Wrong use of MONIT-ERR

(N. Otsuka, 2021-10-06, Memo CP-D/1026)

This paper seeks an approval to combine the heading MONIT-ERR with a unit other than PER-CENT only when the monitor value is coded under MONIT.

An error budget table of measured cross sections usually summarizes fractional (%) uncertainties of the measured quantity. However, a number of recent activation cross section articles from India give them in the absolute unit (b):

Example: I.Pasha+,J,JRN,320,561,2019 (EXFOR 33129)

The authors used the ^{197}Au(n,2n)^{196}Au cross section σ_M=2.160±0.0198 b (0.92%).

Table 4 Detailed of partial uncertainties and correlations from the different attributes of measured reactions relative to monitor reaction

Attributes	Nuclide ^{92m}Nb	Nuclide ^{90m}Y	Nuclide ^{92m}Nb	Correlation
Monitor reaction cross section σ_M	4.682E−03	4.768E−05	5.743E−04	Correlated
γ-ray peak counts C_S	2.742E−02	1.842E−04	9.289E−03	Uncorrelated
γ-ray peak counts C_M	2.861E−03	2.913E−05	3.509E−04	Fully correlated
Decay constant λ_S	2.887E−05[a]	4.168E−06[b]	2.287E−06[c]	a and c are fully correlated c is uncorrelated
Decay constant λ_M	4.436E−06	4.518E−08	5.441E−07	Fully correlated
Weight of sample Wt_S	1.777E−04[a]	1.809E−06[b]	1.818E−05[c]	a and b are fully correlated c is uncorrelated
Weight of monitor Wt_M	8.813E−05	8.975E−07	1.081E−05	Fully correlated
Isotopic abundance a_S	–[a]	–[b]	1.292E−04[c]	a and b found to be with no error and c with error
Average atomic mass A_{VS}	8.788E−09[a]	8.949E−11[b]	1.158E−10[c]	a and b are fully correlated c is uncorrelated
Average atomic mass A_{VM}	1.554E−09	1.583E−11	1.907E−10	Fully correlated
γ-rayabundance $I_{\gamma S}$	2.059E−04[a]	2.136E−06[b]	2.525E−05[c]	a and c are fully correlated b is uncorrelated
γ-rayabundance $I_{\gamma M}$	1.759E−03	1.792E−05	2.159E−04	Fully correlated
Efficiency of detector $\varepsilon(E_\gamma)_S$	8.540E−03[a]	8.875E−05[b]	1.047E−03[c]	a and c are fully correlated b is uncorrelated
Efficiency of detector $\varepsilon(E_\gamma)_M$	7.463E−03	7.601E−05	9.154E−04	Fully correlated
γ-attenuation coefficient $(\Gamma_{atte})_S$	7.515E−04	2.894E−05	8.959E−05	Uncorrelated
γ-attenuation coefficient $(\Gamma_{atte})_M$	8.812E−05	8.944E−07	1.081E−05	Fully correlated

Table 5 The experimentally estimated reaction cross sections relative to the ^{197}Au(n,2n)^{196}Au monitor reaction with its uncertainty and correlation matrix

Reaction	Cross section (barns)	Correlation matrix		
^{93}Nb(n,2n)^{92m}Nb	0.5103±0.03365	1		
^{93}Nb(n,α)^{90m}Y	0.0052±0.00027	0.28	1	
^{92}Mo(n,p)^{92m}Nb	0.0626±0.00968	0.14	0.12	1

Table 4 does not explain the unit of the uncertainties(!). The ratios of the "Monitor reaction cross section σ_M" values to the cross section values in Table 5 are 0.92% for all three reactions (e.g., 4.682E-03/0.5103), and we can infer that the first line of Table 4 is not for the uncertainty in the monitor cross section but for the uncertainty in the measured cross section due to the uncertainty in the monitor cross section.

The uncertainty values in the first line of Table 4were coded under MONIT-ERR in a draft of the EXFOR entry. But this is wrong since this heading is for "Error *in* normalization value" according to Dictionary 24. (N.B. "error" should read "uncertainty" in the current nomenclature in metrology.). I believe this entry must be revised.

/1/ Current 33129.002 (incorrect):

```
SUBENT        33129002   20191113
BIB                  3         18
REACTION    (41-NB-93(N,2N)41-NB-92-M,,SIG)
…
ERR-ANALYS  (ERR-T) Total uncertainty
            (MONIT-ERR) Uncertainty in monitor cross section
…
COMMON               16          9
MONIT       MONIT-ERR
B           B
 2.160        4.682E-03
ENDCOMMON            9
```

/2/ /1/ must be corrected to:

```
SUBENT        33129002   20191113
BIB                  3         18
REACTION    (41-NB-93(N,2N)41-NB-92-M,,SIG)
…
ERR-ANALYS  (ERR-T) Total uncertainty
            (MONIT-ERR) Uncertainty in monitor cross section
…
COMMON               16          9
MONIT       MONIT-ERR
B           B
 2.160       0.0198
ENDCOMMON            9
```

/3/ or alternatively corrected to:

```
SUBENT        33129002   20191113
BIB                  3         18
REACTION    (41-NB-93(N,2N)41-NB-92-M,,SIG)
…
ERR-ANALYS  (ERR-T) Total uncertainty
            (ERR-1) Uncertainty due to monitor cross section
…
COMMON               16          9
MONIT       ERR-1
B           B
2.160        4.682E-03
ENDCOMMON            9
```

The partial uncertainty ERR-1 etc. in the absolute unit is unusual, but this is what the authors report.

The monitor value is always proportional to the measured quantity (c.f. LEXFOR **Standards**). It means the ratio of the absolute MONIT-ERR value (e,g, in barn) to MONIT value always gives the partial uncertainty *of* the measured quantity in %. In the other words, the absolute MONIT-ERR value gives the information on the uncertainty of the measured quantity only when the MONIT value is coded together. I suggest that **the absolute MONIT-ERR value is coded only when the MONIT value is coded together**.

I checked the EXFOR entries compiling the activation cross sections from Indian published in 2015 and later. I found the four entries (33114, 33117, 33129, 33141) use MONIT-ERR for the partial uncertainty in the measured cross section wrongly, and proposed corrections are summarized in the appendix of this memo.

Appendix: Proposed corrections to four EXFOR entries compiling activation cross sections from India

Subentry	EN	DATA	MONIT-ERR ***Wrong***	(ratio, %)	MONIT	MONIT-ERR ***Correct***	(ratio, %)	**Proposed corrections**
	MEV	B	B		B	B		
33114.002	0.61	6.720E-03	3.823E-05	0.57	0.14888	0.00085	0.57	Use MONIT(-ERR)=148.88+/-0.85 mb
33114.002	1.05	7.960E+00	4.620E-02	0.58	0.11272	0.00065	0.58	Use MONIT(-ERR)=112.72+/-0.65 mb
33117.002	11.98	2.358E-01	1.870E-02	7.93	0.153	0.0122	7.97	Use MONIT(-ERR)=0.1530+/-0.0122 b
33117.002	15.75	7.301E-01	2.710E-02	3.71	0.0565	0.002	3.54	Use MONIT(-ERR)=0.0565+/-0.002 b
33129.002	14.78	5.103E-01	4.682E-03	0.92	2.16	0.0198	0.92	Use MONIT(-ERR)=2.160+/-0.0198 b
33129.003	14.78	5.200E-03	4.768E-05	0.92	2.16	0.0198	0.92	Use MONIT(-ERR)=2.160+/-0.0198 b
33129.004	14.78	6.260E-02	5.743E-04	0.92	2.16	0.0198	0.92	Use MONIT(-ERR)=2.160+/-0.0198 b
33141.002	13.52	2.570E-02	1.995E-04	0.78	0.12546	***?***		Delete MONIT-ERR (not in the article)
33141.003	13.52	1.790E-02	1.827E-04	1.02	0.12546	***?***		Delete MONIT-ERR (not in the article)

Note added to Memo CP-D/1026
All these subentries have been already corrected.