

Present Status of CENDL Project

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Yu Hongwei

China Nuclear Data Center
China Institute of Atomic Energy

1 Chinese Nuclear Data Committee Organization

Chinese Nuclear Data Committee assumes responsibility the management of CENDL project. The committee meetings are generally held once per year. The follows is the organization of the committee:

Chair: Dr. Zhao Zhixiang, CIAE
Technical working party: Evaluation Working Party
Measurements Working Party.
Benchmark Working Party.
China Nuclear Data Network: China Institute of Atomic Energy.
Peking University,
Sichuan University.
Lanzhou University.
Nankai University,
Jilin University and et al

2 General purpose file

• CENDL-3.0:

From 1996 to 2001, we have completed the evaluation of CENDL-3.0, total 209 nuclides are include CENDL-3.0, among them, the data of 169 nuclides were newly evaluated. The data are contained in the energy range from 10⁻⁵ eV to 20 MeV. The fission product nuclide file of CENDL-3 has been officially released on October 6, 2001. It includes 2 evaluations from CENDL-2.1(^{107, 109}Ag)and 101 new evaluations for 100 isotopes. The other file of CENDL-3.0 have been tested and improved for the problems found in the test within china .

• CENDL-3.1

The CENDL meeting was held on 17-18 March 2005, the meeting decided the next release version of CENDL is CENDL-3.1 library, the release of CENDL-3.1 is foreseen in the end of 2005. The data file will contain the update of CENDL-3.0 .

• New evaluations

The following nuclear data evaluations have been completed: ⁹Be, ¹²C, ³¹P, ⁵¹V, ^{nat,106,108,110,111,112}Cd, ⁵⁵Mn, ³He, ^{127,129,132,132m,133,133m,134,134m,135,136,136m,137,138,139,140}I, ^{84,86,88,90,92,94,96}Rb, ^{87,88,90,91,92,93,94,95,96,97,98,99,100}Y, ^{92,94,96,98,100,102,104,106}Mo, ^{233,234,235,236,237,241,242,243,244}U, ^{244,245,246}Pu, ^{240,241,242,243,244,245,246}Am, ^{236,237,238,239}Np and

^{232,233,234}Th.

A method to set up file-6 of light nuclei for evaluated neutron data in ENDF/B-6 format below 20 MeV has been established and the energy balance was strictly considered. The UNF code for nuclear data model calculations with the unified Hauser-Feshbach and exciton model are implemented in the CENDL nuclear data evaluations. The APMN code was used for automatically searching a set of optimal optical potential parameter.

• **Covariance**

A code for evaluating the covariance matrix of experimental data was developed. The covariance data are output in ENDF/B-6 format. The code together with the spline fitting code for multi-sets of correlative data was used to practically evaluate the covariance data for ^{58,60,61,62,64,nat}Ni, ^{63,65,nat}Cu and ²⁷Al, the reasonable results have been got. A program RAC for calculating covariance data of light nuclide was developed based on the R matrix theory. The program has been tentatively used to calculate the covariance data for ⁶Li and ¹⁰B, the reasonable results have been got for the cross sections up to 5 MeV.

• **Validation and benchmarking:**

Some nuclei from CENDL-3.0 were tested against the benchmark assemblies. The continuous energy Monte Carlo code MCNP was used to do the benchmark testing calculations. The K_{eff} values, the leakage spectrum and central reaction rate ratios were calculated. The tested nuclei of CENDL-3.0 include Uranium isotope, Plutonium isotope, ²³²Th, ²³⁷Np, partial minor actinide, Pb, Zr, Al, Cu, Fe, Be, C, H, D, O and fission product nuclei etc.

Some conclusions were gotten from the results of benchmark testing. It can be seen that different evaluated nuclear data library is the cause of the difference of the benchmark testing. Validation of CENDL-3.0 for some fissile nuclei and light nuclei, such as Uranium isotopes, Plutonium isotopes and beryllium etc was also done according to the benchmarks testing results, and the validation for some structure materials based on benchmark test results are going on.

For most uranium critical benchmarks, the calculated results with CENDL-3.0 are in good agreements with experimental results. The results based on CENDL-3.0 for some uranium fuel assemblies are even better than the results based on ENDF/B6.5. The data of ²³⁸U from CENDL-3.0 used for calculations lead to good results for all of uranium fuel assemblies with hard and soft spectra.

In the k_{eff} calculations of fast systems, both ²³⁹Pu from CENDL-3 and from ENDF/B-VI.2 give excellent results for most assemblies. But all results obtained for plutonium solution thermal benchmarks, calculated with the evaluation of CENDL-3 are slightly higher than the experimental results, but at the same time some results obtained with ²³⁹Pu from ENDF/B-VI.2 agree better, the ²³⁹Pu capture cross section of CENDL-3 probably needs to be improved.

In the k_{eff} calculations of fast facility, both the evaluation from CENDL-3 and from ENDF/B-VI.2 get good results for some plutonium critical benchmarks, but for those facilities, which contain carbon in the reflector, both k_{eff} calculated with the evaluation from CENDL-3 and ENDF/B-VI.2 ²⁴⁰Pu are slightly high. This may

indicate a problem with the carbon cross sections. Additional benchmark testing on carbon would be useful to examine the supposition. In the calculation of thermal facility, the solution obtained with the evaluation of CENDL-3 ^{240}Pu is better than the one obtained with the evaluation of ENDF/B-VI.2 ^{240}Pu . In general, the ^{240}Pu from CENDL-3 used together with the ^{239}Pu from CENDL-3 can obtain a good result for benchmark testing.

The benchmark testing of the ^{232}Th of CENDL-3.0 for limited integral experiments was also done. In the k_{eff} or k_{∞} calculations of fast systems, results based on ENDF/B-V, ENDF/B-VI.2, CENDL-3 and JENDL-3.3 are higher than the experimental results, this may indicate the (n, 2n) cross sections of ^{232}Th in the MeV range are underestimated for all evaluated libraries, and the continuum inelastic scattering of ^{232}Th is overestimated. In the k_{eff} or k_{∞} calculations of intermediate spectrum systems, the calculated results based on CENDL-3 are higher than the experimental results, and the calculated results based on ENDF/B-V, ENDF/B-VI.2 are better. This may due to an overestimation of ^{232}Th inelastic scattering angular distribution for CENDL-3. In the k_{eff} or k_{∞} calculations of thermal spectrum system, the results based on CENDL-3, ENDF/B-V, ENDF/B-VI.2, JENDL-3.3 are higher than the experimental results, this may indicate a problem with ^{232}Th capture cross sections, and ^{232}Th capture cross sections of all evaluated libraries probably need to be improved. Further benchmark testing will be done with this material.

The results of limited benchmark test for ^{237}Np show that further benchmark testing will be done with this material.

Further benchmark testing for beryllium has been done. The results were improved considerably compared with CENDL-2.1. It can be seen that the ^9Be of CENDL-3.0 shows good agreements with experiment for most assemblies

Benchmark testing for some structure materials has been done at CNDC, such as the benchmark testing of Zr etc. According to the benchmark testing results, slightly overestimate for (n, 2n) DDX and continuum inelastic cross section was also found in the calculated results based on natural zirconium of CENDL-3.

The test results for (n, γ) cross sections of fission product nuclei show that the results based on CENDL-3.0 show good agreements with the experimental results.

3 Nuclear data for ADS

In order to satisfy the need of ADS project of China, a code MEND for calculating the nuclear data in medium energy region has been developed, The following nuclear data have been calculated and evaluated:

Nuclear data for incident neutron from 20 to 250MeV: $^{50,52,53,54}\text{Cr}$, $^{54,56,57,58}\text{Fe}$, $^{90,91,92,94,96}\text{Zr}$, $^{180,182,183,184,186}\text{W}$, $^{204,206,207,208}\text{Pb}$, ^{238}U .

Nuclear data for incident proton from theshold energy to 250MeV: $^{54,56,57,58}\text{Fe}$, $^{180,182,183,184,186}\text{W}$, $^{204,206,207,208}\text{Pb}$, ^{209}Bi , ^{238}U .

4 Structure and decay data

CNDC have taken permanent responsibility for evaluating and updating NSDD for A=51, and 195-198. The mass chain A=197 have been revised using available

experimental decay and reaction data, and A=196 is being updated. Updated evaluation of A=197 has been sent to NNDC, USA. The evaluations of mass chain A=52-56 were being updated at Jilin University. Decay data of ^{232}Th , $^{231,233}\text{Pa}$, $^{232,233,234,236}\text{U}$ have been intercompared and checked. The decay data of ^{233}U and ^7Be were being evaluated on the basis of the new measured data.

5 Fission yield

Based on the mass distribution data up to 200 MeV measured by Zoller, the systematic on dependence of chain yield on incident neutron energy for each mass number A was studied. And also the systematics of mass distribution on mass A and incident neutron energy was investigated by using 5 (or 3) Gaussian model.

Taken some typical important fission products from $^{235, 238}\text{U}$ fission, the dependences of fission yield on incident neutron energy were studied. The covariance data were evaluated for each set of experimental data and the correlation among the data due to the error of fission rate (or normalization), detector efficiency, decay data etc. was taken into account in the fitting and the covariance matrix was obtained for the fit.

6 Nuclear physics basic database

The project is supported by Ministry of science and technology of china, it contains the following data base:

- Nuclear structure and Nuclear Decay database
- Nuclear Model Parameters and computing programs library
- Special Purpose database
- Exfor Database
- Evaluation Nuclear data library

7 Nuclear Data Service:

- A Powerful software TT was developed for nuclear data retrieve and evaluation under Windows and Linux platforms.
- IAEA NDS Mirror site will constructed in CNDC

8 The meeting and symposium:

- (1) The symposium on special purpose database Jun. 2004, Beidaihe
- (2) Chinese Nuclear Data Committe meeting Oct. 2004, Beijing
- (3) The symposium on Nuclear Data Future need, Jan. 2005, Nanjing
- (4) The symposium on Nuclear Data library, Mar. 2005, Beijing