | 002!,003! | 005! |  | 3191 |
| 142Nd | 0.967(16) | 32 | R,AAEC-E-401,1977 | x | 30360 | 005r | 002!,003! | 004! |  | 3191 |
| 143Nd | 0.9507 | 32 | R,AAEC-E-401,1977 | x | 30360 | 009r | 006!,007! | 008! |  |
| 144Nd | 0.967(16) | 32 | R,AAEC-E-401,1977 | x | 30360 | 013r | 010!,011! | 012! |  |
| 145Nd | 0.9507 | 32 | R,AAEC-E-401,1977 | x | 30360 | 017r | 014!,015! | 016! |  |
| 146Nd | 0.9833 | 32 | R,AAEC-E-401,1977 | x | 30360 | 021r | 018!,019! | 020! |  |
| 148Nd | 0.9833 | 32 | R,AAEC-E-401,1977 | x | 30360 | 025r | 022!,023! | 024! |  |
| 204Pb | 1.0737 | 33 | J,PR/C,8,1504,1973 |  | 10155 |  | 007!,011! |  |  |  |
| 206Pb | 1.0000 | 33 | J,PR/C,8,1504,1973 |  | 10155 |  | 008o,013o |  |  |  |
| 206Pb | 1.0737 | 34 | P,AAEC-PR-46,16,1980 | x | 30386 |  | 002! | 003! | 003: SPA -> MXW;  EN-DUMMY=45 keV ->  KT= 30 keV | 3191 |
| 207Pb | 1.0000 | 33  35 | J,PR/C,8,1504,1973  C,71KNOX,2,764,1971 |  | 10155 |  | 009o,015o |  |  |  |
| 208Pb | 1.0000 | 33  36 | J,PR/C,8,1504,1973  P,AAEC-PR-43,36,1977 |  | 10155 |  | 010o,018o |  |  |  |
| 209Bi | 1.0000 | 36 | P,AAEC-PR-43,36,1977 |  | 30450 |  | 002o,003o |  |  |  |