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LIBRARY OF EVALUATED NEUTRON DATA FILES

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Abstract: The authors report on the preparation of the library of evaluated neutron data files which was recommended by the Nuclear Data Commission of the State Committee on the Utilization of Atomic Energy as a basis for improving systems of constants in neutron engineering calculations. A short description of the contents of the library and of its status is given.

A library of evaluated neutron data files has been compiled in the Institute of Physics and Power Engineering. The library contains full sets of neutron data (cross-sections of all reactions and energy and angular distributions of secondary neutrons) in the energy range from 10^{-5} eV to 20 MeV. The data are presented in the ENDF/B-5 format. The library contains data for the main engineering, construction and fuel materials in reactors, radiation shielding materials, the atmosphere, soil materials and biological tissues.

Technological and construction materials:

Hydrogen isotopes
Helium isotopes
Lithium isotopes
Beryllium
Boron isotopes
Carbon
Nitrogen
Oxygen
Fluorine
Sodium
Magnesium
Aluminium
Silicon
Chlorine
Potassium
Calcium
Titanium
Vanadium
Chromium and its isotopes
Manganese
Iron and its isotopes
Cobalt
Nickel and its isotopes
Copper
Gallium
Yttrium
Zirconium
Niobium
Molybdenum
Cadmium
Gadolinium
Hafnium
Europium isotopes
Tantalum
Tungsten isotopes
Rhenium isotopes
Gold
Lead
Bismuth

Actinides:
Thorium-228,232
Protactinium-231,233
Uranium 232-236,238
Neptunium-237,239
Plutonium-236,238-242
Americium-241,242^{m},243
Curium-242-248.

Fission products:
Molybdenum-95,97, 98,100
Technetium-99
Ruthenium-101,102, 104,106
Palladium-105
Silver-109
Iodine-129
Xenon-131,135
Cesium-133,135
Cerium-144
Praseodymium-141
Neodymium-143,145
Promethium-147
Samarium-147,149, 151.

The neutron data files for the main fuel, construction and engineering materials of reactors and also for the most important nuclear fission products are compiled on the dasis of recent evaluations made at the Institute of Physics and Power Engineering [1-7], at the Nuclear Energy Institute of the Byelorussian Academy of Sciences [8 and 9]

and at the Technical University Dresden (German Democratic Republic) [10 and 11]. In the case of materials, used as neutron standards, the data recommended by the IAEA were used [12] . For the remaining materials, data which Soviet specialists considered to be most reliable were taken from existing foreign files and used as a basis. In the majority of these files, the data in the resolved and unresolved resonsnce region were replaced by the results of the latest Soviet evaluations.

Detailed descriptions of the evaluation of most of the files contained in the library are given in the above-mentioned works. However, it should be noted that some of the files were heavily edited prior to inclusion in the library, as part of the re-evaluation carried out in 1984-1985 to take account of new experimental data. These include, primarily, the files for iron, chromium and nickel isotopes. The library's data files for natural mixtures of these nuclides were compiled from files for the individual isotopes; nevertheless they correspond to the evaluated data for the natural element cross-sections. During the review of the data for the above-mentioned construction materials, special attention was paid to re-evaluating the resonance structure of cross-sections and also the low-level excitation cross-sections for inelastic scattering. For this purpose, the opto-static description was used, the parameters of which were determined from the harmonized analysis of the total neutron cross-sections, the differential elastic scattering cross-sections and low collective level excilation cross-sections of even-even nuclei. The values obtained from this for neutron force functions at low energies do not contradict the evaluations obtained by averaging the parameters of the resolved resonances. This approach made it possible to take account of the contributions of direct scattering mechanisms for the whole energy range and, what is important, made it possible to evaluate correctly the low-level excitation functions of odd isotopes, for which there are no direct experimental data.

The analysis of data on radiative capture cross-sections of fission products carried out during the last few years at the Institute of Physics and Power Engineering [7, 13, 14] made it possible, firstly to compile a list of the most important products determining their total capture cross-section and its evolution during burnup and decay of fragments; secondly, to select from among the available files of evaluated data (JENDL-1 and ENDF/B-5) those which correspond most closely to the present-day level of values; thirdly, to determine those nuclides for which the data needed to be reviewed to take account of new experimental information. As a result, new evaluations for the cross-sections in the unresolved resonance region were made for ^{99}Tc, ^{101}Ru, ^{102}Ru, ^{103}Rh, ^{105}Pd, ^{107}Pd, ^{109}Ag, ^{129}I, ^{143}Nd, ^{145}Nd, ^{147}Sm and ^{149}Sm. For isotopes where are no direct experimental data on fast neutron capture cross-sections but only information on the mean resonance parameters, and also for isotopes where there is no information either on cross-sections or on resonance parameters, the evaluations of capture cross-sections for fission products are based on radiation force functions empirical systematics.

Fission products, for which the library has neutron data, determine more than 80% of the radiative capture by fission product mixture in all types of reactor. It is assumed that the contribution of other fission products with low capture cross-sections or low yields can be taken into account with the inclusion of group constants.

All the files were carefully checked by Soviet specialists. For the most im-

portant materials, the Nuclear Data Centre also organized a collective examination carried out by specialists from varius institutes. The library includes files containing data corrected to take account of the remarks made by the ex - perts.

Some of the shortcomings revealed have not yet been eliminated. For ex - ample, the majority of files accepted in the library need to be revised in the case of spectra for inelastically scattered neutrons and neutrons from the (n,2n) reaction taking into account the contribution of the direct and pre-equilibrium processes (at present these spectra are evaluated on the basis of the most simple evaporation model). This type of defect should not significantly affect the results of practical calculations, particularly since they appear only in reactor materials which are present in low concentrations. In future, priority will be given to revising data files with defects of this type.

The format and physical compatibility of the data in all the evaluated neutron data files in the library were checked algorithmically. The majority of files were converted into group cons - tants by means of the GRUKON [15] and NJOY [16] programs.

Group constants were tested using the macroscopic experiments on critical assemblies [17]. The results displayd general consistency of the evaluated micriscopic data.

The Institute of Physics and Power Engineering and the Nuclear Data Commission of the State Committee on the Utilization of Atomic Energy recommend the library as a basis for developing improved constant systems for neutron calculations on various engineering and scientific fields.

The work on evaluation and compilation of new files is going on for future expanded version of the library.

REFERENCES

1. M.N.Nikolaev: Rev.OB-77,Obninsk(1977)
2. M.N.Nikolaev: Rev.OB-45,Obninsk(1978)
3. M.N.Nikolaev:Rev.OB-114,Obninsk(1980)
4. I.M.Bondarenko: VANT Ser. Nucl.Const 3(57) (1984)
5. T.S.Belanova: In: Neutron Physics, Moscow 3 (1984)
6. V.G.Pronyaev: VANT Ser.Nucl.Const. 4 (1986)
7. T.S.Belanova: Atomic Energy 57 (1984)
8. G.V.Antsipov: Nuclear constants for plutonium isotopes,Minsk. Science and Technology (1982)
9. V.A.Kon'shin: Evaluated neutron constants for uranium-235. Minsk, Science and Technology (1985)
10. D.Hermsdorf: Report INDC (GDR)-038/L, (1986)
11. D.Hermsdorf: Report INDC (GDR)-039/L, (1986)
12. Nuclear data standards for nuclear measurements, Vienna, IAEA (1983) Techn. Report 27.
13. B.D.Yurlov: VANT Ser. Nucl. Const. 1(50) (1983)
14. A.M.Tsibulya: VANT Ser.Nucl.Const. 1(50) (1983)
15. V.V.Sinitsa: VANT Ser Nucl.Const. 5(59) (1984)
16. Report LA-9303-M (ENDF-324) (1982)
17. A.V.Korobeinikova: Report on Int. Conf. of Neutron Physics, Sept.(1987) Kiev