

The Evaluated Gamma-ray Activation File (EGAF)*

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The Evaluated Gamma-ray Activation File (EGAF), a new database of prompt and delayed neutron capture γ ray cross sections, has been prepared as part of an International Atomic Energy Agency (IAEA) Coordinated Research Project to develop a "Database of Prompt Gamma-rays from Slow Neutron Capture for Elemental Analysis". Recent elemental γ -ray cross-section measurements performed with the guided neutron beam at the Budapest Reactor have been combined with data from the literature to produce the EGAF database. EGAF contains thermal cross sections for $\gg 35,000$ prompt and delayed γ -rays from 262 isotopes. New precise total thermal radiative cross sections have been derived for many isotopes from the primary and secondary γ -ray cross sections and additional level scheme data. An IAEA TECDOC describing the EGAF evaluation and tabulating the most prominent γ -rays will be published in 2004. The TECDOC will include a CD-ROM containing the EGAF database in both ENSDF and tabular formats with an interactive viewer for searching and displaying the data. The Isotopes Project, Lawrence Berkeley National Laboratory continues to maintain and update the EGAF file. These data are available on the Internet from both the IAEA and Isotope Project websites.

Many neutron cross sections were determined from the EGAF database with comparable precision to those reported by Mughabghab *et al* [1-3], and some disagreements were notable. For example, the most accurate ^{12}C measurements, including our current measurement, are summarized in Table 1. Our new, recommended cross section is 3.84 ± 0.03 mb and differs significantly from the previously accepted value of 3.53 ± 0.07 mb.

Table 1. ^{12}C Cross section measurements.

Measurement Method	σ_0 (mb)	Reference
Capture	3.50 ± 0.16	Prestwich (1981)
Capture	3.53 ± 0.07	Jurney (1963)
Reactivity	3.57 ± 0.03	Nichols (1960)
Pile Oscillator	3.65 ± 0.15	Nichols (1960)
Pulsed Neutrons	3.72 ± 0.15	Sagot (1963)
Pulsed Neutrons	3.83 ± 0.06	Starr (1962)
Pile Oscillator	3.85 ± 0.15	Koechlin (1957)
Capture	3.87 ± 0.05	Molnar (2003)
Capture	4.01 ± 0.15	Yonezawa (2003)
Average of Higher Values	3.84 ± 0.03	
Current Adopted Value	3.53 ± 0.07	Mughabghab (1981)

The EGAF database is often incomplete because continuum γ -rays can comprise up to 90% of the spectrum. We have been applying the γ -ray cascade code DICEBOX by Becvar [4] to calculate this continuum. These calculations are constrained by the EGAF γ -ray cross sections de-exciting low-lying levels in the capture nucleus. Several independent calculations were performed with DICEBOX to estimate theoretical variation. For $^{105}\text{Pd}(n,\gamma)$ an excellent fit with $\chi^2/\text{f}=1.1$ was obtained after revising the ENSDF spin/parity values and removing one level that was inconsistent with the calculations and not confirmed by other experiments. The total radiative cross section derived from this calculation is 21.2 ± 0.5 b, consistent with the compiled value of 21.0 ± 1.5 b [1].

A new series of elemental and isotopic capture γ -ray measurements are planned at the Budapest Reactor with the cold neutron beam. EGAF will be updated to include these data as well as continuum data from the quasicontinuum calculations discussed above. The data will be benchmarked with experimental spectra and provided in ENDF format. Evaluation of the continuum data will provide new nuclear structure information available for ENSDF evaluation. EGAF will also be expanded to include epithermal and fast neutron capture and reaction γ -ray data from ENSDF and other literature sources. Additional measurements are planned with LNBL 2.5 MeV D+D (10^{10} n/s) Neutron Generator Facility [5]. In addition to reaction data, we will measure fission γ -ray data. The EGAF database provides a repository for evaluated neutron-induced γ -ray data that can support a variety of other databases and applications. It offers a data bridge between the traditionally reaction based and nuclear structure based communities.

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REFERENCES

- [1] S.F. Mughabghab, INDC(NDS)-440 (2003).
- [2] S.F. Mughabghab, M. Divadeenam, and N. HOLDEN, *Neutron Cross Sections*, Vol. 1, Part A, Z = 1-60, Academic Press, New York (1981).
- [3] S.F. Mughabghab, *Neutron Cross Sections*, Vol. 1, Part B, Z = 61-100, Academic Press, New York (1984).
- [4] F. Becvar, Nucl. Instrum. Meth. Phys. Res. **A417**, 434 (1998).
- [5] J. Reijonen, K.-N. Leung, R.B. Firestone, *et al*, Nuclear Instruments and Methods in Physics Research A **522**, 598 (2004).