NNDEN/48

NEUTRON NUCLEAR DATA EVALUATION NEWSLETTER

NEA DATA BANK
BANQUE DE DONNÉES DE L'AEN

April 1995

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NEUTRON NUCLEAR DATA EVALUATION NEWSLETTER

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The Newsletter reports:

- Evaluation work on particular nuclides
- Development of codes for nuclear model calculations, and other codes needed for nuclear data work.
- Publications relevant to the neutron data field.

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The next issue of NNDEN has been scheduled for March 1996. Contributors are asked to send in their reports by 1st February 1996.

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I. Recent publications and reports

Bakhanovich L.A., Klepatskij A.B., Maslov V.M., Morogovskij G.B., Porodzinskij Yu.V., Sukhovitskij E.Sh., "Evaluated Neutron Data for U-233", INDC(BLR)-001, December, 1993, IAEA, Vienna, Austria.

Maslov V.M., "Pairing Effects in 239-Pu(n,2n) reaction cross section", Zeitschrift für Phyzik A, Hadron & Nuclei, V.347, No.3, pp.211-215.

Maslov V.M., "Actinide Nuclear Data Evaluation for BROND and Beyond", presented at the Symposium on Nuclear Data '94, 17-18 November, 1994, Tokai, Japan.

Porodzinskij Yu.V., Sukhovitskij E.Sh., "Neutron Absorption Cross Section by Actinides in the Energy Region 8-14 MeV", Yadernaya Fyzika, V.57, pp.1923-1925.

Porodzinskij Yu.V., Sukhovitskij E.Sh., "Realistic Hamiltonian with Allowance of Dynamic Octupole Deformation for Analysis of Neutron Scattering on 232-Th and 238-U", Abstracts of the Seminar on Interaction of Neutrons with Nuclei, 26-28 April, 1994, Dubna, Russia, p.38.

Porodzinskij Yu.V., Sukhovitskij E.Sh., "Analysis of Neutron Scattering by Even-Even Nuclei with the Allowance of Octupole Dynamic Deformations of Their Shape", submitted to Yadernaya Fyzika.

The following papers were presented at the International Conference on Nuclear Data for Science & Technology, ORNL, 9-13 May, 1994, Gatlinburg, USA, and appear in the Procedings of the Conference:

Klepatskij A.B., "Consistent Analysis and Evaluation of Prompt Fission Neutron and Gamma-ray Spectra and Multiplicities".

Maslov V.M., "Pairing Effects in Actinide (n,2n) Reaction Cross Sections".

II. Work recently completed

Analysis of low-lying collective positive and negative parity levels of 238-U, 232-Th, 56-Fe and 76-Se using a deformable rotator model including soft octupole deformations model.

Near-threshold behaviour of (n,2n) reactions on N-odd U, Pu and Cm targets is predicted, 235-U(n,2n) measured data are analyzed.

Non-threshold behaviour of 232-U(n,f) and 236-Pu(n,f) reaction cross sections is interpreted within a statistical model.

Consistent analysis of neutron capture cross sections in the range 0.01 - 5 MeV for U, Pu, Am, Cm nuclides.

Statistical model analysis of deep sub-threshold and bomb-shot Cm neutron-induced fission cross section data in MeV region.

III. Work in progress

Evaluation of 243-Cm, 245-Cm and 246-Cm neutron data.

Investigation of door-way states using strong coupling channel method with a large number incorporated collective levels of realistic Hamiltonian.

IV. Work planned for the future

Evaluation of neutron data for selected Am, Np and Pu nuclides.

Analysis of actinide fission probabilities for symmetric and asymmetric mass divisions.

The optical potential for neutron energies up to 200 MeV.

Neutron-induced actinide fission cross section analysis above 20 MeV.

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1. Recent Publications

G. Georgiev, T. Madjarski, N. Janeva, "Determination of ^{147}Sm and ^{148}Sm Resonance Parameters", *Nucl.Phys.* A565 (1993) 643.

T. Madjarski, "Analysis of 4th Detector System by a Statistical Modeling Method", *Nucl.Instr.Meth.* A351 (1994) 480.

A. Lukyanov, "Multilevel Parametrization of Fissile Nuclei Cross Sections", in Proc. Int. Symp. on Nuclear Data Evaluation Methodology, (Ed.) C.L. Dunford, NY, USA, 12-10 Oct. 1992, World Scientific, 1993, pp 295.

N. Janeva, N. Koyumdjieva, A.A. Lukyanov, "Neutron Cross Section Modeling in the Unresolved Resonance Region", ibid. pp339

N.B. Janeva, N.T. Koyumdjieva, A.A. Lukyanov, "Characteristic Functions in the Statistical R-matrix Theory", in Proc. Int. Conf. on Nuclear Data for Sci. and Techn., (Ed.) J.K. Dickens, Gatlinburg, Tennessee, May 9-13 1994, American Nucl. Soc., Vol. 1, 1994, pp. 445.

I. Sirakov and N. Janeva, "Validation of ^{238}U and ^{239}Pu Resonance Parameters of ENDF/B-VI", ibid. Vol. 1, 1994, pp. 777.

G.P. Georgiev, Yu.V. Grigiriev, G.V. Muradyan, N.B. Janeva, "Neutron Resonance Parameters of ^{119}Sn", ibid. Vol. 1, 1994, pp. 299.

N. Koyumdjieva, A.A. Lukyanov and N. Janeva, "Characteristic Functions in the Statistical R-matrix Theory", accepted for print in *Zeitschrift für Physik A.*

N. Koyumdjieva, "Method for Calculation of Group Neutron Constants in the Unresolved Resonance Region by Using the Periodical Cross Sections Structure", accepted for print in *Bulg.J.Phys.*

2. Work in progress

Using the characteristic function to calculate the neutron group constants and averaged cross sections functionals of ^{238}U in the unresolved resonance region.

Calculation of fissile nuclei cross sections via a transition from Reich-Moore to Adler-Adler parameters. The method proposed has some advantages in comparison with the existing similar procedure POLLA. They concern the speed of transformation, the appropriate optimization of resonance parameters and the accuracy of the cross sections obtained.

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1. The evaluation of Complete Neutron Nuclear Data for Hg, Tl, Cl, Lu, Ga

Liu Tingjin (CNDC, CIAE, Beijing)

The complete neutron nuclear data for natural Hg,Tl,Cl,Lu,Ga have been evaluated in Chinese Nuclear Data Network. The neutron energy range is from 0.00001 eV to 20 MeV,and the files 1-6, 12-15 are included for most of them. The data are in ENDF/B-6 format. The evaluations are based on the EXFOR experimental data *until 1993 and theoretical calculations* with code UNF. The evaluation reports will be published in "Communication of Nuclear Data Progress". The evaluation were completed by Ma Gonggui (Sichuan University, Chengdu) for Hg, Tl; Chao Jingwu (Nanjing University, Nanjing) for Cl; Wu Zihua (Fudan University, Shanghai) for Ga and Yao Lishan (Shanxi Normal University, Xian) for Lu.

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2. GIPS - An Intercomparison System for Gamma-Production Data

Liu Tingjin, Wang Cuilan, Sun Zhengjun (CNDC, CIAE, Beijing 102413)

The Program system GIPS has been developed for gamma-production data plot intercomparison. With the system the evaluated data (files 12-15) and corresponding experimental data can be directly retrieved from evaluated libraries in ENDF/B-6 format and EXFOR master library respectively, processed and plotted. The processing includes calculating the gamma-production multiplicity and spectrum from gamma-emission probability arrays, calculating the gamma-emission cross section and spectrum by summing corresponding data of all reaction channels, calculating cross section of natural element from its isotopes' data, and some format transformation. The system has been used for the intercomparison of natural Fe, Cr, Ni data.

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3. Progress of Calculations and Evaluations of Cross Sections for Neutron Monitor Reactions up to Tens of MeV and Development of Concerned Theories and Codes

Shen Qingbiao, Yu Baosheng, Cai Dunjiu
(Chinese Nuclear Data Center, CIAE, Beijing, China)

The following progress of calculations and evaluations of cross sections for neutron monitor reactions up to tens of MeV and development of concerned theories and codes was achieved.

1) APNOM94 is a program for automatically searching the optimal neutron optical potential parameters in energy region up to 100 MeV for medium-heavy nuclei by means of the improved fastest falling method.

2) SPEC is a program for calculating the neutron or charged particles (p, d, t, He3, alpha) induced reactions on medium-heavy nuclei in the incident energy range up to 70-100 MeV including 6 emission processes [1]. Various cross sections, spectra, and nucleus production cross sections can be calculated by this program.

3) Calculations and evaluations of cross sections for neutron monitor reactions Au197(n,x)Au194, Au195, Au196 in energies of 0.5-80 MeV were made [2-4].

4) Calculations and evaluations of cross sections for neutron monitor reactions Fe54, Fe56, Fe57, Fe58, FeNat(n,x)Cr51, Mn52, Mn54, Mn56 in energy region up to 60 MeV were finished [5,6].

5) Calculations and evaluations of cross sections for neutron monitor reactions Cu63, Cu65, CuNat(n,x)Co56, Co57, Co58, Co60 in energy region up to 70 MeV were completed [7,8].

6) Since the anisotropic behavior of nucleon-nucleus scattering becomes strong with increasing incident energy, the isotropic picture used in previous should be generalized and examined. A discussion of a nucleon double-differential cross section calculation based on anisotropic intranuclear scattering was presented [9].

7) Double-differential cross section formulations were presented of a light composite particle projectile (d, t, He3 ,alpha) considering pickup type reactions with one and two particles above the Fermi sea simultaneously [10].

8) Approach for calculating multistep direct reactions of continuum and discrete levels was proposed [11].

9) Quantum molecular dynamics (QMD), which are the hopeful theoretical framework to calculate the intermediate energy nuclear data, is studying. This work was supported by the International Atomic Energy Agency under contract No.7143/RB.

References

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[2] Shen Qingbiao, Yu Baosheng, Cai Dunjiu, INDC(CPR)-031/L (CNDP,10,53(1993)).
[3] Yu Baosheng, Shen Qingbiao, Cai Dunjiu, INDC(CPR)-032/L (CNDP,11,67(1994)).
[4] Yu Baosheng, Shen Qingbiao, Cai Dunjiu, INDC(CPR)-033/L (CNDP,12,54(1994)).
[5] Shen Qingbiao, Yu Baosheng, Cai Dunjiu, INDC(CPR)-032/L (CNDP,11,31(1994)).
[6] Yu Baosheng, Shen Qingbiao, Cai Dunjiu, INDC(CPR)-032/L (CNDP,11,79(1994)).
[7] Shen Qingbiao, Yu Baosheng, Cai Dunjiu, to be published.
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[9] Qingbiao Shen, Jingshang Zhang, Nucl. Sci. Eng., 117, 88(1994).
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[11] Qingbiao Shen, Jingshang Zhang, Phys. Rev., C 50, 2473(1994).

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4. A Comparison of The Maximum Entropy Method of Analysis to The Exciton Model Plus The Master Equation

(Yan ShiWei, CNDC)

The maximum entropy method of analysis is successful in fitting experimental data. In order to reveal the underlying physics, we apply both method and the conventional approach, i.e the exciton model plus the master equation, to three cases. We have found that both approaches produce almost equally good fits to spectra, and yield almost the same average exciton numbers. This implies that there must be similar physics ideas behind the two approaches, and it should be safe to use the maximum entropy method of analysis to fit data or to estimate reaction cross sections.

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5. Calculation for U-235, Pu-239,240 Neutron Induced Reaction in En=0.001-20 MeV

(Yan Shiwei, CNDC)

For the U-235, Pu-239,240 neutron induced reaction in the energy region of 0.001-20 MeV, the total cross section, the cross section of each openned channels, the elastic/inelastic scattering angular distribution and the

secondary neutron energy spectra are calculated by using the optical model, Hauser-Feshbach statistical theory with width fluctuation correction and the evaporation model including the preequilibrium statistical theory based on the exciton model. The calculated results shows that the calculated resulated reproduce the experiment data very well.

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6. Progress on Optical Model Parameter Sub-library (CENPL-OMP)*

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(Chinese Nuclear Data Center, China Institute of Atomic Energy)

Yu Ziqiang, Zuo Yixin (Dep.of Physics,Nankai Univ., Tianjin)

Ma Gonggui, Chen Zhenpeng
(Inst. Nucl. Sci. & Tech., Sichuan Univ.), (Tsinghua Univ.)

(* The project supported in part by the International Atomic Energy Agency and the National Natural Science Foundation of China.)

Two types of the optical model potential parameter (OMPP) sets, global-regional and nucleus-specific OMPP sets are compiled in the optical model parameter sub-library (OMP), respectively.

I. Global and Regional Optical Model Potential Parameter Sets
The global-regional OMPP sets for six kinds of projectiles are collected and compiled in the first part of OMP data file respectively. There is a brief information table for each kind of projectile and there is an entry for each set of OMPP. The basic information about each set of the global-regional OMPP are listed in the table and entry.

II. Nucleus-Specific Optical Model Potential Parameter Sets
The nucleus-specific OMPP sets for neutron projectile only are collected and compiled in the second part. A standard OMPP form has been determined. It not only can cover most of the OMPP sets existing in the literature at present, but also can be suited for future possible development tendency of OMPP. The brief information on each set of OMPP and potential parameters are listed.

III. Management-Retrieval Code
The management-retrieval code of the OMP sub-library is being developed at CNDC.Its basic functions have been decided. The code notonly could retrieve the optical model parameter sets required for a single reaction channel and several related channels in a neutron induced reaction respectively, but also could calculate the optical model cross sections and compare the calculated results with input experimental data.

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7. Progress and Activities on Chinese Evaluated Nuclear Parameter Library (CENPL) in 1994*

Su Zongdi, Ge Zhigang, Zhang Limin, Sun Zhengjun, Wang Chengxiang
(Chinese Nuclear Data Center, CIAE, P.O.Box 275(41), Beijing)

Huang Zhongfu, Dong Liayuan, Qiu Guochun, Liu Jianfeng
(Dept.of Phys., Guangxi University), (Zhengzhou University)

Yu Ziqiang, Zuo Yixin, Ma Gonggui

(Nankai University), (Sichuan University)

I. Three sub-libraries (Version 1), the atomic masses and characteristic constants of nuclear ground states (MCC), giant dipole resonance parameters for gamma-ray strength function (GDP), fission barrier parameters (FBP), including their data files and the management-retrieval code systems have all been finished. The management-retrieval code systems have retrieved a large amount of data required for many users from different research fields.

II. The data file of the sub-library of the discrete level schemes and gamma radiation branching ratios (DLS) has been set up. The data and information of the DLS data file were translated from the Evaluated Nuclear Structure Data File (ENSDF).

III. The sub-library of nuclear level density (LDL) includes two data files: the data file relative to the level density (LRD) and the data file of the level density parameters (LDP). The LRD file contains S-wave average resonance level spacing Do, strength function So and radioactive capture width at neutron separation energy, as well as the cumulative number No of low-lying levels. The Do and So values were recommended by us in 1993. The LDP file contains eight sets of the level density parameters for three popular kinds of level density formulas, which are the composite four-parameter formula (GC), the back-shifted Fermi gas formula(BS) and the generalized superfluid model(GSM).

IV. In addition, the relevant model parameters are being studied.

(1) In the studies on the level density, a new set of the level density parameters of the generalized superfluid model have been got by fitting the Do and No values mentioned above. An intercompare of the different level density formulas in low-lying region is being made.

(2) In the study of Do values,a new set of Do values are being estimated and recommended according to the resonance data in ENDF/B6, JEF-2 and JENDL-3.

(3) The giant dipole resonance parameters (GDRP) for the more nuclides with $A<50$ by fitting the photo-nuclear cross sections have been obtained. The systematics of the GDRP is being developed.

V. In order to review the work progress, discuss some problems in constructing CENPL, propose and arrange the tasks for the next period, we held the 2nd Working Meeting on CENPL (July 1994, Chengde), as well as two Workshops on the level density (June 1994, Nanning) and the 2nd optical model parameters (Dec. 1994, Tianjing).

We also participated the 1st Research Coordinated Meeting organized by the International Atomic Energy Agency on "Development of Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data" (Cervia, Italy, 19-23, Sep. 1994).

* The project supported in part by the International Atomic Energy Agency and the National Natural Science Foundation of China.

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8. Modification and Improvement of CENDL-2

Liang Qichang, Liu Tingjin, Zhao Zhixiang, Liu Tong, Sun Zhengjun
(CNDC, CIAE, P.O.Box 275(41), Beijing 102413)

1) The characteristic values (thermal cross section, resonance integrals, etc.) have been added in the text in MF1 MT451 for all evalutions of CENDL-2.

2) The secondary neutrons energy spectra for O-16, Na-23, Mg-0, Si-0, P-31, S-0, K-0, Ti-0, V-51, Zr-0, Cd-0, In-0, Sb-0, Hf-0, W-0, Au-197, Pb-0, Np-237, Pu-239 have been modified.

3) The total cross section for natural S, K, Ti, Ni, Zr, Sb, Hf, Pb have been updated.

4) The gamma-production data for Ti-0, Zn-0, Zr-0, Mo-0, Cd-0, In-0, Sn-0, Sb-0, Hf-0, Ta-181 ,W-0, Au-197, Pb-0 have been supplemented in the data files.

5) The re-evaluations for Ca-0 and U-238 by using new model theory codes have replaced the old one in CENDL-2.

6) The new evaluations for Fe-56 and natural Lu, Hg, Tl have been added in CENDL-2.

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9. Homogeneous Fast Reactor Benchmark Testing of CENDL-2 and ENDF/B-VI

Liu Guisheng (CNDC,CIAE,P. O. Box 1, Beijing 102413, China)

A new evaluated nuclear data file of Uranium-238 was produced. In order to test the validation for the CENDL-2, especially for U-238, nine homogeneous fast assemblies were used in this testing.

NJOY-91.91/MILER code system was applied to processing nuclear data and generating 175 group cross-sections in VITAMIN-J structure in the AMPX master library format from CENDL-2 and ENDF/B-VI. To test weighting spectrum effect on generating averaged cross-sections, three weighting functions, such as W-A (thermal maxwelliam + 1/E + fission spectrum), W-B (thermal + 1/E + fast reactor + fission + fusion) and W-C (VITAMING-J weighting function, option 11 of module GROUPR in the NJOY-91.91) were used in running NJOY, respectively. In fact, it is the correct weighting option that makes us obtain satisfying results about the benchmark testing of CENDL-2 for 3 homogeneous uranium fuel assemblies.

Transport calculations of Keff and spectra indexes for these benchmark assemblies in P3 S32 and 175 groups were carried out by the PASC-1 code system. Table 1 presents the calculational results of Keff values for CENDL-2 and ENDF/B-VI. A more detail results will be published in the CNDP.

Table 1. Results of Keff calculations

CNDC	*	*	**	***	Ref.1		Ref. 2
Assembly	**CENDL-2**	**ENDF/B-6**	**ENDF/B-6**	**ENDF/B-6**	**ENDF/B-6**	**JEF-2**	**JENDL-3**
GODIVA	1.00003	0.99946	0.99626	0.99626	0.9954	0.9934	1.0066
FLATTOP-25	1.00142	1.00785	1.00356	1.00101	1.0007	0.9898	1.0033
BIG-10 C	0.99541	1.01576	1.01693	1.00555	1.0063	0.9928	1.0038
C/E	0.99940	1.01984	1.02101	1.00959			
JEZEBEL	1.00430	1.00056	0.99753	0.99753	0.9960	0.9952	1.0001
JEZEBEL-Pu	1.00391	1.00261	1.00040	1.00040	0.9893	0.9898	0.9963
FLATTOP-Pu	1.00066	1.00886	1.00424	1.00742	1.0025	0.9887	0.9974
JEZEBEL-23	0.99463	0.99458	0.99301	0.99301	0.9929	0.9756	1.0206
FLATTOP-23	1.00187	1.00645	1.00341	1.00470	1.0026	0.9836	1.0175
THOR	1.00925	1.00721	1.00389	1.00719	1.0056	0.9797	0.9985

* W-C were used in generating multigroup constants for assemblies, except W-B for BIG-10. These results should be correct.

** W-A were used in generating multigroup constants with resonance self-shielding processing.

*** W-A were used in generating multigroup constants without resonance self-shielding processing.

Ref. 1: M. Caro and S.Pelloni, Nuclear Data for Science and Technology. Berlin, Proceedings an International Confernce, held at the Germany, 13-17 May 1991.

Ref. 2: Kikuchi Y., same as the Reference 1.

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10. Averaged analytical forces in intermediate and high energy reactions

(Lu Zhongdao, CNDC)

By use of the effective Skryme-type potentials, we derived the averaged analytical forces which include the two-body Skryme force, three-body Skryme force, Yukawa force and the Coulomb force. Compared with the difference method,the application of the analytical forces can raise the calculation speed to 6 time and raise the accuracy significantly.

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11. Light particle emissions in fission diffusion process and the nuclear friction coefficient

(Lu Zhongdao, CNDC)

In order to include the emissions of other light particles (such as proton,alpha,...) into the fission diffusion process, we give out the extensive Smoluchowski equation with the inclusion of these light particle emissions. We also showed the formulas for the multiplicities of these particles, with them the comparisions to experimental data can be made and the nuclear friction coefficient can be extracted.

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12. Progress in the Feshbach-Kerman-Koonin Multistep Compound Reaction Theory

Li Baoxian, Su Zongdi (CNDC ,CIAE,P.O.Box 275(41) Beijing 102413)

The three refinements to the Feshbach-Kerman-Kioonin multistep compound reaction (MSC) theory are given below descriptions:

1) Angular momentum in MSC theory

In our work,the angular momentum coupling factors are deduced in both the transition matrix element and the geometrical coefficient in the differential cross section formula, when the nucleon is treated as a spin-half particle, the target nucleus is allowed to have a non-zero spin and the angular momentum coupling is treated rigorously.

2) Entrance strength function and r-stage

Firstly, the entrance strength function can obtained in consistent way with the optical model (OM) by equating it to the OM transmission coefficients. Secondly, the escape widths of the equilibrium emission

in the r-stage can be evaluated the OM transmission coefficients. A unified theory formula described the multistep compound emission of pre-equilibrium and compound nucleus emission of full equilibrium is presented. The emission description of the equilibrium system is fully consistent with the Hauser-Feshbach theory if the pre-equilibrium emission is neglected.

3) Two-component MSC theory

In our work, the neutrons and protons are distinguished rigorously by isospin in wave function. The formulas of double differential cross-section,damping and escape width are deduced in the two component theory. The two-component theory lead to (n,n) emission cross section is enhanced and (n,p) reaction cross section becoming smaller. The explanation is presented for Vt= 1.6Vs in phenomenological potential from the interaction matrix elements.In order to satisfy the experimental results of (n,n) and (n,p) reaction, R parameter (2.89) which is the rate of n-p and n-n residual interaction strength was phenomenologically introduced in the exciton model of the two-component theory. The average R parameter is 2.75 by calculated without any phenomenological parameter in our work .

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13. Neutron Induced Reaction on Actinide Nuclides by Channel Theory of Fission with Diffusive Dynamics

(Wang Shu Nuan, CNDC)

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14. Comparison of Consistent Dynamical and Statistical Descriptions of Fission of Hot Nuclei

(Wang Shu Nuan, CNDC)

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15. Relativistic Exciton Transition Rate Calculation

(Wang Shu Nuan, Liu Wen Qin, Ma Zhong Yu, CNDC)

Progress and Activities on Chinese Evaluated Nuclear Parameter Library (CENPL) in 1994*

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Yu Ziqiang Zuo Yixin Ma Gonggui
(Nankai University) (Sichuan University)

A great progress on setting up the CENPL and studies of the relative model parameters has been got for a year. Three sub-libraries (the first edition) , the atomic masses and characteristic constants of nuclear ground states(MCC), giant dipole resonance parameters for gamma-ray strength function(GDP) , fission barrier parameters (FBP), including their data files and the management-retrieval code systems have all been finished . The management-retrieval code systems have retrieved a large amount of required data for many users from different research fields.

The data file of the sub-library of the discrete level schemes and gamma radiation branching ratios (DLS) has been set up , and the management-retrieval code system is being written . The data and information of the DLS data file were translated from the Evaluated Nuclear Structure Data File (ENSDF).

The sub-library of level density (LDL) includes two data files: the data file relative to the level density (LRD) and the data file of the level density parameters (LDP) . The LRD file contains S-wave average resonance level spacing Do , strength function So and radioactive capture width at neutron separation energy,as well as the cumulative number No of low-lying levels. Do and So values were recommended by us in 1993 . The LDP file contains eight sets of the level density parameters for three popular kinds of level density formulas, which are the composite four-parameter formula(GC), the back-shifted Fermi gas formula (BS) , the generalized superfluid model (GSM). The management-retrieval code system of this sub-library has achieved a great progress.

The data file of optical model parameter sub-library (OMP) includes two part: the global and regional optical model parameters and nucleus-specific ones. The first part has had an initial scope , and another has appeared in an embryonic form . The management-retrieval code has achieved a great progress.

In addition, the relevant model parameters are being studied.

In the studies on the level density , fitting the Do and No values recommended by us, we got a set of the level density parameters for the generalized superfluid model for 249 nuclides ranging from 41-Ca to 250-Cf. There are parameters of ourselves for the three popular kinds of level density fumulas, and intercompare of the different level density formulas in low-lying region has been made.

In the study of Do values,a new set of Do values about 336 nuclides ranging from 16-N to 254-Es have being estimated and recommended according to the resonance data in ENDF/B-6, JEF-2 and JENDL-3.

Except that, we have extracted the giant dipole resonance parameters (GDRP) for the more nuclides with A<50 by fitting the photonuclear cross sections and the systematics of the GDRP will be developed.

In order to review the work progress , dicuss some problems in constructing CENPL,propose and arrange the tasks for the next period, we held the 2nd Working Meeting on CENPL (July 1994,Chengde),as well as two Workshops on the level density(June 1994,Nanning) and the 2nd optical model parameters(Dec. 1994,Tianjing).

We also participanted the 1st Research Coordinated Meeting organized by the International Atomic Energy Agency on "Development of Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data" (Cervia, Italy, 19-23, Sep. 1994).

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PROGRESS ON OPTICAL MODEL PARAMETER SUB-LIBRARY(CENPL-OMP)*

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Here the progress on the OMP sub-library of Chinese Evaluated Nuclear Parameter Library(CENPL) will be presented.For convenience of setting up data file and retrieval, we divide the optical model potential parameter (OMPP) sets into two parts, in which two types of OMPP sets , global and regional OMPP sets and nucleus-specific OMPP sets are compiled respectively.

I. Global and Regional Optical Model Potential Parameter Sets

The global and regional OMPP sets for six types of projectiles are collected and compiled in (1)-(6) of this data file respectively. There is a brief information table, which includes authors,published date,mass region of target nucleus,energy region of incident particle , spherical or deformed (S/D), local or nonlocal(L/N) and fitted experimental data types,for each type of projectile.There is an entry for each set of OMPP , and each entry contains 13 subjects denoted by different keywords.They are "Entry", "Tital", "Authors", "Affil.", "Ref." , "Projectile", "Nucleus Region", "Energy Region", "Potential" , "Parameters" , "Primary Data" , "Optim. Method" and "Comments".

II. Nucleus-Specific Optical Model Potential Parameter Sets

The nucleus-specific OMPP sets for neutron projectile only are collected and compiled in this data file . The brief information on each set of OMPP and potential parameters are listed. The brief information contains target nucleus,neutron incident energy,spherical or deformed (S/D) , fitted experimental data types and made model calculations , deformed parameter and standard abbreviation of reference.

A standard OMPP form has been determined.It not only can cover most of the OMPP sets existing in the literature at present , but also is suited for future possible development tendency of OMPP.

III. Management Retrieval Code

The management-retrieval code of the OMP sub-library is being developed at CNDC . The its basic functions have been decided . The code not only could retrieve the required optical model parameter sets for a single reaction channel and several related channels in a neutron induced reaction respectively , but also could calculate the optical model cross sections.Therefore this code should include two optical model codes for the spherical and deformed potential respectively , and could compare the results of the optical model calculations from different parameter sets with input experimental data.

PROGRESS IN THE FESHBACH–KERMAN–KOONIN MULTISTEP COMPOUND REACTION THEORY

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The following four refinements to the Feshbach–Kerman–Kioonin multistep compound reaction (MSC) theory are given below descriptions:

1.Angular momentum in MSC theory

The original FKK theory [1] treaded the nucleons as being spinless and assumed that the target nucleus spin is always zero, so the double–differential cross section formula and the transition matrix elements are given in the l–s coupling . In our work,the angular momentum coupling factors are deduced in both the transition matrix element and the geometrical coefficient in the differential cross section formula, when the nucleon is treated as a spin–half particle ,the target nucleus is allowed to have a non–zero spin and the angular momentum coupling is treated rigorously .Thus a multistep compound formalism with the spin–half particle and the angular momentum coupling treated the in j–j representation has been deduced.

2.Entrance strength function and r–stage

Firstly , the entrance strength function can obtained in more consistent way with the optical model (OM) by equating it to the OM transmission coefficients;secondly the escape widths of the equilibrium emission in the r–stage can be evaluated the OM transmission coefficients to describe the emission from the equilibrium system in full consistent with the Hauser–Feshbach theory .A unified theory formula described the multistep compound emission of preequilibrium and compound nucleus emission of full equilibrium is presented.

The entrance strength function of primitive formula[1,2] can be replaced by OM transmission coefficients as the formation factor of a compound system .Thus, the results of MSC theory are consistent with OM and are restricted by OM if the direct reaction can be neglected.

When full equilibrium in the r–stage has been established , the detailed

balance principle is justifiable ,the escape width and total width can be evaluated by the transmission coefficient of OM in the r–stage too .

In view of the refinements mentioned above , a unified formula for the MSC of pre–equilibrium emission and compound nucleus emission of full equilibrium is presented in the representation j–j coupling.

3.Two–component MSC theory

In our work , the neutrons and protons are distinguished rigorously by isospin in wave function.Because the two–body residual interaction is of zero–range and the wave–function of compound system must be antisymmetry , if the nucleon spin is $1/2$ and the neutrons and protons are not distinguishable, the total spin of the system of interaction two nucleons must be zero. If the neutrons and protons are distinguishable ,then the total spin of the system can be zero or one,so the interaction matrix elements[3] become complex more . The formulas of double differential cross–section ,damping and escape width are deduced in the two component theory .

The two–component theory lead to (n,n) emission cross section is enhanced and (n,p) reaction cross section becoming smaller .The explanation is presented for $V_t = 1.6V_s$ in phenomenological potential[4] from the interaction matrix elements.In order to satisfy the experimental results of (n,n) and (n,p) reaction , R parameter[5] (2.89) which is the rate of n–p and n–n residual interaction strength was phenomenologically introduced in the exciton model of the two–component theory .The average R parameter is 2.75 by calculated without any phenomenological parameter in our work .

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5).Beijing International Symposium on " Fast Neutron Physics " 9–13 Sep.(1991)155

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RECENT PUBLICATIONS

F. Storrer, "Test of JEF2 Decay data and Fission Yields by means of Decay Heat calculations", GATLINBURG Conference, p.819 (May 1994)

E. Fort, M. Salvatores, "JEF2 Validation-Methodology - Present Results - Future Plans", GATLINBURG Conference, p.768 (May 1994)

K. Dietze, E. Fort, S. Rahlfs, G. Rimpault, M. Salvatores, "JEF-2 Data Check by Reanalysis of the Rossendorf Experiments in Reactor Configurations with Specially Designed Adjoint Spectra", GATLINBURG Conference, P.789 (May 1994)

WORK IN PROGRESS

- Continuing activities on JEF2 validation :
  - concerning the nuclei of the General Purpose file in the thermal and fast ranges; final conclusions to be released in 1995.
  - concerning the Special Purpose file (Fission Yields, Decay Data)
- Preparation of JEFF3 starter file
- Implementation in a version of GNASH code of an improved formalism for the Width fluctuation corrective factor (cooperation with B.R.C. laboratory)
- Investigation of the possibility to directly "adjust" the nuclear model parameters (resonance parameters) from the integral data information (Ph.D. thesis).
- Consistent evaluation of $\overline{\upsilon_p}$, $\overline{Q}$, $\overline{TKE}$, $\overline{E_\gamma^f}$, $\overline{\upsilon_d}$ for the main and minor actinides.
- Contribution to the high resolution measurement of $\sigma_{n,n'}$ of ^{56}Fe (Ph.D. thesis) (In cooperation with GEEL Laboratory).

FUTURE PLANS

- Reevaluation of ^{239}Pu as a fallout of the NEA/NSC subgroup 5 activity.
- Reevaluation of ^{240}Pu starting from the resolved and the unresolved ranges (in cooperation with OAK-RIDGE Laboratory)
- Contribution to the measurement of Fission Yields of ^{232}Th (in cooperation with the STUDSVIK Laboratory)

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1. Cs.M. Buczkó, J. Csikai, T. Chimoye, B.W. Jimba
Cross sections of $^{113}In(n,n')^{113m}In$ and $^{113}In(n,2n)^{112m,g}In$ reactions around 2 and 14 MeV neutron energies
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4. J. Csikai
Some results on the production of long-lived radionuclides in fast neutron induced reactions
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5. A. Grallert, J. Csikai, Cs.M. Buczkó, I. Shaddad
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6. S. Sudár, F. Szelecsényi, S.M. Qaim
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Phys. Rev., C48 (1993) pp. 3115

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Excitation functions and isomeric cross section ratios of the $^{63}Cu(n,\alpha)^{60}Co^{m,g}$, $^{65}Cu(n,\alpha)^{62}Co^{m,g}$, and $^{60}Ni(n,p)^{60}Co^{m,g}$ processes from 6 to 15 MeV
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8. Cs.M. Buczkó, J. Csikai, S. Sudár, A. Grallert, S.A. Jonah, B.W. Jimba, T. Chimoye, M. Wagner
Excitation function and isomeric cross section ratio of the $^{58}Ni(n,p)^{58}Co^{m,g}$ reactions from 2 to 15 MeV
Phys. Rev., C (to be published)

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1. ORAGANIZED MEETINGS

At ENEA "E. Clementel" Center in Bologna the "Specialists' Meeting on Measurement, Calculation and Evaluation of Photon Production Data" was yointly oranized in November 9 to 11, 1994 by the NEA (C. Norborg) and the Settore Fisica Applicata (Applied Physics) of ENEA (C. Coceva, A. Mengoni and A. Ventura) according to an action by the NEANDC confirmed by the NEA-NSC and as a follow-up of the previous Specialists' Meeting on the matter organised by the IAEA in February 1990.
A close cooperation by the Nuclear Data Section of IAEA, in particular organising (by P. Oblozinsky) the first Meeting of the IAEA Coordinated Research Program on the same topics at the Bologna Center in close dates (according to a specific recommandation by INDC) allowed a substantial partecipation of non-OECD countries and reciprocal scientific benefits from the presented contributions and discussions on the matter of common interest.
The most relevant topics concerned:

i) experimental methods and measurements of gamma-rays and cross sections mainly for neutron induced reactions ;

ii) theoretical aspects, in particular direct-semidirect and pre-equilibrium models, and related calculations;

iii) photon production libraries;

iv) applications, mainly concerning shielding calculations (in particular for ITER Project) and analytical chemistry by gamma-ray spectroscopy.

2. MODELS AND CODES

A. Collective contribution to nuclear level density calculation.

A new parameterization of the standard Fermi-gas model (FGM) has been constructed [1] . This provided a wide basis on which to test the various prescriptions proposed for the inclusion of collective excitations in nuclear level density evaluations.
The Interacting Boson Model (IBM) has been employed for the calculation of the enhancement factor of nuclear level density formulations [2.3]. A unique scheme for treating rotational, and vibrational excitations is provided by the IBM prescriptions.
At present, a special effort is being devoted to deriving simple relations for the collective enhancement factors, to be used in nuclear reaction codes.

B. Structure and neutron reaction mechanisms in light nuclei.

The tail of single-particle wave funtions outside the nuclear radii has been known to have fundamental effects on the neutron capture mechanism. Its connection with the incoming, or channel, wave funtions through the emission of electric dipole radiation gives an indication of a capture mechanism without compound nucleus formation: the direct radiative capture process.
Following the discovery of drip-line nuclei with halo structure, it has been recently recognized that the neutron capture mechanism can be affected by the neutron halo of the capturing state. The case of the p-wave neutrons in the $^{12}C(n,\gamma)$ reaction channel has been recently analyzed as a tool for detecting the halo structure of the loosely-bound a- and d-wave states in ^{13}C[4].
We have obtained promising results in the calculation of the 12C(n,γ)cross section as compared to the recent neutron capture mechanism with the neutron halo in light nuclei has been shown together with new applications in the calculation of capture cross section for light nuclei [4,5].

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"Fermi-Gas model parametrization of nuclear level density"
The Journal of Nuclear Science and Technology, 31 (1994), 151

2. A. Mengoni, G. Maino, A. Ventura and Y. Nakajima
"Algebraic and geometric approaches to the collective enhancement of nuclear level densities"
Proceedings of the International Conference on the Perspectives for the Interacting Boson Model. R.F. Casten et al. Eds, World Scientific (1995) 421.

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"Far from stability: evaluation of properties of nuclear excites states"
Proceedings of the 3nd International Symposium on Nuclear Astrophysics, "Nuclei in the Cosmos" L'Aquila, Italy, July 1994. The Institute of Physics Publishing. In press (1995).

4. A. Mengoni, T. Otsuka, and M. Ishihara
"Gamma-rays from direct capture mechanisms"
Proceedings of a Specialists' Meeting on Measurements, Calculation and Evaluation of Photon Production Data. C. Coceva et al. Eds., published as NEA/NSC/DOC(95)1 (1995) page 181.

5. A. Mengoni, T. Otsuka, and M. Ishihara
"Halo structure of nuclear excited states and the neutron radiative captue process"
Proceedings of the Workshop on Experimental Perspectives with Radiactive Nuclear Beams, Podova, 14-17 November 1994. In press (1995).

3. PROGRESS IN NUCLEAR DATA EVALUATION

i) The collaboration to the evaluation of structural materials for the European Fusion File (EFF), according to ENDF/B-6 format, mainly concerned evaluated data of natural Mo isotopes and a revision of Fe evaluation (F.Fabbri, G.C. Panini).

ii) The (n,p) cross section of ^{28}Al was evaluated by considering its relevance as dosimetric reaction and as one reference cross section for fast neutron activation analysis. Critical comparison was made with respect to ENDF/B-6 file. The new evaluated data were presented at the" 4th International Conference on the Applications of Nuclear Techniques" (Crete, June 1994) /1/.

iii) As a result of model calculations (see previous NNDEN issue) evaluated data for (gamma, n) reaction on ^{124}Xe were produced for the puposes of ^{123}I medical radioisotope production. Significant differencies were found with respect to the previous evaluations based on parameter systematics. /2/

1. E. Menapace. "Nuclear Data for Fast Neutron Activation Analysis" (invited paper). Proceedings of the Conference in press.

2. E. Maino and M. Rosetti "Xenon photonuclear cross sections for the production of ^{123}I radionuclide" to be published in Rad.Phys. Chem.

4. NUCLEAR DATA PROCESSING

The following libraries have been completed:

GEFF-2: this Pc library for fusion neutronics calculations is based upon the 175 neutron, 42 photon VITAMIN-J group structure with the standard weighting functions. It includes 93 materials (see annexed tables, most from EFF-2.4 basic data, at 3 temperatures and 6 dilution corss section values; thermal treatment includes 10 groups below 3 eV. Neutron cross sections and

diffusion matrices, photon and gas production, kerma and DPA are given; in a separate file a 42 group photon interaction P8 library from EPDL-90 has been preparad too. NJOY code version 91.38 has been used to process all the data. The library is available both in GENDF and in MATXS format (this one including photon interaction data too); the occupancy of the library in GENDF card image format is about 5.5 milions of recods corresponding to 450 Mbytes. This work has been carrid out with the financial support of the European Programme for Fusion NET.

COVNET: a group library of error data from EFF-2.4 is available in two version: the 24 neutron energy group DOSCOV and the standard VITAMIN-J tructure. It includes 18 materials - The ones with error data in EFF-2.4, i.e: H-1, Li-6, C, V, Cr-52, Mn-55, Fe-56, Ni-58, Ni-60, Ni-61, Ni-62, Ni-64, Cu-63, Cu-65, Nb-93, Re-185, Re-186 - processed by the NJOY 91.38 module ERROR and COVR. Data are written in BOXER format; graphs of covariance matrices have been produced by the graphics facilities of NJOY for the VITAMIN-J version. The work had the financial support of the European Programme for Fusione NET.

COVIRDF: IRDF-90 Version 2 has been collapsed into the VITAMIN-J structure in order to provide activation and dosimetry cross sections to carry away computations in connection with COVNET. Similarly an error data library has been generated by NJOY modules in the VITAMIN-J. The library is complete and in use: the available format are GENDF, BOXER and, without error data, ANITA.

RFL-2: a group library of reaction cross sections, gas production, kerma and DPA has been completed based upon the data of GEFF-2.4. Its primary use is to complete the neutron transport libraries in FIDO format with data normally not present in the traditional files. It includes all the materials of GEFF-2 as above and beside the ones already present in MACKLIB-IV.
The library preserves the structure of the Macklib's Activity Table. It gives delayed kerma, i.e. the energy release generated by the decay of radioactive nuclei produced in the primary reactions, and delayed photon production matrices, i.e. data for photons produced by the disintegration of the radioactive product nuclides. The Library being derived from GEFF-2 is based upon the Vitamin-J structure and is in DTF format. A special computer code has been developed for this library to merge data from GENDF and from Radioactive Decay Data from JEF-2.2 and to produce delayed kerma and photon production matrices. The standard version includes decay within 10000 seconds; a code is available to make a selection based upon ZA, the decay time and the temperature, eventhough it has been shown that the temperature effect can be neglected in this kind of data. This work had the financial support of the European Programme for Fusion NET.

- **A VITAMIN-J** based group library from JEF-2.2 has been completed for shielding analysis with additional materials from JEF-2.2 at 1 temperature with neutron data, photon production data and kerma from single reactions in "reduced" form, i.e. partial kerma are divided by cross section in order to account for self shielding, eventhough in an approximate form. NJOY code version 91.38 has been used to process the library which is in GENDF* format includes additional identifiers (MT) for use in the ECCO System. This work has been performed upon committment by ENEA - Dipartimento Energia in the frame of ENEA/CEA Collaboration for Future Reactors.

	Material	Source	T, σ_0	γ prod.	COV	MF6	RRP	URP	GENDF
41	Ni-58	EFF 2.4	a,6	Y	Y	Y	Y		78479
42	Ni-60	EFF 2.4	a,6	Y	Y	Y	Y		86176
43	Ni-61	EFF 2.4	a,6	Y	Y	Y	Y		107172
44	Ni-62	EFF 2.4	a,6	Y	Y	Y	Y		84708
45	Ni-64	EFF 2.4	a,6	Y	Y	Y	Y		75869
46	Cu-63	EFF 2.4	a,6	Y	Y	Y	Y		135232
47	Cu-65	EFF 2.4	a,6	Y	Y	Y	Y		111056
48	Zr	EFF 2.4	a,6	Y			Y		37005
49	Nb-93	EFF 2.4	a,6	Y	Y		Y		80387
50	Mo-92	EFF 2.4	a,6	Y		Y	Y	Y	88000
51	Mo-94	EFF 2.4	a,6	Y		Y	Y	Y	100378
52	Mo-95	EFF 2.4	a,6	Y		Y	Y	Y	129244
53	Mo-96	EFF 2.4	a,6	Y		Y	Y	Y	99993
54	Mo-97	EFF 2.4	a,6	Y		Y	Y	Y	128272
55	Mo-98	EFF 2.4	a,6	Y		Y	Y	Y	106465
56	Mo-100	EFF 2.4	a,6	Y		Y	Y	Y	99710
57	Ag-107	JEF 2.4	e,1				Y		9642
58	Ag-109	JEF 2.4	e,1				Y	Y	12672
59	Cd	JEF 2.4	a,6						32963
60	In-113	EFF 2.4	a,6				Y	Y	81804
61	In-115	EFF 2.4	a,6				Y	Y	69429
62	Sn-112	EFF 2.4	e,1				Y	Y	19627
63	Sn-114	EFF 2.4	e,1				Y	Y	20532
64	Sn-115	EFF 2.4	e,1				Y	Y	19379
65	Sn-116	EFF 2.4	e,1				Y	Y	15053
66	Sn-117	EFF 2.4	e,1				Y	Y	18185
67	Sn-118	EFF 2.4	e,1				Y	Y	14091
68	Sn-119	EFF 2.4	e,1				Y	Y	21917
69	Sn-120	EFF 2.4	e,1				Y	Y	16857
60	Sn-122	EFF 2.4	e,1				Y	Y	14271
71	Sn-124	EFF 2.4	e,1				Y	Y	18017
72	Ba-130	EFF 2.4	e,1				Y	Y	15989
73	Ba-134	EFF 2.4	e,1				Y		8340
74	Ba-135	EFF 2.4	e,1				Y		10210
75	Ba-136	EFF 2.4	e,1				Y		8900
76	Ba-137	EFF 2.4	e,1				Y		8953
77	Ba-138	EFF 2.4	e,1	Y					7486
78	Hf-174	JEF 2.4	a,1				Y		58968
79	Hf-176	JEF 2.4	a,1				Y		62871
80	Hf-177	JEF 2.4	a,1				Y		62341

List of materials in GEFF-2. (cont'ed)

	Material	Source	T, σ_0	γ prod.	COV	MF6	RRP	URP	GENDF
1	H-1	EFF 2.4	a,1	Y	Y				55001
2	H-1 (H_2O)	EFF 2.4	b,1	Y					54966
3	H-2	EFF 2.4	a,1	Y		Y			42256
4	H-3	EFF 2.4	a,1						27658
5	He-3	EFF 2.4	a,1						21662
6	He-4	EFF 2.4	a,1						17914
7	Li-6	EFF 2.4	a,1	Y	Y				102813
8	Li-7	EFF 2.4	a,1	Y		Y			61635
9	Be-9	EFF 2.4	a,1	Y		Y			37425
10	Be-9 (metal)	EFF 2.4	c,1	Y		Y			37566
11	B-10	EFF 2.4	a,1	Y					78280
12	B-11	EFF 2.4	a,1	Y		Y			55868
13	C	EFF 2.4	a,1	Y	Y				30511
14	C (graphite)	EFF 2.4	d,1	Y					30655
15	N-14	EFF 2.4	a,1	Y					76298
16	N-15	EFF 2.4	a,1	Y					31375
17	O-16	EFF 2.4	a,1	Y					51906
18	F-19	EFF 2.4	a,1	Y					65171
19	Na-23	EFF 2.4	a,1	Y			Y		71167
20	Mg	EFF 2.4	a,1	Y			Y		85232
21	Al-27	EFF 2.4	a,6	Y		Y	Y		95831
22	Si-28	EFF 2.4	a,6	Y		Y	Y		75793
23	P-31	EFF 2.4	e,1	Y					8073
24	S	EFF 2.4	e,1	Y			Y		25361
25	Cl	EFF 2.4	a,1	Y			Y		33936
26	Ar-40	EFF 2.4	d,1				Y		40734
27	K	EFF 2.4	d,1	Y					36942
28	Ca	EFF 2.4	a,6	Y			Y		103459
29	Ti	EFF 2.4	a,1	Y			Y		91756
30	V	EFF 2.4	a,1	Y	Y		Y		57442
31	Cr-50	EFF 2.4	a,6	Y			Y		63802
32	Cr-52	EFF 2.4	a,6	Y	Y	Y	Y		89343
33	Cr-53	EFF 2.4	a,6	Y			Y		74611
34	Cr-54	EFF 2.4	a,6	Y			Y		59271
35	Mn-55	EFF 2.4	a,6	Y	Y	Y	Y		137412
36	Fe-54	EFF 2.4	a,6	Y			Y		50286
37	Fe-56	EFF 2.4	a,6	Y	Y	Y	Y	Y	111260
38	Fe-57	EFF 2.4	a,6	Y			Y		69838
39	Fe-58	EFF 2.4	a,6	Y			Y	Y	61149
40	Co-59	EFF 2.4	e,1	Y	Y		Y		17937

List of materials in GEFF-2.

	Material	Source	T, σ_0	γ prod.	COV	MF6	RRP	URP	GENDF
81	*Hf-178*	*JEF 2.4*	*a,1*				*Y*		*62040*
82	*Hf-179*	*JEF 2.4*	*a,1*				*Y*		*56395*
83	*Hf-180*	*JEF 2.4*	*a,1*				*Y*		*61364*
84	*Ta-181*	*EFF 2.4*	*a,6*	*Y*			*Y*	*Y*	*64371*
85	*W*	*EFF 2.4*	*a,6*	*Y*			*Y*		*119406*
86	*W-182*	*JEF 2.4*	*a,6*	*Y*			*Y*	*Y*	*46096*
87	*W-183*	*JEF 2.4*	*a,6*	*Y*			*Y*	*Y*	*52316*
88	*W-184*	*JEF 2.4*	*a,6*	*Y*			*Y*	*Y*	*47228*
89	*W-186*	*JEF 2.4*	*a,6*	*Y*			*Y*	*Y*	*47498*
90	*Re-185*	*EFF 2.4*	*a,1*		*Y*		*Y*	*Y*	*35560:*
91	*Re-187*	*EFF 2.4*	*a,1*		*Y*		*Y*	*Y*	*46965:*
92	*Pb*	*EFF 2.4*	*a,6*	*Y*		*Y*			*87458*
93	*Bi-209*	*EFF 2.4*	*a,6*	*Y*					*68596*

List of materials in GEFF-2. (cont'ed)

T(°K)
a = 293.6, 900, 1500
b = 293.6, 473.6, 623.6
c = 293.6, 600, 1200
d = 293.6, 600, 1000
e = 293.6

σ_0
1 = ∞
6 = ∞, 10^4·10^3·10^2·10^1·10^0

All the above processed libraries are available via anonymous ftp from Unix based host in Bologna. Contact the responsible of the nuclear data Services G.C. Panini for more details in one of the following ways:

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5. NUCLEAR DATA VALIDATION

A detailed ENEA report 1 was published on the validation of the ENDF/B VI iron cross sections, on the (H20/Fe) PCA-REPLICA neutron shielding benchmark. The results presented include a comparison with those of a previous JEF-2.1 iron validation and are based on a conclusive paper 2 presented at the JEF Working Group Meetings in December 1992 at the NEA Data Bank.
A second paper (3), on the ENDF/B VI iron validation on the same benchmark, was presented at the 8th international Conference on Reactor Shielding in Arlington (Texas - USA) on April 1994.
It is to be recalled that the (H20/Fe) PCA-REPLICA (UKAEA-Winfrith) low-fluw shiedling experiment reproduces the ex-core radial geometry of a PWR and is closely related to LWR saferty. In particular this benchmark permits to test the accuracy of the calculated neutron exposure parameters in a reactor pressure vessel simulator.
The progress on all the matter was presented at the JEF Working Group Meeting in June 1994 at the NEA-Data Bank sede at the session devoted to the data validation through shielding benchmarks and resulted in a significant contribution to the evaluators in the frame work of a revised evaluation of Fe-56 data, mainly concerning inelastic scattering in the energy region 0.8 to 3 MeV within the JEF Project.
Validation calculations have been initiated on JENDL-3 file with respect to the same PCA-Replica benchmark.

REFERENZE

/1/ M. Pescarini, ENDF/B VI IRON VALIDATION ON THE PCA-REPLICA (H20/FE) SHIELDING BENCHMARK EXPERIMENT, Technical Report ENEA RT/INN/94/11, maggio, 1994.

/2/ M. Pescarini, "PCA-REPLICA SHIELDING BENCHMARK: FINAL COMPARISON OF THE VALIDATIONS OF THE ENDF/B VI AND JEF-2.1 IRON CROSS SECTION SETS", JEF Working Group Meetings on Benchmark Testing, Data Processing and Evaluations. JEF-DOC 392, NEA Data Bank, Issy-les-Moulineaux, 9th and 10th Drcember 1992.

/3/ M. Pescarini, ENDF/B VU AND JEF-2 IRON VALIDATION ON THE (H20/FE) PCA-REPLICA SHIELDING BENCHMARK, Proceedings of the 8th International COnference on Radiation Shielding, pp. 832 - 839, Vol. 2, Arlington, Texas, USA, April 24-28, 1994.

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Publications

1) A. Mengoni and Y. Nakajima: "Fermi-Gas Model Parameters of Nuclear Level Density," *J. Nucl. Sci. Technol., 31, 151 (1994).*
   A new parametrization of the Fermi-Gas model was made by adopting the standard Fermi-Gas model with pairing and shell-effect corrections.

2) H. Derrien: "R-Matrix Analysis of Neutron Effective Total Cross Section, Fission Cross Section and Capture Cross Section of ^{233}U in the Energy Range from Thermal to 150 eV," *J. Nucl. Sci. Technol., 31, 379 (1994).*
   Reich-Moore resonance parameters for ^{233}U were obtained by fitting selected experimental data in the energy range from thermal to 150 eV by means of SAMMY.

3) N. Yamamuro: "Activation Cross-Section Calculation on the Production of Long-Lived Radionuclides," *Nucl. Sci. Eng., 118, 249 (1994).*
   The calculated results are presented up to 20 MeV for production of long-lived radioactive nuclides ^{60}Co, ^{59}Ni, ^{63}Ni, ^{91}Nb, ^{94}Nb, ^{93}Mo, ^{99}Mo, ^{108m}Ag, ^{150m}Eu, ^{152}Eu, ^{158}Tb and ^{186m}Re.

4) S.Chiba, T. Fukahori, Y. Watanabe and Y. Koyama: "Evaluation of Neutron Cross Sections of ^{12}C up to 50 MeV," *JAERI-M 94-019, p.300 (1994).*
   The neutron cross sections of ^{12}C were evaluated in the energy range of 20 MeV to 50 MeV.

5) T. Kawano, N. Fujikawa and Y.Kanda: "Evaluation of ^{238}U Inelastic Scattering Cross Section," *JAERI-M 94-019, p.290 (1994).*
   A coupled-channel model was adopted for calculation of direct inelastic scattering. The calculated level excitation cross sections and the calculated DDX reproduce consistently the experimental data.

6) T. Kawano, K. Kamitsubo, T. Iwamoto and Y. Kanda: "Covariance Matrix Calculated from Nuclear Models," *JAERI-M 94-068, p.32 (1994).*
   A production method of a covariance matrix from a nuclear model calculation was described. The covariance matrices of $^{54, 56}Fe$ cross sections were calculated from the uncertainties of model parameters.

7) V.A. Konshin: "Consistent Calculations of Fast Neutron Induced Fission, (n,2n) and (n,3n) Cross Sections for 71 Isotopes of Th, Pa, U, Np, Pu, Am, Cm, Bk and Cf," *JAERI-research 94-010 (1995).*
   The neutron cross sections for fission, (n,2n) and (n,3n) reactions have been calculated for $^{227-234}Th$, $^{229-233}Pa$, $^{230-240}U$, $^{235-239}Np$, $^{236-247}Pu$, $^{239-245}Am$, $^{238-251}Cm$, $^{245-249}Bk$ and $^{249-252}Cf$ using the Hauser-Feshbach statistical model code STAPRE. Neutron transmission coefficients were calculated with the coupled-channel code ECIS.

8) S. Chiba, T. Fukahori, H.Takada, T.Maruyama, K. Nitta and A. Iwamoto: "Applicability of the Quantum Molecular Dynamics to Nucleon-Nucleus Collisions," *Proc. International Conf.*

on Nuclear Data for Science and Technology, Gatlinburg, Tennessee, May 9–13, 1994, Vol. 1, p.505 (1994).

It was found that results of the QMD can give a remarkable agreement with the data of the (N,xN') type reactions over the energy region from several tens MeV to several GeV.

9) S. Iwasaki and N. Odano: "Theoretical Model Calculation of Dosimetry Cross-Sections for Cobalt from Threshold Energy to 50 MeV," *ibid., Vol. 2, p.627 (1994).*

The cross sections of (n,2n), (n,3n), (n,4n), (n,p), (n,α), (n,2nα) and He production for Cobalt were calculated with GNASH.

10) T. Ohsawa and T. Shibata: "Evaluation of Fission Neutron Spectra for Minor Actinides," *ibid. Vol. 2, p.639 (1994).*

An evaluation method for fission neutron spectra was developed and applied to minor actinides. The present method was based on Madland-Nix model and combined with Ignatyuk model of the level density, Moriyama-Ohnishi model of the fission fragment mass distributions and the mass formula of Tachibana et al.

11) Y. Kikuchi: "JENDL-3 Revision-2 - JENDL-3.2," *ibid., Vol.2, p. 685 (1994).*

Main parts of revisions and results of preliminary benchmark tests of JENDL-3.2 were described.

12) T. Nakagawa and Y. Kikuchi: "JENDL Special Purpose Files," *ibid., Vol. 2, p.709 (1994).*

Status of JENDL special purpose files were reviewed.

13) M. Kawai, T. Nakagawa, S. Chiba, Y. Nakajima, T. Sugi, Y. Kikuchi, T. Watanabe, A. Zukeran and H. Matsunobu: "Revision of Fission Product Nuclear Data for JENDL-3.2," *ibid., Vol. 2, p.727 (1994).*

Reevaluation of the nuclear data for about 60 fission product nuclides were made for JENDL-3.2 taking account of new experimental data and results of integral tests for JENDL-3.1. Integral tests of the revised data were made with STEK experiments.

14) T. Fukahori, S. Chiba, Y. Kikuchi, M. Kawai and N. Kishida: "Status of Nuclear Data Evaluation for JENDL High Energy File," *ibid., Vol. 2, p.765 (1994).*

The present status of the JENDL High Energy File was reported. The PKA/KERMA File and the Photonuclear Data File were also introduced.

Work recently completed

1) The second Revision of JENDL-3 (JENDL-3.2)

JENDL-3.2 was released in June 1994, which provides the neutron induced reaction data for 340 nuclei in the energy range from 10^{-5} eV to 20 MeV. The data are available from OECD/NEA Data Bank, NNDC at BNL and IAEA Nuclear Data Section as well as Nuclear Data Center of JAERI.

2) N. Yamano and K. Ueki: "Validation of γ-Ray Production Data of Iron in JENDL-3.2 with Shielding Benchmark," submitted to *J. Nucl. Sci. Technol.* (1994)

An integral test of γ-ray production data of iron in JENDL-3.2 has been performed by means of a shielding benchmark analysis of KfK leakage neutron and γ-ray spectrum measurements from iron spheres with a ^{252}Cf source in the center. For comparison, analyses with JENDL-3.1, FENDL-1 and ENDF/B-IV have been also carried out. The calculation using JENDL-3.2 showed a good agreement with the experiment. It has been concluded that the γ-ray production data of iron in JENDL-3.2 were applicable for

shielding designs and analyses of the fission neutron source problem.

3) N. Yamamuro: "Cross Section Calculations for Neutron Induced Reactions up to 50 MeV," submitted to *Nucl. Sci. Eng.* (1995).
Cross sections were calculated for ^{24}Na production by ^{27}Al(n,α), ^{28,29}Al production by Si(n,Xnp), ^{27}Mg production by Si(n,Xn2p), ^{49,48}Cr production by ^{50}Cr(n,2n) and (n,3n), ^{52,53}V production by Cr(n,Xnp), ^{54,52}Mn production by ^{55}Mn(n,2n) and (n,4n), ^{51}Ti production by ^{55}Mn(n,pα), ^{62,61}Cu production by ^{63}Cu(n,2n) and (n,3n), ^{65}Ni production by ^{65}Cu(n,p), ^{62m}Co production by ^{65}Cu(n,α) and ^{63}Cu(n,2p), γ-ray production by Cr(n,Xγ), and H and He productions by structural materials.

Work in progress

1) Evaluation of JENDL Activation Cross Section File
Y. Nakajima et al.
Neutron activation cross sections have been evaluated on the basis of JENDL-3.2 and by SINCROS-II for the JENDL activation cross section file. The file contains 1,158 reactions for 225 nuclei, and will be released very soon.

2) Evaluation of Neutron Nuclear Data of ^{235}Np and ^{244}Pu
T. Nakagawa and V. Konshin
The evaluation was made in the neutron energy range from 10^{-5} eV to 20 MeV. Quantities evaluated are the total, elastic and inelastic scattering, capture, fission, (n,2n) and (n,3n) reaction cross sections, the angular and energy distributions of secondary neutrons, and number of fission neutrons. The results will be stored in JENDL Actinoid File.

Work about Codes

1) Y. Watanabe, M. Harada, Y. Koyama, H. Kashimoto, H. Shinohara and S. Chiba: "Calculations of Double Differential Particle Emission Cross Sections for Nucleon-Induced Reactions on ^{12}C and Carbon Kerma Factors Using A Monte Carlo Method," *Proc. International Conf. on Nuclear Data for Science and Technology, Gatlinburg, Tennessee, May 9-13, 1994, Vol. 1, p.574 (1994).*
A Monte Carlo based code was developed to calculate double differential particle emission cross sections of nucleon-induced reactions for ^{12}C.

Work planned for the Near Future

1) Evaluation of Neutron Nuclear Data of ^{246}Pu and ^{235}Np
T. Nakagawa and V. Konshin
The evaluation will be made in the neutron energy range from 10^{-5} eV to 20 MeV.

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1. Recent publications and reports

Low energy data:

1. J. Kopecky, H. Gruppelaar, A. Hogenbirk, H.A.J. van der Kamp and D. Nierop, "European Fusion File EFF-2.4: Final report on basic data file", ECN-report ECN-C–94-016, July 1994.

2. M. Uhl and J. Kopecky,"Gamma-ray strength function models and their parametrization", contribution to the IAEA consultants' Meeting on *Standard input data sets for nuclear model computations*, September 19-23, 1994, Cervia, Italy (ECN-report ECN-RX-099).

3. J. Kopecky and M. Uhl,"Present status of experimental gamma-ray strength functions", contribution to the NEA/ENEA and IAEA Specialists' Meeting on *Measurement, calculation and evaluation of photon production data*, November 9-17, 1994, Bologna, Italy (ECN-report ECN-RX-103).

4. A.J. Koning, A. Hogenbirk and H. Gruppelaar, "Inelastic neutron scattering from Pd Isotopes: Nuclear model calculations and update of the JEF-file for ^{110}Pd", ECN-report ECN-C–94-085, June 1994.

5. A.J. Koning and H. Gruppelaar, "Fluctuation factors in the ^{56}Fe file of EFF-3", EFF-DOC-341, December 1994.

High energy data:

6. A.J. Koning, "Review of intermediate energy nuclear reaction models for accelerator-based transmutation of radioactive waste", proceedings of the *8th Journees Saturne: Accelerators applied to the Nuclear Waste Problem*, 55-59, May 5-6 1994, Saclay, France (ECN-report: ECN-RX–94-033).

7. A.J. Koning, O. Bersillon and J.-P. Delaroche, "Quantum-mechanical direct, pre-equilibrium and equilibrium spectra up to 200 MeV", proceedings of the *International Conference on Nuclear Data for Science and Technology*, ed. J.K. Dickens, May 9-13 1994, Gatlinburg, Tennessee USA (ECN-report: ECN-RX–94-019).

8. A.J. Koning, "Present status of intermediate energy data evaluation for accelerator-based transmutation of radioactive waste", proceedings of the *International Conference on Nuclear Data for Science and Technology*, ed. J. K. Dickens, May 9-13 1994, Gatlinburg, Tennessee USA (ECN-report: ECN-RX–94-037).

9. A.J. Koning, O. Bersillon and J.-P. Delaroche, "Nuclear model calculations below 200 MeV and evaluation prospects", proceedings of the NEA Specialist Meeting on *Intermediate Energy Nuclear Data: Models and Codes*, 87-105, May 30-June 1 1994, Issy-les-Moulineaux, France (ECN-report: ECN-RX–94-068).

10. K. Abrahams, W.M.P. Franken, J.H. Bultman, J.A. Heil and A.J. Koning, "Specific contributions of the Dutch programme "RAS" towards accelerator-based transmutation", proceedings of the *International Conference on Accelerator-Driven Transmutation Technologies*, July 25-29 1994, Las Vegas, USA (ECN-report: ECN-RX–94-060).

11. A.J. Koning and J.M. Akkermans, "KAPSIES: A program for the calculation of multi-step direct reaction cross sections", Comput. Phys. Comm. 85 (1994) 110-126 (ECN-report: ECN-RX–94-078).

12. R. Bonetti, A.J. Koning, J.M. Akkermans and P.E. Hodgson: "The Feshbach-Kerman-Koonin multistep direct reaction theory", Phys. Rep. 247 no. 1, October 1994.

2. Work recently completed

- See above-mentioned publications and reports.
- Completion of the point-wise revision EFF-2.4 of the European Fusion File.
- Completion of activation cross section file EAF-4.0.
- Completion of the first version of the code system MINGUS for intermediate energy nuclear reactions.
- Completion of first pilot evaluated proton data file up to 200 MeV for ^{90}Zr and ^{208}Pb.
- Improvement of JEF-file for 110Pd.

3. Work in progress

- Inclusion of fluctuation factors in EFF-3 file for ^{56}Fe.
- In cooperation with J. Raynal (CEA): extension of coupled-channels code ECIS with the compound nuclear reaction mechanism.

4. Future plans

- Extension of code system MINGUS to lower energies (to make it suitable for low energy neutron evaluation activities).

- Improvement of inelastic scattering cross sections for fission products (JEF-update) with the new version of ECIS.
- Further studies on nuclear data needs for accelerator-based transmutation of radioactive waste.
- Creation of intermediate energy data file for ^{56}Fe (neutrons and protons) in the framework of NEA pilot evaluation.

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Activity: Investigation of preequilibrium effects in (n,xn), (n,xp) and (p,xn) reactions.

Facilities: HP-Apollo 720 work station.

Work in progress: Implementation of the model of gradual absorption, a phenomenon accompanying MSD reactions, in calculations of the MSC cross sections. Detailed account of collective contributions to neutron emission cross sections. Extended version of EMPIRE for calculation of MSC continuum cross sections and TYTUS for DWBA calculations of MSD continuum cross sections.

Publications:

– A. Marcinkowski, D. Kielan, Gradual absorption of fast neutrons in niobium, Nucl. Phys. A578 (1994) 168;
– D. Kielan, A. Marcinkowski, Cross sections for (n,p) reaction on ruthenium isotopes in terms of the novel multistep compound reaction model, Acta Phys. Pol. B25 (1994) 1219;
– A. Marcinkowski, Doorway states or gradual absorption, in *Proc. Int. Conf. on nuclear data for science and technology*, Gatlinburg, Tennessee, May 9–13, 1944, edited by K. Dickens (to be published by the American Nuclear Society).

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I. Recent Publications

1. M. Avrigeanu, V. Avrigeanu: "Energy-dependent single-particle state density effects in the hybrid model of pre-equilibrium nuclear reactions", *J.Phys. G: Nucl.Part.Phys.* **20**,613(1994)
2. V. Avrigeanu, P.E. Hodgson, M. Avrigeanu: "Global optical potentials for emitted alpha particles", *Phys. Rev. C* **49**, 2136 (1994)
3. M. Avrigeanu, A. Harangozo, V. Avrigeanu: "Realistic particle-hole state density effects in multistep reaction calculations", in *Proc. 7th Int. Conf. on Nuclear Reaction Mechanisms*, Varenna, Italy, June 6-11 1994, edited by E. Gadioli (Ricercha Scientifica ed Educazione Permanente, Suppl. 100, Milano, 1994), p. 165.

II. Work Recently Completed

1. M. Avrigeanu, P.E. Hodgson, V. Avrigeanu, A. Harangozo: "Statistical multistep and semiclassical calculations for neutron induced reactions on the titanium isotopes", in *Int. Conf. on Nuclear Data for Science and Technology*, Gatlinburg, May 9-13 1994, edited by K. Dickens (in press).
Particle-hole state densities using energy-dependent different single-hole/particle state densities as well as pairing- and shell-corrections ([1] above) have been used within both the geometry-dependent hybrid (GDH) semiclassical preequilibrium emission model and the Feshbach-Kerman-Koonin (FKK) quantum-mechanical theory. To enable correct interpretation of model parameters that enter into cross section calculations, consistent sets of input parameters – determined by means of various independent types of experimental data – have been used for unitary account of a whole body of related reaction data for isotope chains and neighboring elements (the $^{46-50}$Ti isotopes in this work).

2. V. Avrigeanu, P.E. Hodgson, M. Avrigeanu: "Alpha-particle mean field and statistical emission", *ibid.*
Generalized GDH precquilibrium (including J^{π}-conservation and α-particle) emission and Hauser-Feshbach-Moldauer model calculations (code STAPRE-H94) of fast neutron induced reactions on $^{46-50}$Ti, ^{51}V, ^{55}Mn and ^{59}Co isotopes were carried out consistently with similar work for all stable isotopes of Cr, Fe and Ni. The GDH local density approximation α-particle Fermi energy is found consistent with the respective optical model potential (OMP) [2].

3. M. Avrigeanu, A. Harangozo, V. Avrigeanu: "Surface effects in multistep reaction calculations", in *XIIIth Int. Workshop on Nuclear Theory*, Rila Mountains, Bulgaria, June 13-18 1994, and *Romanian J. Phys.* (in press).
The FKK theory formalism, using complete formulae for densities of accessible final states [3] as well as gradual absorption into successive quasibound states of increasing complexity (local versions of codes MUDIR and GAMME), has been extended to take into account the decreasing Fermi energy at the nuclear surface. Multistep direct and compound nucleon emission calculations have been carried out for 14 Mev neutrons on ^{46,48}Ti, ^{56}Fe and ^{93}Nb.

4. M. Avrigeanu, V. Avrigeanu: "Development of a computerized system for the storage, retrieval and optimization of optical model parameters", *IPNE-Bucharest Report NP-83-1994*, Oct. 1994.
Under the request of NDS/IAEA (TC No.7408) an OMP compilation format based on the EXFOR system, with essential text information being given in the first "subentry" properly keyworded while different potential types are included in subsequent subentries, was developed. Compilation of the α-particle OMP for A>100 (34 works) was carried out within this format. Alternatively, an extended version of the SCAT2 code subroutine SYSPOT including different parameter and volume integral energy dependences, was made.

III. Work in Progress

Completion of a code system FKK–STAPRE-H for the Feshbach-Kerman-Koonin theory analysis of reaction excitation functions.

Limit analysis of using energy-dependent single-particle state densities within the Williams formula of particle-hole state density; adoption of a two-component Fermi-gas particle-hole state density.

Calculation of (N,α) and (α,N) reaction cross-sections for astrophysics: study of the ^{40}Ar(p,α)^{37}Cl reaction and related fast neutron induced reaction cross sections.

IV. Work Planned for Near Future

Inclusion of the multiple preequilibrium emission within both the semiclassical and quantum mechanical models, to enable analysis of realistic particle-hole state densities at intermediate energies.

Preequilibrium and statistical model analysis of fast neutron reactions on the stable molybdenum isotopes up to 30 MeV.

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1. Recent publications

V.N. Manokhin, Systematics of the (n,2n) and (n,3n) reaction exitation functions, J., Yadernye Konstanty, 1994, v.1, p. 18 (in Russian).

V.N. Manokhin, Evaluation of the (n,2n) reactioncross section for scandium. J., Yadernye Konstanty, 1994, v.1, p.23 (in Russian).

K.I. Zolotarev, V.N. Manokhin, A.B. Pashchenko, Evaluation of the Pr-141(n,2n)Pr-140 reaction cross-section in the energy range from threshold up to 20 MeV. J., Yadernye Konstanty, 1994, v.2 (in Russion).

V.N. Manokhin, Evaluation of the Na-23(n,2n)Na-24 reaction cross sections. J., Yadernye Konstanty, 1994, v.3 (In Russion).

V.G. Pronjaev, Evaluation of the I-127 cross section for transport calculations in a large NaI-detectors. J., Yadernye Konstanty, 1994, v.3 (in Russion).

A.I. Blokhin et al., Atlas of photon energy-angular distributions produced in neutron interactions. J., Yadernye Konstanty, 1993, v.2, p.3.

2. Work in progress

Evaluation of As-75(n,2n)AS-74 reaction exitation function.
Evaluation of cross-sections for Ni-isotopes.
Evaluation of threshold reaction cross-sections for gas production file.
Cross-section evaluation for the zinc isotopes.
Evaluation of Pa-231 neutron cross-section for Brond-2.
Evaluation of gamma-ray production data for Bi-209 and for the lead isotopes.

3. Data library released

ADL-3, the Russian neutron activation data library was completed in Nov. 1993, containing 20 049 excitation functions in ENDF format. The index was published in Yadernye Konstanty, Issue 3-4, 1993, with a brief introductiion in Russian.

Authors: O.T. Grudzevich, A.V. Zelenetskij, A.V. Ignatjuk, A.B. Pashchenko.

The ADL-3 library is available from the IAEA Nuclear Data Section.

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A cross-section library "WIND" for Waste Incineration Nuclear Data has been elaborated containing data for 576 neutron reactions on isotopes of U, Np, and Pu in the energy range from 0 to 100 MeV. It also contains a first set of proton induced reactions on U-238 up to 100 MeV. The data are in ENDF format with special assignment of MT numbers for the various reactions.

Reference: Kerntechnik vol 59 p. 87 (1994).

The WIND library is available from the IAEA Nuclear Data Section.

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Recent Publications:

1. A. Balanda, J.C.S. Bacelar, **E. Běták**, J.A. Bordewijk, A. Krasznahorkay, H. van der Ploeg, R.H. Siemssen, H.W. Wilschut, A. van der Woude:
Photons in the proton induced reaction with In at $E_p = 50$ MeV.
Nucl. Phys. *A575* (1994), 348–360

2. **E. Běták:**
Hard gammas from low-energy heavy-ion collisions.
Acta Phys. Slov. *44* (1994), 69–73

3. **E. Běták, P. Obložinský:**
Spin effects in the pre-equilibrium decay.
in 7th International Conference on Nuclear Reaction Mechanisms, Varenna 1994. Ed. E. Gadioli. [Univ. Milano, 1994], p. 186–195

4. M.B. Chadwick, **P. Obložinský:**
Continuum angular distributions in preequilibrium nuclear reactions: Physical basis for Kalbach systematics.
Phys. Rev. *C50* (1994) 2490–2493

5. M.B. Chadwick, P.G. Young, **P. Obložinský**, A. Marcinkowski:
Preequilibrium spin effects in Feshbach-Kerman-Koonin and exciton models and application to high-spin isomer production.
Phys. Rev. *C49* (1994), R2885–R2889

6. **S. Hlaváč, P. Obložinský**, I. Turzo, L. Dostál, J. Kliman:
Cross sections of the ^{16}O(n,$\alpha\gamma$) reaction at 14.7 MeV.
Report INDC(SLK)-002 [IAEA Vienna 1994]

7. M. Pachr, M. Šumbera, A. Kugler, V. Wagner, **S. Hlaváč**, R.S. Simon:
Neutron emission in Bi+Pb collisions at 1 GeV/u
Acta Phys. Slov. *44* (1994), 35–41

Work Recently Completed and in Progress:

1. F. Cvelbar, **E. Běták**, A. Likar:
Pre-equilibrium and direct–semi-direct model calculations of nucleon radiative capture excitation functions on heavy nuclei.
J. Phys. G *(in press)*

2. **S. Hlaváč, P. Obložinský**, I. Turzo, L. Dostál, H. Vonach, A. Pavlik, S. P. Simakov:
Study of γ radiation from interaction of 14.7 MeV neutrons with ^{208}Pb.
Nucl. Sci. Eng. *(in press)*

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I. RECENT PUBLICATIONS

1. Dispersive Correction to the $p + {}^{16}O$ Optical Model and the Effective Nucleon-Nucleon Potential. By G. Pantis, S.A. Sofianos, H. Fiedeldey, R. Lipperheide and P.E. Hodgson. *Nucl. Phys.* **A559**, 266, 1993.
2. The Microscopic Alpha-Alpha Potential. By S.A. Sofianos, K.C. Panda and P.E. Hodgson. *J. Phys.* **G19**, 1929, 1993.
3. Analysis of the Multistep Direct Component of 14 MeV. Neutron Inelastic Scattering. By P. Demetriou, P. Kanjanarat and P.E. Hodgson. *J. Phys.* **G19**, L193, 1993.
4. Alpha-Particle Momentum Distributions in Nuclei within the Coherent Density Fluctuation Model. By A.N. Antonov, E.N. Nikolov, I.Zh. Petkov, P.E. Hodgson and G.A. Lalazissis. *Bulgarian J. of Phys.* **19**, 11, 1992.
5. Intercomparison of FKK Model Codes for One-Step Direct Reaction Calculations. By Y. Watanabe, M. Avrigeanu and W.A. Richter. Oxford Report OUNP–93–30.
6. Pre-equilibrium (p, p') Measurements and Calculations for ${}^{90}Zr$ and Neighbouring Nuclei for incident energies up to 200 MeV. By W.A. Richter, A.A. Cowley, G.C. Hillhouse, J.A. Stander, J.W. Koen, S.W. Steyn, R. Lindsay, R.E. Julies, J.J. Lawrie, J.V. Pilcher and P.E. Hodgson, *Phys. Rev.* **C49**, 1001, 1994.
7. Global Optical Potentials for Emitted Alpha-Particles. By V. Avrigeanu, P.E. Hodgson and M. Avrigeanu, *Phys. Rev.* **C49**, 2136, 1994.

Contributions to the International Conference on Nuclear Data for Science and Technology, May 9—13, 1994. Gatlinburg, USA:

8. Statistical Multistep and Semi-Classical Calculations for Neutron Induced Reactions on the Titanium Isotopes. By M. Avrigeanu, P.E. Hodgson and V. Avrigeanu. Paper A18.
9. FKK Analysis of 14.1 MeV Neutron Inelastic Scattering. By P. Demetriou, P. Kanjanarat and P.E. Hodgson. Paper A22.
10. Alpha-Particle Mean Field and Statistical Emission. By V. Avrigeanu, P.E. Hodgson and M. Avrigeanu. Paper B12.
11. Measurement of Double Differential Charged-Particle Emission Cross-Sections for Reactions Induced by 26 MeV Protons and FKK Model Analysis. By Y. Watanabe, A. Aoto, H. Kashimoto, S. Chiba, T. Fukahori, K. Hasegawa, M. Mizumoto, S. Meigo, M. Sugimoto, Y. Yamanouti, N. Koori, M.B. Chadwick and P.E. Hodgson. Paper C26.
12. Pauli-Blocking Effects in Neutron-Alpha Reactions. By M. Avrigeanu, V. Avrigeanu, A.N. Antonov, M.B. Chadwick, P.E. Hodgson and M.V. Stoitsov. Paper C39.

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13. Multistep Processes in Nuclear Reactions: The Feshbach-Kerman-Koonin Theory. By H.B. Olaniyi and P.E. Hodgson. *Romanian J. Phys.* **38**, 371, 1993.
14. New Effective Internucleon Forces in Microscopic α-cluster Model. By A. Tohsaki. *Phys. Rev.* **C49**, 1814, 1994.
15. Effect of Nucleon Correlations on Natural Orbitals. By A.N. Antonov, D.N. Kadrev and P.E. Hodgson. *Phys. Rev.* **C50**, 164, 1994.

16. Alpha-Particle Mean Field and Statistical Emission. By V. Avrigeanu, P.E. Hodgson and M. Avrigeanu. IPNE Report. Bucharest 1994.
17. Statistical Multistep and Semi-Classical Calculations for Neutron-Induced Reactions on the Titanium Isotopes. By M. Avrigeanu, P.E. Hodgson, V. Avrigeanu and A. Harangozo. IPNE Report. Bucharest 1994.
18. Pre-Equilibrium (p, alpha) Calculations with the Multistep Direct Feshbach-Kerman-Koonin Theory. By H.B. Olaniyi, P. Demetriou and P.E. Hodgson. Contributed paper 53 to "Cluster 94". Strasbourg, France 1994.
19. The Nucleon Optical Model. By P.E. Hodgson. Pp 421. World Scientific.
20. A Survey of Alpha-Clustering. By P.E. Hodgson. *Z. Phys.* **A349**, 197, 1994.
21. The Feshbach-Kerman-Koonin Multistep Direct Reaction Theory. By R. Bonetti, A.J. Koning, J.M. Akkermans and P.E. Hodgson. *Phys. Rep.* **247**, 1, 1994.
22. FKK Analysis of Nucleon-Induced Reactions. By P. Demetriou, P. Kanjanarat, P.E. Hodgson and H.B. Olaniyi. Proc. 7th Int. Conf. on Nuclear Reaction Mechanisms. Varenna, June 6–11 (Ed. E. Gadioli), 155, 1994.
23. Alpha-Particle Reactions. By P.E. Hodgson. Proc. 7th Int. Conf. on Nuclear Reaction Mechanisms. Varenna, June 6–11 (Ed. E. Gadioli), 379, 1994.
24. Natural Orbitals and Short-Range Correlations in Nuclei. By A.N. Antonov, M.V. Stoitsov, S.S. Dimitrova, D.N. Kadrev, M.K. Gaidarov and P.E. Hodgson. Proc. 7th Int. Conf. on Nuclear Reaction Mechanisms. Varenna, June 6–11 (Ed. E. Gadioli), 411, 1994.
25. FKK Analysis of 14 MeV Neutron-Induced Reactions. By P. Demetriou, P. Kanjanarat and P.E. Hodgson. *J. Phys.* **G20**, 1779, 1994.
26. Dispersion Relation Analysis of the Elastic Scattering of Alpha-Particles by ^{40}Ca. By W. Haider and P.E. Hodgson. *Acta Physica Slovaca* 44, 481, 1994.
27. Feshbach-Kerman-Koonin Model Analysis of Pre-Equilibrium (p,p') and (p,n) Reactions at Low Incident Energies. By Y. Watanabe, A. Aoto, H. Kashimoto, S. Chiba, T. Fukahori, K. Hasegawa, M. Mizumoto, S. Meigo, M. Sugimoto, Y. Yamanouti, N. Koori, M.B. Chadwick and P.E. Hodgson. JAERI Report, 27, 1993.

II. WORK RECENTLY COMPLETED AND IN PROGRESS

1. Study of Possible Asymmetry in Compound Nucleus Reactions

(P. Demetriou)

Some investigation on the asymmetry of the experimental data at the evaporation energy region has been carried out after recent publications (Kun, 1993) arguing in favour of spin correlations in the evaporation process. Various checks on the experimental data available at these low outgoing energies (Takahashi *et al*, 1992; Baba *et al*, 1988; Marcinkowski *et al*, 1989; Vonach *et al*, 1991) seem not to be conclusive since the systematic errors in this region are always very large and undeterminable due to the measurement difficulties and contamination from source neutrons at these low energies and forward angles. Calculations of ratios of forward/backward cross-sections indicate symmetry within the uncertainties.

2. Preequilibrium (N,α) Cross Section using FKK Formalism

(H.B. Olaniyi, P. Demetriou and P.E. Hodgson)

The Feshbach, Kerman and Koonin formalism of preequilibrium multistep direct (MSD) reaction was applied to (nucleon, alpha) reaction. A cluster model, in which a preformed alpha in a bound shell model state was knocked out by a nucleon, was assumed. The (p,α) data of Ferrero *et al* on ^{93}Nb, ^{118}Sn and ^{165}Ho at an incident energy of 44 MeV were analysed using zero-range, Yukawa (range=1.0fm) and Gaussian (range=1.7fm) forms of nucleon-alpha potential. The cross section due to the first and second stage processes were calculated.

The experimental data were analysed using the subtraction method of Demetriou *et al.* The three forms of potential were found to fit the data well. The optical potential of McFadden and Satchler and of Avrigeanu *et al* were used to calculate the distorted waves of the ejected alpha particle. The contribution to the cross section from the second stage MSD process involving the (p,p'), (p',α) sequence was calculated. It was found to be at least two orders of magnitude smaller than contribution from the first stage process and so was not included in the fit.

3. Global Optical Potentials for Emitted Alpha-Particles

(V. Avrigeanu, P.E. Hodgson and M. Avrigeanu)

A set of global optical potentials for alpha-particles with energies above 80 MeV has been extended to lower energies and proved appropriate to describe (n,α) reactions. It is found that the transmission coefficients for alpha-particle emission can fit fusion cross sections and elastic scattering at energies above 80 MeV, but not elastic scattering at lower energies where the optical potential is sensitive to specific features of the target nucleus.

4. Pauli-Blocking Effects in Neutron-Alpha Reactions

(M. Avrigeanu, V. Avrigeanu, A.N. Antonov, M.B. Chadwick, P.E. Hodgson and M.V. Stoitsov)

A model of (n,α) knockout reactions in which the restriction on the available phase space for the four nucleons of the alpha-particle after the knockout is imposed by the Pauli-blocking function is developed and applied to calculate of the excitation functions of (n,α) reactions on ^{48}Ti, ^{51}V, ^{52}Cr, ^{54}Fe, ^{55}Mn and ^{59}Co nuclei. It is shown that the Pauli-blocking effects are important for the explanation of the cross sections of (n,α) reactions.

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The Nuclear Theory and Applications Group at Los Alamos is involved in the evaluation and calculation of nuclear data for applications, as well as the development of nuclear theory and models for this purpose.

I. Recent Publications and Reports

T. Hoch, D. Madland, P. Manaleus, T. Mannel, B. A. Nikolaus, and D. Strottman, "Relativistic Interactions and Realistic Applications," *Physics Reports* **242**, 253 (1994).

T. R. England and B. F. Rider, "Evaluation and Compilation of Fission Product Yields-1993," LA-UR-94-3106 (ENDF-349), Oct. 1994.[Note: this is a comprehensive document available on the Internet node t2.lanl.gov under directory "yields." The node accepts anonymous ftp using e-mail addresses as a password. The appendices document evaluated yields for ENDF/B-VI and contain all compiled, published data from 1939-1993.]

R. E. Shamu and P. G. Young, "Coupled-Channels Optical-Model Analysis of n-^{208}Pb Scattering at Low Energies," *J. Phys. G: Nucl. Part. Phys.* **19**, L169 (1993).

M. B. Chadwick, P. G. Young, P. Oblozinsky, and A. Marcinkowski, "Preequilibrium Spin Effects in Feshbach-Kerman-Koonin and Exciton Models and Application to High-Spin Isomer Production," *Phys. Rev. C* **49**, R2885 (1994).

M. B. Chadwick, P. G. Young, D. C. George and Y. Watanabe, "Multiple Preequilibrium Emission in the Feshbach-Kerman-Koonin Analyses," *Phys. Rev. C* **50**, 996 (1994).

H. Vonach, A. Pavlik, M. B. Chadwick, R. C. Haight, R. O. Nelson, S. A. Wender, and P. G. Young, "^{207,208}Pb(n,xnγ) Reactions for Neutron Energies up to 200 MeV," *Phys. Rev. C* **50**, 1952 (1994).

M. B. Chadwick, M. Gardner, D. Gardner, O. T. Grudzevich, A. V. Ignatyuk, J. W. Meadows, A. Pashchenko, N. Yamamuro, and P. G. Young, "Intercomparison of Theoretical Calculations of Important Activation Cross Sections for Fusion Reactor Technology," Proc. IAEA 2nd Research Coordination Meeting of the Coordinated Research Program on *Activation Cross Sections for the Generation of Long-Lived Radionuclides,* San Diego, CA, 29-30 April 1993 (LA-UR-93-3633);IAEA Report INDC(NDS)-286 (1993), page 123, edited by A.B. Pashchenko, Vienna.

G. M. Hale, P. G. Young, M. B. Chadwick, and Z.-P. Chen, "R-Matrix Analysis for Nitrogen and Oxygen," Proc. 8th International Conference on *Radiation Shielding*, Arlington, Texas, April 24-28, 1994, to be published by the American Nuclear Society (LA-UR-94-384).

M. B. Chadwick, P. G. Young, and F. S. Dietrich, "Progress in Applying the FKK Multistep Reaction Theory to Intermediate-Energy Data Evaluation" (invited), Proc. OECD Nuclear Energy Agency Specialists Meeting on *Intermediate Energy Nuclear Data*, May 30 - June 1, 1994, Issy-les-Moulineaux, France, [Pub. OECD Paris, 1994] p. 67.

P. G. Young and M. B. Chadwick, "Calculation of Proton and Neutron Emission Spectra from Proton Reactions with ^{90}Zr and ^{208}Pb to 160 MeV with the GNASH Code" (invited), Proc. OECD Nuclear Energy Agency Specialists Meeting on *Intermediate Energy Nuclear Data*, May 30 - June 1, 1994, Issy-les-Moulineaux, France, [Pub. OECD Paris, 1994] p. 49. (LA-UR-94-1830).

E. D. Arthur, W. B. Wilson, and P. G. Young, "Nuclear Data Needs for Accelerator-Driven Transmutation Systems" (invited), Proc. OECD Nuclear Energy Agency Specialists Meeting on *Intermediate Energy Nuclear Data*, May 30 - June 1, 1994, Issy-les-Moulineaux, France, [Pub. OECD Paris, 1994] p. 363. (LA-UR-94-1908).

P. G. Young, W. B. Wilson, and M. B. Chadwick, "Nuclear Data Requirements for Accelerator-Driven Transmutation Systems," Proc. International Conference on *Accelerator-Driven Transmutation Technologies and Applications*, July 25-29, 1994, Las Vegas, Nevada (LA-UR-94-1565), to be published.

P. G. Young, "Experience at Los Alamos with Use of the Optical Model for Applied Nuclear Data Calculations," Proc. Int. Atomic Energy Agency 1st Research Coordination Meeting on Development of Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data, Cèrvia, Italy, 19-23 September 1994 (LA-UR-94-3104).

W. B. Wilson, T. R. England, D. C. George, D. W. Muir and P. G. Young, "Recent Development of the CINDER'90 Transmutation Code and Data Library for Actinide Transmutation Studies," submitted to the Global 95 International Conference on Evaluation of Emerging Nuclear Fuel Cycle Systems, 11-14 September 1995, Versailles, France.

P. G. Young and M. B. Chadwick, "Radioactive Nuclide Production and Isomeric State Branching Ratios in p + W Reactions to 200 MeV," submitted to the Global 95 International Conference on Evaluation of Emerging Nuclear Fuel Cycle Systems, 11-14 September 1995, Versailles, France.

The following papers were published in the proceedings of the Int. Conf. on *Nuclear Data for Sci. and Tech.*, 9-13 May 1994, Gatlinburg, Tenn. [Ed: J, K. Dickens, Publ: Amer. Nucl. Soc. (1994)]:

P. G. Young and M. B. Chadwick, "Improvements to the Nuclear Model Code GNASH for Cross-Section Calculations at Higher Energies," p. 582.

S. M. Sterbenz, F. B. Bateman, T. M. Lee, R. C. Haight, Rc C. Goeckner, C. E. Brient, S. M. Grimes, H. Vonach, P. Maier-Komor, P. G. Young, and M. B. Chadwick, "The $^{56}Fe(n,x\alpha)$ Reaction from Threshold to 30 MeV," p. 318.

F. Goeckner, S. M. Grimes, C. E. Brient, T. M. Lee, S. M. Sterbenz, F. B. Bateman, R. C. Haight, P. G. Young, M. B. Chadwick, O. A. Wasson, and H. Vonach, "The $^{59}Co(n,\alpha)$ Reaction from Threshold to 30 MeV," p. 607.

H. Hitzenberger, A. Pavlik, H. Vonach, , M. B. Chadwick, R. C. Haight, R. O. Nelson, and P. G. Young, "Study of ^{27}Al (n,xγ) Reaction up to E_n = 400 MeV," p. 367.

G. M. Hale, P. G. Young, and M. B. Chadwick, "Cross Sections for n+^{14}N from an R-Matrix Analysis of the ^{15}N System," p. 607.

A. Pavlik, H. Vonach, M. B. Chadwick, R. C. Haight, R. O. Nelson, S. A. Wender, P. G. Young, $^{207,208}Pb$(n,xnγ) Reactions for Neutron Energies up to 200 MeV," p. 363.

M. B. Chadwick, M. Blann, G. Reffo, and P. G. Young, "Model Calculations of Nuclear Data for Biologically-Important Nuclei," p. 658.

R. W. Roussin, P. G. Young, and R. D. McKnight, "Current Status of ENDF/B-VI," p. 692.

D. C. George, R. J. LaBauve, and P. G. Young, "A Los Alamos Multigrouped Activation File," p. 718.

D. G. Madland, "Calculation of Prompt Fission Neutron Spectra and Average Prompt Neutron Multiplicities for the Spontaneous Fission of the Even Isotopes of Plutonium" p. 532.

D. W. Muir and W. B. Wilson, "Validation of a Large Activation Cross-Section Library," p. 772.

G. Reffo, M. B. Chadwick, A. V. Ignatyuk, J. Kopecky, D. W. Muir, P. Oblozinsky, and A. Pashchenko, "Development of a Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data," p. 604.

G. M. Hale and T. L. Talley, "Cross Sections and Spectra for Charged-Particle Induced Reactions," p. 403.

J. E. White, R. Q. Wright, D. T. Ingersoll, R. W. Roussin, N. M. Greene, and R. E. MacFarlane, "VITAMIN-B6: A Fine-Group Cross Section Library Based on ENDF/B-VI for Radiation Transport Applications," p. 733.

R. E. MacFarlane, "Energy Balance of ENDF/B-VI," p. 780.

R. E. MacFarlane, "Data Testing of ENDF/B-VI," p. 786.

D. J. Pullen, J. M. Campbell, G. P. Couchell, S. Li, H. V. Nguyen, W. A. Schier, E. H. Seabury, S. V. Tipnis, and T. R. England, " High Resolution Gamma-Ray Spectra for $^{235}U(n_{th},ff)$," p. 962.

G. P. Couchell, J. M. Campbell, S. Li, H. . Nguyen, D. J. Pullen, W. A. Schier, E. H. Seabury, S. V. Tipnis, and T. R. England, "A Study of Gamma-Ray and Beta-Particle Decay Heat Following Thermal Neutron Induced Fission of ^{235}U," p. 966.

W. A. Schier, J. M. Campbell, G. P. Couchell, S. Li, H. V. Nguyen, D. J. Pullen, E. H. Seabury, S. V. Tipnis, and T. R. England, "Energy Distributions of Gamma and of Beta Decay Heat as Function of Decay Time for ^{238}U(n,f)," p. 970.

J. L. Ullmann, P. Staples, G. Butler, M. Fowler, A. Gavron, R. Gritzo, D. Jagnow, J. D. King, R. Laird, P. W. Lisowski, D. Mayo, R. O. Nelson, L. Waters, S. A. Wender, J.

Wilhelmy, W. B. Wilson, M. A. Yates, and C. Zoeller, "Thick Target Spallation Product Yields from 800 MeV Protons on Tungsten," p. 274.

II. Work Recently Completed

Extension of ^{27}Al + n evaluation to 40 MeV for ENDF/B-VI, Release 3.

Extension of ^{2}H + n evaluation to 100 MeV for ENDF/B-VI, Release 3.

See publications.

III. Work in Progress

Extension of ENDF/B/VI evaluations of neutron reactions on ^{56}Fe, ^{59}Co, and ^{208}Pb to 40 MeV.

IV. Work Planned for the Future

Theoretical analyses and evaluations will continue for materials not included in the first issue of ENDF/B-VI.

Model and nuclear theory development effort into the medium-energy range will continue. We plan to begin developing evaluated data libraries up to the 150 MeV region.

Full Hauser-Feshbach calculation of neutron and gamma-ray spectra from fission.

Continuing work on activation, actinide and fission-product decay and yield data, and data testing.

V. Work on Codes

CINDER'90: expanded capabilities and libraries for various CINDER version using ENDF/B-VI data.

GNASH and FKK-GNASH: being utilized for incident nucleon energies to 200 MeV in analyzing WNR measurements to improve modeling capabilities at higher energies. We plan to develop a user friendly version of GNASH that will include built-in parameterizations and that can be used to calculate cross sections for large transmutation libraries.

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I. Recent Publications and Reports

The ENDF-202 Data Formats and Procedures Manual for the Evaluated Nuclear Data File ENDF-6 has been prepared in electronic format and will be available online in 1995.

II. Work Recently Completed

18 new materials for the Incident-Neutron Sublibrary and 12 materials for the Thermal Neutron Scattering Sublibrary have been reviewed and corrected; they will be issued as ENDF/B-VI, Release 3, in the spring of 1995.

III. Status of ENDF Codes

The ENDF Utility codes release, version 6.9, was completed and distributed. These programs are written to process ENDF-6 formatted files, including all formats approved through the October 1993 CSEWG Meeting with the exception of the generalized R-Matrix resonance region format and the generalized format for covariances (file 30). This release contains mainly corrections to Version 6.8.

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1. Selected meetings and resulting reports:

- Development of an International Nuclear Decay Data and Cross-Section Database, Vienna, 24-28 Oct. 1994. Summary report of the meeting: INDC(NDS)-328. Papers presented at the meeting: INDC(NDS)-329.

  Note: The meeting agreed on a mechanism to obtain international approval for new evaluations of

  - half-lives of nuclear ground states and isomers, and related decay data such as emission probabilities and energies, and branching ratios.

  - thermal neutron cross-sections, resonance integrals, Westcott g-factors.

  Authors of such evaluations are invited to submit their results with documentation to the IAEA Nuclear Data Section (H.D. Lemmel).

- Comparison of neutron activation cross-section measurements, and experimental techniques. (The results will be used for improving the FENDL/A library.) St. Petersburg, Russia, 7-9 Sept. 1994, report INDC(NDS)-319

- Establishment of an international reference data library of nuclear activation cross-sections, Debrecen, Hungary, 4-7 Oct. 1994, report INDC(NDS)-320.

- Development of reference input parameter library for nuclear model calculations of nuclear data, Cervia, Italy, 19-23 Sept. 1994, report INDC(NDS)-321.

- Improvement of measurements, theoretical computations and evaluations of neutron-induced He-production cross-sections, Beijing, China, 1-4 Nov. 1994, report INDC(NDS)-323.

- Measurement, calculation and evaluation of photon production data, Bologna, Italy, 14-17 Nov. 1994, report INDC(NDS)-330.

- Compilation and evaluation of fission yield nuclear data, Vienna, 17-19 Oct. 1994, report in preparation.

2. Data libraries and related publications:

For details see

- IAEA Nuclear Data Newsletter No. 19 (Sept. 1994), including new nuclear data libraries received; recent INDC reports and other publications; index to the Russian series "Yadernye Konstantye"; how to access NDIS, the online Nuclear Data Information System, and how to use the FTP data file transfer. Contact us, if you are not yet on the Newsletter distribution list.

- Index to nuclear data libraries available from the IAEA/Nuclear Data Section. Document IAEA-NDS-7 Rev. 94/11.

- Joint index to BROND-2.1, CENDL-2 (update 93), ENDF/B-6 (update 93), JEF-2.2, JENDL-3.2 (94), IRDF-90 (update 93). Document IAEA-NDS-107 Rev. 9 (94/7).

- Progress in fission product nuclear data, issue 14, report INDC(NDS)-304.

3. FENDL: evaluated nuclear database for fusion

(contact: A.B. Pashchenko)

The data base "FENDL-1" was completed. For a summary of files see next page.

Meetings related to FENDL:

- on "Uncertainty files and improved multigroup cross-section files", JAERI, Japan, 8-12 Nov. 1993, report INDC(NDS)-297.

- on "Improved evaluations and integral data testing", Garching, Germany, 12-16 Sept. 1994, report INDC(NDS-312.

- on "Preparation of fusion benchmarks for nuclear data validation", Vienna, 13-16 Dec. 1993, report INDC(NDS)-298.

- on "Evaluation of charged particle and photonuclear data", Smolenice, Slovakia, 18-21 April 1994, report INDC(NDS)-306.

FENDL SUMMARY

FENDL, the evaluated nuclear database for fusion applications, has been completed. Its present version consists of the following sublibraries. At the ITER neutronics coordination meeting in San Diego, Feb. 1995, the ITER participants agreed to use FENDL in all design calculations.

1. **FENDL/A-1.1** (April 93): neutron activation cross-sections, selected from different available sources, for 636 nuclides, given in four representations:
   - "point data", i.e. cross-sections as function of energy in ENDF-6 format
   - "FENDL/G": VITAMIN-J 175 group data using a flat weighting spectrum
   - "FENDL/A-MCNP": processed into the format for input to the MCNP Monte-Carlo transport code
   - "FENDL/A-175G": VITAMIN-J 175 group data using the VITAMIN-E weighting spectrum for input to the code REAC*2/3

2. **FENDL/C-1.0** (Nov. 91): data for the fusion reactions D(d,n), D(d,p), T(d,n), T(t,2n), He-3(d,p) extracted from ENDF/B-6 and processed

3. **FENDL/D-1.0** (Jan. 92): nuclear decay data for 2900 nuclides in ENDF-6 format, extracted from ENDF/B-6 and ENSDF

4. **FENDL/DS-1.0** (Oct. 93): neutron activation data for dosimetry by foil activation. This is identical with file 1 (neutron activation cross-sections) of the International Reactor Dosimetry File IRDF-90 version 2 of Oct. 1993, given as multigroup data in 640 group extended SAND-2 format, without covariance data.

5. **FENDL/E-1.0** (Nov. 94): data for coupled neutron-photon transport calculations, including
   - a data library for neutron interaction and photon production for 63 elements or isotopes, selected from ENDF/B-6, JENDL-3, or BROND-2
   - a photon-atom interaction data library for 34 elements taken from ENDF/B-6

   These are available in three representations:
   - original ENDF-6 format, as above, with resonance-parameters where applicable
   - "FENDL/MG" (Nov. 94): processed by NJOY into multigroup data in MATXSR format
   - "FENDL/MC" (Nov. 94): processed into the format needed for input to the Monte Carlo code MCNP4A

FENDL BENCHMARK

The FENDL/BENCHMARKS file contains compiled fusion benchmark descriptions and data contributed by different institutes.

INTERNET/FTP online access to FENDL files

The FENDL data files can be electronically transferred to users from the IAEA Nuclear Data Section online system through INTERNET from NDS open area 'FENDL'.

OECD - NEA Data Bank

A. JEF (Joint Evaluated File) project

A.1 Release Status of JEF-2-2

The JEF-2.2 library is now frozen and freely available. It consists of the following five sublibraries :

(Tapes 1 - 9)	General Purpose file (parameter file)	(Dist - Jan 92)
(Tapes 11 - 19)	General Purpose file (pointwise file)	(Dist - Apr 95)
(Tape 21)	Thermal Scattering Law Data	(Dist - Nov 92)
(Tape 22)	Radioactive Decay Data	(Dist - Jul 93)
(Tape 24)	Fission Product Yields Data	(Dist - Jun 93)
(Tape 25)	Photo-Atomic Interaction Data	(Dist - Aug 90)

An index to the exact contents of each of these sublibraries is provided in *JEF NEWS no 7.*

A.2 Validation of JEF-2.2

General Purpose file :

An extensive programme of benchmark testing of the JEF-2.2 data has been undertaken during the past two years. The general purpose file has been validated both for thermal and fast reactor applications, as well as for many other special applications, such as radiation shielding including a special emphasis on the major structural materials. Overall, the library has performed well in both the thermal and fast energy ranges [JEF/DOC-478], but there are still areas in need of further benchmarking activities, e.g., for thermal absorbers, fission products and minor actinides. In addition, calculational benchmarks have been carried out to investigate the influence of the choice of calculational models on the final validation results [JEF/DOC- 496].

Detailed results from all of these benchmark testing activities have been extensively documented in the JEF/DOC series of documents which catalogue the papers presented at the bi-annual meeting of the JEF Working Groups on Benchmark Testing, Data Processing and Evaluations.

Special Purpose sublibraries :

The JEF-2.2 Radioactive Decay data and Fission Product Yields sublibraries were frozen and released in the summer of 1993.

Although these special purpose files have not benefited from the same level of benchmark testing and validation as the general purpose library, some important generic conclusions relating to these libraries are given in the Feedback List, which will henceforth be published in each edition of *JEF NEWS*.

A.3 Derived files

Tapes 11-19 contain the JEF-2.2 General Purpose library in pointwise format at a temperature of 0 K (reconstructed from Tapes 1- 9 using NJOY-94.0).

Also available are two sets of pointwise data at 293.16 K ; the first has been generated using the PRE-PRO 94 suite of codes (LINEAR, RECENT and SIGMA1), and the second was generated using NJOY91.91

Multigroup data will be generated during the course of 1995.

A.4 Recent JEF publications

JEF Report 13

This publication contains information from the JEF-2.2 Radioactive Decay and Fission Product Yields data sublibraries, in the form of four tables showing ; origin of the JEF-2.2 radioactive decay data and subsequent modifications ; summary of the JEF-2.2 radioactive decay data file ; main decay and fission yield data from the JEF-2.2 Fission Product Yields sublibrary ; a comparison of the main decay parameters from the JEF-2.2, ENDF/B-VI and JNDC-2.0 libraries.

JEF Report 14

This report contains an intercomparison of simple integral neutron cross section data from JEF-2.2, ENDF/B-VI, JENDL-3.2, BROND-2 and CENDL-2, including thermal cross section data (2200 m/s and Maxwellian averaged cross sections and resonance integrals) and fast cross section data (14 MeV and fission averaged cross sections).

JEF-PC (Electronic publication)

This self-contained PC package provides, in a use-friendly manner, the ability to display selected data from the JEF-2.2 library in both numerical and graphical form. No experience or familiarity with evaluated data formats is required; a display of the "Chart of the Nuclides" is used as the interface for the selection of specific nuclides and the corresponding data.

Data contained in JEF-PC includes; neutron cross section data in a groupwise format; radioactive decay data such as half-life, spin, decay modes, Q-values, branching ratios,

emission lines and spectra ; and independent and cumulative fission yields. Additional pointwise neutron cross section data, taken from JEF-2.2 , ENDF/B-VI and JENDL-3.2, are provided on CD-ROM.

JEF News no. 7

A newsletter reporting on the status of the JEF library and other recent events pertaining to the JEF project. Also included is the information on the status of other evaluated projects and the activities of the NEANSC International Evaluation Cooperation. Exceptionally, issue no.7 of this newsletter also contains complete listings for ; (a) the contents of each of the JEF sublibraries by isotopes, (b) titles of documents in the JEF/DOC series , (c) titles of the reports in the JEF Report series.

A.5 Future Plans - JEFF-3

A close cooperation has always existed between the JEF and EFF projects. A decision was taken at the last meeting of the JEF Scientific Coordination Group to initiate work on a common JEF/EFF library - JEFF-3. Members of the JEF and EFF communities have been selected to form a working group. This group will be charged with creating a starter file, JEFF-3.0, based on selections from the existing files, and making recommendations for future work. The activities of this group will be coordinated by John Rowlands.

A draft proposal for a JEFF-3 starter file is currently being prepared by J. Rowlands. The selection of data will be made in two stages; 1/ selection of evaluations between JEF-2.2 and EFF-2.4; 2/ selection of evaluations from other files (ENDF/B-VI, JENDL-3.2, BROND-2) in preference to the present JEF-2.2 evaluations.

A.6 New chairman for JEF Project

At the JEF Scientific Coordination Group meeting on 7th December 1994, Massimo Salvatores stepped-down from his position as chairman, which he had held for ten years. At the same meeting, Phillip Finck (CEN Cadarache), was elected as the new chairman.

A.7 Next JEF Meeting

The next meeting of the JEF Working Group in Benchmark Testing, Data Processing and Evaluations will be held at the NEA Data Bank in the week commencing 12th June 1995.

B. International Evaluation Cooperation

The sixth meeting of the Working Party on International Evaluation Cooperation was held at Oak Ridge, USA, on 5th and 6th May 1994. The Working Party reviewed the status and future plans of the major evaluation projects, and the coordinator of each subgroup reported on recent development and needs for further work.

Following the earlier decision to create long term subgroups, the Working Party decided to propose to the NEA Nuclear Science Committee, that Subgroup A on Nuclear Data Measurement Activities should be transformed into a separate Working Party, considering its fundamental role in the nuclear data field. The Nuclear Science Committee later approved the proposal and a separate Working Party on International Nuclear Data Measurement Activities was created. The first meeting of this new Working Party will be held in conjunction with the Working Party on International Evaluation Cooperation at the NEA Headquarters on 16th May 1995. The main items for discussion at this meeting will be the availability of measurement facilities and a review of the preliminary high priority request list from subgroup C of the International Evaluation Cooperation. The new Working Party will issue a newsletter, describing existing nuclear data measurement facilities and their present and future programme of work.

A new subgroup on "Epithermal capture of ^{235}U" was recently established. A proposal for such a subgroup was discussed at the last Working Party meeting, and following initiatives both from the US and the European side, work to re-evaluate capture resonance widths have already started in Oak Ridge.

A list of subgroups and their status can be found in Table 1. The subgroups marked in **bold** characters in list are the ones that are still active. The other subgroups have fulfilled *their tasks and the final reports are being published.*

The Working Party will meet on 17th and 18th May 1995 in Paris, France.

Table 1

NO	TOPIC	COORDINATOR	STATUS
1.	Comparison of ^{52}Cr, ^{56}Fe and ^{58}Ni	C.Y. Fu,USA	*Completed. Final report written*
2.	Generation of covariance files for Fe	H. Vonach, Austria	Completed. Final report written
3.	Actinide data in the thermal energy range	H. Weigmann, CEC H. Tellier, France	Completed. Final reports written
4.	^{238}U capture and inelastic scattering cross sections	Y. Kanda, Japan	Completed. Inelastic part ongoing as experimental activity
5.	^{239}Pu 1 - 100 keV fission cross section	E. Fort, France	Completed. Final report expected
6.	**Delayed Neutron Data**	**A. Filip, France**	**Ongoing**
7.	Multigroup Cross Section Processing	R. Roussin, USA	Redefined; See subgroup B below
8.	**Minor Actinide Data**	**T. Nakagawa, Japan H. Takano, Japan**	**Graphical part completed Benchmark part ongoing**
9.	High Priority Request List	M. Salvatores, France	Redefined; See subgroup C below
10.	Fission Product Inelastic Scattering	M. Kawai, Japan	Completed. Follow up: see subgroup 17
11.	**Inter-Comparison of the Resonance Region of ^{52}Cr, ^{56}Fe, and ^{58}Ni**	**C.Y. Fu, USA**	**Graphical part completed ^{52}Cr experiment done; Ongoing**
12.	***Nuclear Model Validation***	**G. Reffo, Italy**	**Ongoing**
13.	**Intermediate Energy Nuclear Data Evaluation**	**A. Koning, Holland N. Kishida, Japan**	**Ongoing**
14.	**Kerma and Radiation Damage**	**R. MacFarlane, USA**	**Ongoing**
15.	**Self-shielding treatment in the unresolved resonance region**	**F. Fröhner, Germany**	**Ongoing**
16.	**Nuclear Level Densities for model calculations of Neutron Induced reactions with ^{52}Cr, ^{56}Fe and ^{58}Ni**	**C.Y. Fu, USA**	**Ongoing**
17.	**Fission Product Cross Sections**	**M. Kawai, Japan**	**Being set-up**
18.	**Epithermal capture of ^{235}U**	**C. Lubitz, USA**	**Newly established**
A.	Experimental Activities	H. Weigmann, CEC D. Larson, USA	Transformed into a separate Working Party
B.	**Evaluated Data Formats and Processing for Application Libraries**	**R. Roussin, USA**	**Ongoing**
C.	**High Priority Request List**	**J. Rowlands, France**	**Ongoing**

C. Intermediate Energy Data

The Nuclear Science Committee has expressed an interest in intermediate energy data, mainly related to accelerator transmutation applications. Two calculation benchmarks, one on thin and on thick target yields, have been conducted by the NEA. The results of the benchmarks were discussed at a specialists' meeting at the NEA in May 1994. Both the results of the benchmarks and the proceedings of the specialists' meeting have been published by the OECD.

Following the recommendations of the above mentioned specialist's meeting and of subgroup 13 of the International Evaluation Cooperation, the Data Bank has started an activity to compile important experimental intermediate energy data into the EXFOR data base. Nearly 100 compilations were performed in 1994, and another 100 are foreseen for 1995.

D. Recent Specialists' Meetings and Publications

The Nuclear Science Committee sponsored a specialists' meeting on Measurement, Calculation and Evaluation of Photon Production Data in November 1994. The meeting was organised by C. Coceva, ENEA Bologna, Italy, and the proceedings have ben published with the reference NEA/NSC/DOC(95)1.

The following list contains selected NEA Nuclear Science and Data bank publications in 1994 in addition to those already mentioned in section A:

- International Code Comparison for Intermediate Energy Nuclear Data; OECD Publication
- Report on the NEA Task Force on the Analysis of Resonance Parameters of Uranium; NEA/NSC/DOC(93)4
- Blind Intercomparison of Nuclear Models for Predicting Charged Particle Emission; NEA/NSC/DOC(93)4
- Sensitivities of calculated cross sections of Fe-56 to Nuclear Model parameters; NEA/NSC/DOC(93)5
- Proceedings of a Specialists Meeting on Intermediate Energy Nuclear Data ; OECD Document

Nuclear Data Services

Online Access

Online access to the databases for experimental and evaluated neutron nuclear data is available from the NNDC, Brookhaven National Laboratory, the NEA Data Bank, Paris, and the IAEA Nuclear Data Section, Vienna. Information on how to access these databases is given below.

1. U.S. National Nuclear Data Center

network INTERNET (or ESNET)

command: **TELNET BNLND2.DNE.BNL.GOV** (or **130.199.112.132**)

or

network DECNET (ESNET only)

command **SET HOST BNLND2**(or **44436** or **43.404**)

```
BROOHHAVEN NATIONAL LAB. NNDC COMPUTER SYSTEM
OpenVMS AXP V1.5

Username:  NNDC

Enter NNDC assigned authorization code (or GUEST):
      GUEST (or your authorization code if you have one)

Logout (to terminate a session)
```

2. NEA Data Bank

network INTERNET :

command: **TELNET DB.NEA.FR** (or **193.51.64.1**)

```
OECD Nuclear Energy Agency
Node NEADBB: VAX 6000-510/VMS 6-1

Username: NEADB

Use GUEST for trying out the service (time limited)
Enter your personal username: GUEST

Exit (to terminate a session) (i.e. move cursor to "EXIT" and
press RETURN)
```

3. IAEA Nuclear Data Section

network INTERNET :

command: **TELNET IAEAND.IAEA.OR.AT** (or **161.5.2.2**)

```
IAEA/Nuclear Data Section's VAX

Username :   IAEANDS

The IAEA/NDS ONLINE DATA SERVICE

Enter NDS assigned auhorization code (or GUEST):
      GUEST (or your authorizaiton code if you have one)

Logout (to terminate a session)
```

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ICELAND	M. Magnusson
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KOREA, REP . OF	Jung-Do Kim
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Telefax : +33 (1) 45 24 11 10
Telex : OCDE 620 160 F

INTERNET : *name* @ NEA.FR
BITNET : discontinued
X-400 : S=*name*, P=NEA, O=OECD, A=ATLAS, C=FR
X25 : 2080 92 160 7751 (international)
X25 : 1 92 160 7751 (france)

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