Draft of Revised LEXFOR

(N. Otsuka, 2022-04-25, Memo CP-D/1045, A6;
M. Mikhailiukova, 2022-06-09, Memo 4C-4/0232)

> This paper seeks an approval of the revised LEXFOR (submitted as an appendix of CP-D/1045) including the items not listed under NRDC 2021 Action 6.

Memo CP-D/1045

In fulfilment of Action 6 of the NRDC 2021 meeting, I prepared a draft of the updated LEXFOR (IAEA-NDS-0208). All conclusions from NRDC 2016 to 2021 meetings are also considered. The draft will be further revised <u>by the end of May as per your comments</u>.

In addition to the updates summarized below, I also adopted

- LEXFOR Sample and Thermal Neutron Scattering formulated in WP2017-35 (C22)

- LEXFOR Reference formulated in WP2018-08 (C8)

though their approvals are not explicitly mentioned in the meeting summaries.

Updates of items listed under NRDC 2021 Action 6

Paper	Concl.	Memo	Chapter	Remark
WP2016-08	C5	4C-3/0403	Thermal neutron scattering	(rewritten by IAEA CM)
WP2016-09	C6	CP-D/0895	Fission yields	R-value
WP2016-31	C16	CP-D/0893	Thick- and thin-target yields	Energy differential yield (TM)
WP2016-33	C19	CP-D/0896	Isomeric states	Isomeric flag assignment
WP2017-31	C20	CP-D/0932	Resolution	HW and FW not restricted to HWHM and FWHM
WP2017-35	C22	CP-D/0928	Sample	TMP moved from SF6 to SF8
WP2017-35	C22	CP-D/0928	Thermal neutron scattering	Usage of SF8=TMP when SF3=THS
WP2018-08	C7	CP-D/0953(Rev.)	Multilevel resonance parameters	Explanation of R-function. Implementation of NRDC2017 C11.
WP2018-08	C8	CP-D/0953(Rev.)	Reference	Addition of INDC report number. Implementation of NRDC2017 C21.
WP2018-11	C11	CP-D/0956	Thermonuclear reaction rate	(rewritten)
WP2019-08	C6	CP-D/0964	Sum	Elemental cross section divided by isotopic abundance. Implementation of NRDC2018 C19+C20.
WP2019-09	C7	CP-D/0970	Polarization	Spin-spin asymmetry
WP2019-10	C8	4C-4/0219	Kerma factor	(new chapter)
WP2019-11	C9	CP-D/0976	Institute	Deletion of protocol matters
WP2019-21	C14	CP-D/0965(Rev.)	Supplemental information	(new chapter)

WP2019-27	C17	CP-C/0393	Decay data	(The WP does not propose any LEXFOR revision.)
WP2019-27	C17	CP-C/0393	Outgoing particle	(The WP does not propose any LEXFOR revision.)
WP2019-29	C19	CP-D/0977(Rev.)	Independent and cumulative data	Revision of two tables
WP2019-30	C21	4C-3/0414(Rev.)	Data type	Addition of indirectly derived Pn
WP2019-30	C21	4C-3/0414(Rev.)	Delayed fission neutrons	nu-d for a given precursor nuclide
WP2019-32	C23	CP-D/0973	Status	Replacement with CURVE or TABLE
WP2019-33	C24	CP-D/0974	Fission yields	Fractional yield (FRC)
WP2019-33	C24	CP-D/0974	Ratio	FY/RAT rather than SIG/RAT
WP2021-10	C12	CP-D/1014	Differential data	SF7 separator
WP2021-12	C15	CP-D/0982	Derived data	Description under ANALYSIS
WP2021-14	C17	CP-D/1002	Scattering	Partial scattering
WP2021-15	C19	CP-D/1007	Fitting coefficients	Equations of DA,,LEG/RS0 and DA,,LEG/RSD
WP2021-29	C36	4C-3/0415(Rev.)	Thermal neutron scattering	Hydrogen cross section (HYD)
WP2021-30	C37	CP-D/0646	Light-nuclei reactions (Z≤6)	REACTION for breakup reactions
WP2021-31	C38	CP-D/0984	Fission yields	Yields of correlated pairs
WP2021-31	C38	CP-D/0984	Reaction product	Variable product
WP2021-34	C43	CP-D/0993(Rev.)	Fission	Particle emission followed by fission
WP2021-34	C43	CP-D/0993(Rev.)	Outgoing particle	Combination with process code in SF3

Other major updates

Activation
(*Removal of descriptions against the current rule for frequently occurring reaction combination*)
…
The activation cross section is usually identified with one of the following:

1. a specific reaction, and, therefore, the data given should be coded under the appropriate reaction, *e.g.*, (n,γ) or (p,n).

2. the production of a specific radioactive nuclide, which may be produced by two or more parallel reactions; this case is coded as a production cross section, ~~or as a sum of the possible reactions, whichever is more appropriate~~. (See also, **Production and Emission Cross Sections~~, Sums~~**).

Examples~~s~~:
~~a.) ((26-FE-58(N,N+P)25-MN-57,,SIG)+~~
~~(26-FE-58(N,D)25-MN-57,,SIG))~~

~~b.)~~ (26-FE-0(N,X)25-MN-57,,SIG)

Angle
(Removal of "Errors: Correlations". I do not see any relation between two LEXFOR sections.)
(See also ~~Errors: Correlations,~~ **Differential Data**).

Angle
(Replacement of the obsolete code ANG-AZ with ANG-AZ-RL)

Data headings:
…

```
q            =    momentum transfer
ANG-AZ-RL    =    azimuthal angle
```


Angle
(Addition of the requirement of the definition of ANG1, ANG2 etc. under the new keyword ANG-SEC)

The secondary angle that is not defined by the REACTION code 3 must be defined under the keyword ANG-SEC.

Decay data
(Replacement of "abundance" with "intensity" according to NRDC 2021 Conclusion 22 thoroughly)

Decay data
(Implementation of NRDC 2021 Conclusion 23)

…
Free text explanation is often desirable, for example, a statement on whether the decay data were obtained from the experiment or quoted from another source.

- If the authors quote only the source of the decay data but not their numerical values, the source should be coded under REL-REF.

- If the data given are taken from a known source, the reference for it may be coded under the keyword REL-REF.

Differential Data
(Replacement of the obsolete code ANG-AZ with ANG-AZ-RL)
…
5. Non-coplanar angular correlations: The more general situation is for particle *a* and particle *b* not in the same reaction plane. Then θ_a is the angle of particle *a* relative to the beam direction in plane *A*, θ_b is the angle of particle *b* relative to the beam direction in plane *B*, and a third angle ϕ is defined as the angle between the *A* and *B* reaction planes (azimuthal angle).

…

The angles θ_a and θ_b are coded under the headings ANG1 and ANG2, in the same order as the particles appear in SF7. The azimuthal angle is coded under the heading ANG-AZ-RL.

Element: Super Heavy Elements:
(*Replacement of Z-113 with Z-120*)

Super-heavy elements that do not have an element symbol are coded using an * for the element symbol (*e.g.*, `120-*-302`). See Dictionary 8.

Measurement Techniques: INC-SOURCE:
(*Implementation of NRDC 2018 C13*)

INC-SOURCE is used to enter the source of the incident-projectile beam used in the experiment (see Incident Beam Source). This keyword is used exclusively for the nuclear reaction used as an incident projectile source. The apparatus in which this reaction took place is entered under `FACILITY`, and the quality of the resulting particle beam is entered under INC-SPECT (see under Incident Projectile Energy).

Nuclear Quantities: Level-density parameter
(*Replacement of the mathematical symbol D with g*)
…

Level-density parameter a is proportional to single-particle level spacing g at top of Fermi-sea (Fermi energy) in the Fermi-gas model of the nucleus, in specified formalism. In Fermi-gas model, $a = (\pi^2/6) \, g$.

Ratio: Frequently Occurring REACTION Ratios
(*Addition of the description on the frequently occurring REACTION ratios, which was moved from the EXFOR Formats Manual Chapter 6 "Reaction combination"*)

...

The reaction ratio formalism is not used for certain frequently occurring ratios for which specific quantity codes have been introduced.

***Example*:**

Alpha value = Capture cross section / fission cross section
```
(92-U-235(N,G)92-U-236,,SIG)/
(92-U-235(N,F),,SIG)
→ (92-U-235(N,ABS),,ALF)
```

Resonance strength (Capture kernel)
```
((82-PB-208(N,EL),,WID,,G)*(82-PB-208(N,G),,WID)/
(82-PB-208(N,TOT),,WID))
→ (82-PB-208(N,G),,WID/STR)
```

Reference: Reports (footnote)
(*Addition of NRDC 2019 Conclusion 25*)

Exceptions are conference proceedings identified with a CEA-CONF, CONF, NBS-SPEC-PUB or STI/PUB report number. They are generally not considered as reports and coded with a conference code.

Quantum Numbers: Excited States in Product Nuclei

(Restoration of the words deleted in Rev. 2011/01 by mistake; addition of LVL-NUMB in the 3rd case where an independent variable of the secondary energy was missing.)

…

When an excited state is defined in a reference by its quantum numbers:

    spin J   the spin value of a level in a product nucleus,

    parity π the parity of a level in a product nucleus,

these quantum numbers may be entered in the BIB section under the keyword LEVEL-PROP to define the level for which the data are measured (see also EXFOR Exchange Formats Manual Chapter 7, LEVEL-PROP). These properties may be associated with specific data lines in one of the following ways.

…

3. Using flags.

Example:
```
BIB
...
LEVEL-PROP  ((1.)26-FE-56,LVL-NUMB=1.,SPIN=2.,PARITY=+1.)
            ((2.)26-FE-56,LVL-NUMB=2.,SPIN=4.,PARITY=+1.)
...
ENDBIB
NOCOMMON
DATA
EN          LVL-NUMB    DATA        LVL-FLAG
MEV         NO-DIM      MB          NO-DIM
  1.          1.          ...         1.
  1.          2.          ...         2.
...
ENDDATA
```

Secondary Energy: Numerical Values

(Revision of the explanation of S=0 to be consistent with the figure image)

…

d. In some cases, where the data is a function of the energy of two secondary particles, in order to reduce a 3-dimensional plot to two dimensions, the data are given as a function of the distance along the kinematic locus of the energies (S):… The point ~~of minimum energy of E_1~~ where $E_1=E_2$ is assigned the value $S = 0$. In this case …
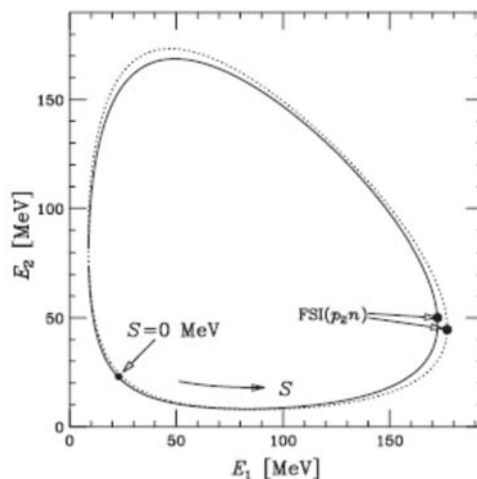
Spectrum Average: Bremsstrahlung Spectrum Average

(Addition of NRDC 2018 Conclusion 18)

…

The factor E/E_{max} in the denominator of the definition is due to normalization by the number of **equivalent quanta** (instead of number of incident photons) determined by the Wilson quantameter, and the cross section is sometimes referred to as the **cross section per equivalent quantum**. For more background, see [1].

Status: Source of the Data

(Addition of NRDC2021 Conclusions 39, 40 and 41)

…

When the author's original numerical values have been lost or are not obtainable, data read from graphs, if available, should be entered into EXFOR for completeness. Data of this type should be labelled with the status code CURVE.

The table or figure number in free text must be followed by the reference information (e.g., J. Nucl. Phys. 12(2021)345) when there are two or more reference under REFERENCE. This is also preferably done when there is only one reference.

Example:
```
STATUS      (CURVE) Scanned from Fig. 1 of Yad.Fiz.12(1951)345
STATUS      (TABLE) Taken from Table 1 of Phys.Atom.Nucl.12(1951)678
```

The information must be indicated under STATUS of each data subentry when the numerical values of the entry are from several tables and/or figures.

Sums: Frequently Occurring REACTION Sums
(Addition of the description on the frequently occurring REACTION sums, which was moved from the EXFOR Formats Manual Chapter 6 "Reaction combination")

The reaction sum formalism is not used for certain frequently occurring sums for which specific quantity codes have been introduced.

Examples:

Data for natural target = Sum data for all contributing target nuclides
```
(46-PD-106(P,2P)45-RH-105-G,CUM,SIG,,A)+
(46-PD-108(P,X)45-RH-105-G,CUM,SIG,,A)+
(46-PD-110(P,X)45-RH-105-G,CUM,SIG,,A)
→(46-PD-0(P,X)45-RH-105-G,CUM,SIG)
```

Production = Sum of processes
```
(46-PD-102(P,D)46-PD-101,CUM,SIG)+
(46-PD-102(P,N+P)46-PD-101,CUM,SIG)
→ (46-PD-102(P,X)46-PD-101,CUM,SIG)
```

Scattering = Elastic scattering + inelastic scattering
```
(3-LI-7(N,EL)3-LI-7,,SIG)+
(3-LI-7(N,INL)3-LI-7,PAR,SIG)
→ (3-LI-7(N,SCT)3-LI-7,PAR,SIG)
```

Thermal-neutron scattering
(*Addition of NRDC 2021 Conclusion 14*)

Coding
…
- The scattering <u>length</u> is compiled with AMP in REACTION SF6. This parameter code is combined with MSC in REACTION SF8 when the scattering <u>amplitude</u> is compiled.

<div align="center">

Memo 4C-4/232 (extraction)

</div>

Comments for LEXFOR and EXFOR format manuals (updated in memos CP-D/1044 & CP-D/1045) are given below in the form: page#: text => comment.

LEXFOR Manual
- D.1: Pn value obtained as the ratio of the measured delayed neutron yield to the estimated fission yield => Replace "estimated" with "assumed".
- D.20: different data are summarized: => Add "(not exhaustive)" before the colon.
- R.6: The reaction product maybe a variable of the data table=>Replace "maybe" with "may be".

…