



INTERNATIONAL ATOMIC ENERGY AGENCY

# NUCLEAR DATA SERVICES

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**"EN6-PHOTO" and "JEF-2/PHOTO"**

**PHOTO-ATOMIC INTERACTION DATA LIBRARY**

by the Lawrence Livermore National Laboratory, USA

Summary documentation

by H.D. Lemmel

**Abstract:** The Photo-Atomic Interaction Data Library of the Livermore Evaluated Photon Data Library (EPDL) contains pair production cross-sections, photoelectric cross-sections, atomic form factors, coherent scattering cross-sections and some other data for all the elements from  $Z=1$  to 100. There are two versions of this library, the one being part of the U.S. ENDF/B-6 system, the other being part of the European JEF-2 system. Both are available upon request from the IAEA Nuclear Data Section, costfree, on floppy diskette, or CD-ROM. The library is available online within NDIS, the Nuclear Data Information System and also from the WWW pages of the Nuclear Data Section available on magnetic tape costfree from the IAEA Nuclear Data Section.

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Online: TELNET or FTP: [iaeand.iaea.org](http://iaeand.iaea.org)  
username: IAEANDS for interactive Nuclear Data Information System  
usernames: ANONYMOUS for FTP file transfer;  
FENDL2 for FTP file transfer of FENDL-2.0;  
RIPL for FTP file transfer of RIPL;  
NDSOINL for FTP access to files sent to NDIS "open" area.

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Web: <http://www-nds.iaea.org>

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**Note:**

The IAEA-NDS-reports should not be considered as formal publications. When a nuclear data library is sent out by the IAEA Nuclear Data Section, it will be accompanied by an IAEA-NDS-report which should give the data user all necessary documentation on contents, format and origin of the data library.

IAEA-NDS-reports are updated whenever there is additional information of relevance to the users of the data library.

For citations care should be taken that credit is given to the author of the data library and/or to the data center which issued the data library. The editor of the IAEA-NDS-report is usually not the author of the data library.

Neither the originator of the data libraries nor the IAEA assume any liability for their correctness or for any damages resulting from their use.

## "EN6-PHOTO" and "JEF-2/PHOTO"

### Photo-atomic Interaction Data Library

This data library is the ENDF-6 format version of the Evaluated Photon Data Library (EPDL) of the Lawrence Livermore National Laboratory, USA. It was issued as part of the U.S. ENDF/B-6 library and, more recently, as part of the NEA Data Bank JEF-2 library. In the JEF-2 version of this library, the photo-electric cross-sections have been updated in 1990, so that "JEF-2/PHOTO" is presently the most up-to-date version. **In 2001 the LLNL version of the library was updated to extend the energy range from 1ev to 100Gev.**

The library supersedes the earlier photo-atomic data library by the US Radiation Shielding Information Center RSIC that was included in the data libraries ENDF/B-5 and JEF-1.

EPDL was published in graphical form in the report UCRL-50400 Vol. 6 Rev. 4 (1989) by D.E. Cullen et al. This report has 804 pages in 2 volumes ( $Z = 1$  to 50 resp.  $Z = 51$  to 100). It contains cross sections, from 10 eV to 100 GeV, average energy deposits, and form factors in tabular and graphic form; in addition, photoelectric cross-sections for each shell and coherent anomalous scattering factors are presented in graphic form. This handbook is available as a set of microfiches from the IAEA INIS Microfiche Service, or from the US National Technical Information Service, 5285 Port Royal Rd., Springfield, VA, USA-22161. A more recent version of EPDL was released in 1993; see the document IAEA-NDS-158.

The library contains data for all elements from  $Z=1$  to  $Z=100$ . The accession-numbers (MAT-numbers) are identical to the  $Z$  numbers. Cross-sections are given in the photon energy range from 1 keV to 100 MeV (**1ev to 100Gev for the LLNL version**). The ENDF/B-6 version has **286230 records**; the JEF-2 version has 260 770 records.

Included are the following data types:

MF/MT

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23/501	Total cross-section
23/502	Coherent scattering cross-section
23/504	Incoherent scattering cross-section
23/515	Incoherent pair production cross-section (triplet)
23/516	Total pair production cross-section
23/517	Coherent pair production cross-section
23/522	Total photoelectric cross-section (= sum of subshell cross-sections)
23/534 to 23/572	Photoelectric subshell cross-sections
27/502	Coherent scattering form factors
27/504	Incoherent scattering functions
27/505	Coherent imaginary scattering factor
27/506	Coherent real scattering factor

An earlier version of this library was fully documented in the report ORNL/RSIC-46. Since much of this report still applies, a copy of it is attached.

The following earlier libraries are superseded:

The first predecessor of this library had been known under different designations such as

DLC-7/HPICE,  
or LLL Photon Cross-Sections Library,  
or ENDF/B-4 Photon-Interaction Library,  
or ENDF Photon-Interaction Cross-Section Library of 1977, which was  
tabulated and plotted in the report UCRL-50.400 vol. 6 Rev. 2 (1978).

The 1983 version of this library was known under designations such as

DLC-99/HUGO,  
or RSIC Photon-Interaction Data Library, documented in the  
report ORNL/RSIC-46 of which a copy is attached,  
or ENDF/B-5 Photon-Interaction Library,  
or JEF-1 Photon-Interaction Library, also in ENDF/B-5 format.

This 1983 version is still available from the IAEA Nuclear Data Section either in the ENDF/B-5 version ("EN5-Photo") with 24.637 records or in the JEF-1 version ("JEF1-Photo") with 25.337 records. The additional records in the latter are due to text lines added for JEF. This library does not contain the data types MF/MT = 23/534 to 23/572, 27/505, 27/506 which were newly introduced for ENDF/B-6 and may still cause problems in available computer codes. Note that the Photoelectric cross-section is given under MF/MT = 23/602 in ENDF-5, but under MF/MT = 23/522 in ENDF-6.

## Related References

**D.E. Cullen, J.H. Hubbell, L. Kissel: EPDL97: The Evaluated Photon Data Library '97 version. Report UCRL-ID-50400 Vol.6, Rev.5 (1997).**

D.E. Cullen, S.T. Perkins, S.M. Seltzer: Photon and electron databases and their use in radiation transport calculations. Appl. Radiat. Isot. 44, p. 1343-1347, 1993.

D.E. Cullen, S.T. Perkins, J.A. Rathkopf: The 1989 Livermore Evaluated Photon Data Library (EPDL). Report UCRL-ID-103424 (1990).

D.E. Cullen: Program SCATMAN, a code designed to calculate photon coherent scattering anomalous scattering factors and cross-sections. Report UCRL-ID-103422 (1989).

D.E. Cullen: Program EPICP, electron photon interaction code; photon test module (version 94.2). Report UCRL-ID-118400 (1994).