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A STATUS REPORT FOR DATA FILES AND
MONTE CARLO TRANSPORT CODES
MAINTAINED BY THE PHYSICAL DATA GROUP OF LLNL

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A STATUS REPORT FOR DATA FILES AND MONTE CARLO TRANSPORT CODES
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The Physical Data Group of the Theoretical Physics Division of LLNL has developed and maintains several basic data files, several Monte Carlo transport codes, and the requisite processing codes that convert the basic data to the form required by our own transport codes and by other laboratory transport and burn codes.

The data files (libraries) that we maintain are listed below together with a few comments about each.

- ENDL (Evaluated Neutron Data Library)

This is the file for neutron induced reaction data and contains cross sections, angular and energy distributions for all secondary particles, secondary particle multiplicities for neutrons and gammas, average energies for all secondary particles and residuals. In short, it contains all appropriate data associated with neutron-induced reactions for 98 isotopes or elemental mixtures of isotopes plus a lumped fission product. ENDL is documented in Volume 4, Rev. 1; Volume 15, Parts A through E of UCRL 50400. ENDL is now a relatively stable data file with modifications to existing data usually made only as new experimental data come to hand or when we are requested to check the validity of some part of the data and find that an improvement should be made.

- ACTL (Neutron-Induced Activation Library)

This file contains cross sections for the production of radioactive residual nuclei from neutron-induced reactions. There are currently 1822 individual cross section sets in ACTL. About 20% of the reactions have a stable nucleus for the residual. These are included for two reasons. First, they provide data for those applications in which the depletion of a population of a particular nuclear specie is important. Second, for completeness in the sense of including all reactions of a particular type (e.g. n, γ ; n,p ; n,α ; $n,2n$) that have been requested. An early version of ACTL is documented in Volume

18 of UCRL 50400. In contrast to the ENDL file, ACTL is being continuously developed within the limitations of available effort that can be allocated to that function. To update existing reaction data and extend the file to a satisfactory state of completeness would require the full-time effort of one person on a continuing basis. While a full-time effort of one person for two years would bring ACTL to a state of relative completeness, it would require a continuing effort to improve and develop the empirical and theoretical methods that must be used to obtain cross sections where they cannot be measured because of the unavailability of target materials.

- ECPL (Evaluated Charged Particle-Induced Library)

This file contains data for reactions induced by the five light charged particles (p, d, t, ^3He , ^4He) for light targets ($Z \leq 8$). In addition to the usual reaction properties such as cross sections, angular/energy distributions, etc., temperature (Doppler) broadened cross sections, energy loss cross sections, Maxwell-averaged reaction rates, Maxwell-averaged average energy distributions for particles and residuals, and energy distributions from thermal equilibrium reactions are included. While the ECPL file has existed in one form or another for twenty or so years, it is only within the past few years that the extension from cross sections and Maxwell-averaged reaction rates has occurred. To bring it to a maintenance level in the sense of including all reactions for all charged particles for all targets with $Z \leq 8$ will require considerable work. We are just now discussing a joint effort with the T-2 group at LANL that hopefully will expedite the review of existing data in ECPL and fleshing it out to include all the necessary reactions. Likewise a continuation of a long-standing collaboration with A. P. Smith's group at ANL will likely yield new measurements (by ANL) of important charged-particle induced reactions that are needed for ECPL. Parts of the ECPL file are documented in Volumes 15, Part F; and 21, Part A of UCRL 50400.

- EGDL (Evaluated Gamma Data Library)

This file contains cross sections, etc. for photons with energies from 100 eV to 100 MeV interacting with cold ions of the elements from $Z = 1$ to $Z = 98$. The reactions included are coherent scattering, incoherent scattering, photon-electric, and pair production. The EGDL file is documented in Volume 6 Revision 3 of UCRL 50400.

- ENSL (Evaluated Nuclear Structure Library)

This file contains the nuclear structure data that were published in the Seventh Edition of the Table of Isotopes. The level schemes in ENSL were derived from the

decay data of the Table of Isotopes. Another more extensive file (CDRL) contains the level schemes obtained from particle-induced reactions merged into the ENSL file. Both ENSL and CDRL are documented in Volume 23 of UCRL 50400.

- GANTOT83 is a file of photon energies and multiplicities associated with the time-dependent decay of radio-active isotopes and with thermal neutron capture (prompt photons). This file is for use with the GAMIDEN code and is documented in Volume 22, Revision 2 of UCRL 50400.

The Monte Carlo transport codes that we have developed and maintain are:

- TART is a data dependent Monte Carlo neutron and/or photon transport code. It uses cross sections as histograms (e.g. 175 values from 1.3×10^{-9} to 20 MeV for neutrons) but follows particles on a continuous energy basis. For transport problems in which extreme fluctuations of cross sections (resonances) are not very important TART is the code of choice. For problems that are sensitive to resonance regions the code ALICE (see below) which is based on the multi-band method is the code of choice. TART is a CRAY-I code. Its predecessor and CDC 7600 equivalent was the TARTNP code that is documented in UCRL 50400 Volume 14. The methods described there are those used in TART.

- ALICE is a Monte-Carlo multi-band method neutron and/or photon transport code. It is, in essence, the TART code with the multi-band method and a capability for scattering in a temperature dependent medium added. This code provides a tool for transport calculations where the materials and neutron energy range of importance in the problem are characterized by resonance structure in the cross sections and/or a high temperature environment.

Other Physical Data Group activities are all intimately related to the data files and code development functions described above. For example, an extensive file of experimental neutron-induced data (ECSIL) is maintained as the basic source of experimental data for ENDL and ACTL. Likewise, a family of codes is subsumed under a controller (OMEGA). This family of codes provides the means for updating and otherwise manipulating the data in ENDL, ACTL, EGD, and ECPL. This includes providing the standard data files used by the LLNL transport and burn codes.

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