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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

BROND

USSR Recommended Evaluated Neutron Data Library

БРОНД

Библиотека рекомендованных оцененных нейтронных данных

Editor: V.N. Manokhin
USSR Nuclear Data Centre
Obninsk 1986

Translated by IAEA
1988

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

Abstract

BROND is the recommended evaluated data library of the USSR for neutron induced nuclear reactions. It is a computer library recorded on magnetic tape presented in the internationally recommended format ENDF-5. It contains 65 files with recommended data for 65 elements or isotopes. For each file the present report gives a summary documentation on the contents, the evaluation methods and the originators of the files.

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USSR Recommended Evaluated Neutron Data Library

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Contents

Note by IAEA

The Russian original of this report has been received at the IAEA Nuclear Data Section in September 1987. The magnetic tapes containing the BROND library have been received soon after. The IAEA Nuclear Data Section maintains a master file containing all released BROND data in their latest version, accompanied by a document IAEA-NDS-90. A copy of the tape is available costfree, upon request. Identical copies are available also from the USA National Nuclear Data Center at the Brookhaven National Laboratory and from the OECD Nuclear Energy Agency Data Bank at Saclay, France. Users of BROND data are invited to verify with above data centres about the latest version available.

The table on page vi quotes the IAEA as source for some of the files. In these cases the IAEA was not the orginator of the files but only the distributor. Therefore the source should rather be quoted as follows:

BROND File		Source
H-1	BROND-0111	ENDF/B-5-1301
He-3	BROND-0211	ENDF/B-5-1146
B-10	BROND-0511	ENDF/B-5-1305
C-12	BROND-0611	ENDF/B-5-1306
Nb-93	BROND-4101	INDL-4111 (GDR)
Np-237	BROND-9311	INDL-9337 (France)

(H.D. Lemmel)

INTRODUCTION

This report contains the description of 65 files of the first version (1985) of the Recommended Evaluated Neutron Data Library (BROND) of the Nuclear Data Commission, USSR State Committee on the Utilization of Atomic Energy.

The purpose of this library is to ensure that design calculations are comparable and standardized, and it is recommended as the nuclear data base for reactor calculations and other applications in science and technology.

The library contains complete sets (files) of evaluated neutron data obtained on the basis of experimental data and calculations by theoretical models of nuclear reactions.

Descriptions are given for

- 43 files evaluated in the USSR;
- 2 files evaluated jointly by the Dresden Technical University and the Power Physics Institute (FEhI);
- 5 files recommended by the IAEA;
- 11 files of other foreign libraries (JENDL, ENDF and UKNDL) recommended by Soviet specialists.

These files were analysed and checked and were recommended for inclusion in BROND by the meetings of USSR specialists organized in 1984-1985 by the Nuclear Data Centre of the USSR State Committee on the Utilization of Atomic Energy. The data have been corrected where necessary.

The scientific guidance for BROND was provided by the Power Physics Institute, while the selection was carried out by the Nuclear Data Centre.

The Soviet BROND files were evaluated at the Power Physics Institute and at the Nuclear Power Institute of the Byelorussian Academy of Sciences. Specialists from the Power Physics Institute, the I.V. Kurchatov Institute of Atomic Energy, the Radium Institute and the Nuclear Research Institute (Ukrainian Academy of Sciences) took part in the checking of the files and in the preparation of recommendations on inclusion of data in BROND.

The files included in BROND are recorded on magnetic tape in the ENDF/B-5 format, and they were checked by the CHECKER and FIZCON programs for conformity with the format and for physical consistency of the data.

I	2	3	4	5	6
22	Ni	280I	I985	I985	FEhI
23	Ni - 58	28II	I985	I985	"
24	Ni - 60	282I	I985	I985	"
25	Ni - 61	283I	I985	I985	"
26	Ni - 62	284I	I985	I985	"
27	Ni - 64	285I	I985	I985	"
28	Nb - 93	4I0I	I985	I985	TUD
29	Mo - 95	425I	I982	I985	JENDL
30	Mo - 97	427I	I982	I985	JENDL
3I	Mo - 98	428I	I982	I985	JENDL
32	Mo - 100	429I	I982	I985	JENDL
33	Tc - 99	43II	I984	I985	FEhI
34	Ru - 101	44II	I984	I985	"
35	Ru - 102	442I	I984	I985	"
36	Ru - 104	444I	I984	I985	"
37	Ru - 106	446I	I985	I985	JENDL
38	Rh - 103	450I	I984	I985	FEhI
39	Pd - 105	465I	I984	I985	"
40	Pd - 107	467I	I985	I985	"
4I	Ag - 109	479I	I984	I985	"
42	I - 129	539I	I985	I985	"
43	Xe - 131	54II	I985	I985	"
44	Cs - 133	553I	I98I	I984	JENDL
45	Cs - 135	555I	I985	I985	"
46	Ce - 144	584I	I985	I985	"

Note by IAEA: The Russian original contains misprints.
In line 28 the file source was corrected from FEhI to TUD.
In line 32 the MAT number in col. 3 was corrected from 4211 to 4291.
In line 38 the MAT number was corrected from 4301 to 4501.

I	2	3	4	5	6
47	Pr - 141	590I	I980	I984	ENDF/B-V
48	Nd - 143	603I	I985	I985	FEhI
49	Nd - 145	605I	I985	I985	"
50	Pm - 147	6I7I	I984	I985	"
5I	Sm - 147	627I	I984	I985	"
52	Sm - 149	629I	I984	I985	"
53	Sm - 151	62II	I984	I985	"
54	Eu - 151	63II	I979	I985	ENDF/B-V
55	Eu - 153	633I	I979	I985	ENDF/B-V
56	Pb	8202	I984	I985	TUD + FEhI
57	U - 235	9235	I985	I985	N.Power Inst. Byel.
58	U - 238	927I	I978	I985	FEhI
59	Pu - 239	942I	I984	I985	N.Power Inst. Byel.
60	Pu - 240	943I	I984	I985	" " " "
6I	Pu - 241	944I	I984	I985	" " " "
62	Pu - 242	945I	I984	I985	" " " "
63	Np - 237	93II	I98I	I985	IAEA
64	Am - 241	95II	I980	I985	UKNDL
65	Am - 243	954I	I98I	I985	UKNDL

FEhI = Power Physics Institute, USSR State Committee on the Utilization of Atomic Energy. (Obninsk)

TUD = Dresden Technical University.

N.Power Inst. Byel. = Nuclear Power Institute, Academy of Sciences of the Byelorussian Soviet Socialist Republic. (Minsk)

Note by IAEA: The Russian original contains misprints.
In line 52 the MAT number in col. 3 was corrected from 6231 to 6291.
In line 56 the MAT number was corrected from 8201 to 8202.
In line 57 the MAT number was corrected from 9241 to 9235.

LIST OF FILES OF THE RECOMMENDED EVALUATED NEUTRON DATA LIBRARY
DESCRIBED IN THE REPORT

	ISOTOPE	LIBRARY No. OF FILE	EVALUATION DATE	CHECKING AND CORRECTION DATE	FILE SOURCE
I	2	3	4	5	6
I	H - 1	0III	I977	I985	IAEA
2	D - 2	0I2I	I980	I985	FEhI
3	He - 3	02II	I968	I985	IAEA
4	Li - 6	036I	I984	I985	FEhI
5	Li - 7	037I	I984	I985	FEhI
6	B - 10	05II	I977	I985	IAEA
7	C - 12	06II	I977	I985	IAEA
8	N	070I	I975	I985	ENDF/B-IV
9	O	080I	I978	I980	FEhI
IO	Na	IIII	I978	I982	FEhI
II	Si	I402	I984	I985	TUD +FEhI
I2	Cr - Nat	2400	I984	I985	FEhI
I3	Cr - 50	24II	I984	I985	"
I4	Cr - 52	242I	I984	I985	"
I5	Cr - 53	243I	I984	I985	"
I6	Cr - 54	244I	I984	I985	"
I7	Fe	260I	I985	I985	"
I8	Fe - 54	26II	I985	I985	"
I9	Fe - 56	262I	I985	I985	"
20	Fe - 57	263I	I985	I985	"
2I	Fe - 58	264I	I985	I985	"

Note by IAEA: The Russian original contains misprints.
In line 11 the MAT number in col. 3 was corrected from 1401 to 1402.
In line 12 the MAT number was corrected from 2401 to 2400.

The descriptions of BROND files included in the present report give:

- Content of the file and brief information on the evaluation methods;
- Information on the evaluation source (institute where the main evaluation was made or library from where the file was recommended for inclusion in BROND);
- Information on the authors of evaluation and the compilers of the file;
- The dates of evaluation, checking and correction of the file.

<u>Documentation of BROND files</u>

MF = 12, MT = 102 Multiplicity of capture photons.

MF = 14, MT = 102 The angular distributions of capture photons are assumed to be isotropic at all energies.

MF = 33 Correlated errors.

MT = 1 Covariance matrix for MT = 2, 102

MT = 2 Covariance data added by D. Foster for elastic scattering.

MT = 102 Covariance data for radiative capture added by P. Young.

REFERENCES

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2. HOPKINS, J.C., BREIT, G., Nuclear Data A 9, (1971) 137.

3. HORSLEY, A., Nuclear Data A 2 (1966) 243.

1 - H-1 MAT = 0111
1 - H-1 LASL

Evaluation - 1970

Revision - 1977

Checking - 1985

Authors of evaluation: L. Stewart, R. La Bauve and P.G. Young

The elastic scattering cross-section and the elastic scattering angular distribution (MF = 3,4; MT = 2) are taken as standard in the 1 keV-20 MeV region.

A description of the evaluation and a detailed list of the references used are given in Ref. [1].

Content of the file:

MF = 1 General information:

MT = 151 Scattering length = 1.27565 x 10^{-12} cm.

MF = 3 Neutron cross-sections (1 x 10^{-5} eV-20 MeV)

MT = 1 The total cross-section was obtained by adding the elastic scattering and radiative capture cross sections.

MT = 2 Elastic scattering was obtained by Hopkins and Breit [2] from a theoretical analysis of measurements.

MT = 102 The radiative capture cross-section was obtained from Ref. [3], where the cross-section was taken as equal to 332 mb for the thermal point.

MT = 251 Average value of the cosine of the scattering angle in the laboratory system of co-ordinates.

MT = 252 Average logarithmic energy loss per collision.

MT = 253 Gamma

MF = 4 Angular distributions

MT = 2 Angular distributions of elastic scattering in the centre-of-mass system. Normalized probabilities are given in the pointwise representation.

MF = 7 Data on thermal neutron scattering law.

MT = 4 0.00001-5 eV - scattering cross-section for free atoms = 20.449 b.

MF = 6 ---------------- ENERGY-ANGULAR DISTRIBUTIONS ---------------------

MT = 16 (n,2n) reaction

The neutron spectrum of the (n,2n) reaction depends substantially on the angle of emission of neutrons so that it was necessary to present data in the format of file MF = 6.

The data given correspond to the evaluation of Nikolaev [23]. It is assumed that the basic reaction mechanism is divided into three particles. The energy-angular distribution of these neutrons is described by the phase space model, which totally neglects the binding of nucleons in the final state.

In addition, account was taken of the contribution of the direct processes, whose cross-section increases linearly from 0.0 mbarn at 4.45 MeV to 8.2 mbarn at 14.4 MeV (4.6%) and then to 15.0 mbarn at 20.0 MeV (8.4%). The direct processes are taken into consideration on the assumption of a strong binding of two nucleons - products of the reaction. In these processes neutrons are emitted either almost forwards with an energy smaller by a factor of ~ 2 than the maximum possible energy for emission forwards or almost backwards with an energy approximately equal to or smaller by a factor of ~ 2 than the maximum possible energy for emission backwards, depending on which of the nucleons - reaction products - are bound.

MF = 12 ------------------- MULTIPLICITY OF PHOTONS -----------------------

MT = 102 Radiative capture

It is assumed that single photons are emitted in the entire energy range.

MF = 14 ------------------PHOTON ANGULAR DISTRIBUTIONS --------------------

MT = 102 Radiative capture

The angular distributions are taken to be isotropic.

REFERENCES

(for original English references see overleaf)

1 - H-2	FEhI - GCL	Eval. - 1974 Distr. - 1975 Mod. - 1980	Scient. Head - M.N. Nikolaev Compiler - V.N. Koshcheev Responsible for evaluation - N.O. Bazazyants, M.N. Nikolaev

DEUTERIUM

MF = 3 — SMOOTH CROSS-SECTIONS

For E = 0.0253 eV:
SIG TOT = 3.39 barn
SIG GAM = 531.0 μbarn

MT = 1 Total cross-section

In the low-energy region the evaluation was based mainly on the experimental data of Dilg [1] and Stoler [2], which made it possible to resolve the contradictions noted in previous evaluations in the total cross-section data for this region.

For higher energies (~ 0.5 MeV) experimental studies [3-8] were used.

MT = 2 Elastic scattering

The elastic scattering cross-section was determined as the difference between the total cross-section and the inelastic interaction cross-section.

MT = 16 (n,2n) reaction

The evaluated curve is based on experimental data of Refs [9-13].

MT = 102 Radiative capture

At 0.0253 eV the recommended capture cross-section is 531 μbarn from Merritt et al. [14]. Up to 1.0 keV the energy dependence of the cross-section is ~ 1/V. Above 1.0 keV, the evaluation of Horsley [15] was taken.

At 14.0 MeV the capture cross-section is 9.5 μ barn.

MF = 4 — ANGULAR DISTRIBUTIONS

MT = 2 Angular scattering

The data are presented in the form of coefficients of expansion of the scattering indicatrix in the laboratory system of co-ordinates into a Legendre polynomial series. References [13, 16-22] were used for evaluation.

2 - He-3 MAT = 0211
2 - He-3 LASL Evaluation - 1968
Checking - 1985

Author of evaluation: L. Stewart

The (n,p) cross-section was recommended as the standard in the neutron energy region from thermal to 50 keV.

Content of the file:

MF = 1 General information

MT = 451 Comments

MF = 2, MT = 151 Scattering radius 0.2821 x 10^{-12} cm.

MF = 3 Neutron cross sections

MT = 1 Total cross-sections:

0.00001 eV-10.8 keV - sum of MT 2 + MT 103.
10.8 keV-20 MeV - the cross-sections were evaluated on the basis of the data of Ref [6].

MT = 2 Elastic scattering cross-sections.
0.00001 eV-10.8 keV - taken to be constant and equal to 1.0 b
10.8 keV-20 MeV - MT 2 = MT 1 - MT 103 - MT 104 with the use of experimental data of Refs [9, 11] for verification.

MT = 103 (n,p) reaction cross section
0.00001 eV-1.42 keV, the cross-section was taken according to law 1/v (5327 b at 0.0253 eV) from Ref. [13].
1.42 keV-20 MeV. The cross-section was evaluated on the basis of experimental data of Refs [1, 4, 5, 8, 10-12, 14-16].

MT = 104 (n,d) reaction cross-section.
Threshold = 4.36147 MeV, Q = -3.2684 MeV. Evaluation from detailed balance [13] and from experimental data of Ref. [11].

MT = 251 Average cosine of the scattering angle in the laboratory system of co-ordinates. Obtained from the data of MF = 4, MT = 2.

MT = 252 Value of χ obtained from the data of MF = 4, MT = 2.

MT = 253 Value of gamma obtained from the data of MF = 4, MT = 2.

16. NIKOLAEV, M.N., BAZAZYANTS, N.O., The Anisotropy of Neutron Inelastic Scattering, Atomizdat, Mowcow (1972) (in Russian)

23. NIKOLAEV, M.N., et al. Neutron data for deuterium. Rep. OB-114 (1980) (in Russian)

1. W.Dilg et al., Phys.Let., 36B (1971) 2208.
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22. S.Kikuchi et al. J.Phys.Soc.Japan, 15(1960) 9.

3 - Li-6 MAT = 0361
3 - Li-6 Evaluation - 1984

Author of evaluation: I.M. Bondarenko
Compilers of the file: I.M. Bondarenko and M.V. Ulaeva

Content of the file:

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

MT = 151 There are no resonance parameters except potential scattering radius R = 2.42 fm.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-section in the region up to 0.1 MeV was determined as the sum of the standard cross-section of the (n,t) reaction [1] and the neutron elastic scattering cross-section [2]. In the energy range from 0.1 to 4.8 MeV the cross-section recommended in Ref. [3] was taken. Above 4.8 MeV, the evaluation was based on the data of Ref. [4].

MT = 2 The elastic scattering cross-section in the energy region up to 0.1 MeV and above 4 MeV was obtained from the description by the least-square method of the available set of experimental data [5]. In the region from 0.1 MeV to 1 MeV it was obtained by subtraction of the (n,t) reaction from the total cross-section. In the region from 1 to 4 MeV the cross-section recommended in Ref. [3] was taken.

MT = 24 The (n,2np) four-particle reaction cross-section was taken from the ENDF/B-5 evaluation [6].

MT = 4, 51-53, 91 The neutron inelastic scattering cross-sections were obtained from the optimum description of the set of experimental data of Ref. [5].

MT = 102 The neutron radiative capture cross-section was taken from the ENDF/B-5 evaluation [6].

MT = 103 The (n,p) reaction cross-section was obtained on the basis of the recommendations of Refs [8, 7].

MT = 105 The (n,t) reaction cross-section in the neutron energy region up to 0.1 MeV was taken from the standards file [1], and in the case of higher energies, it was obtained from the optimum description of the available set of experimental data [5].

MF = 4 Angular distributions:

MT = 2 The angular distributions of elastically scattered neutrons were evaluated on the basis of experimental data of Refs [2, 7, 9, 11, 16, 17].

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3 - Li-7	MAT = 0371	
3 - Li-7	Power Physics Institute	Evaluation - 1984

Author of evaluation: I.M. Bondarenko

Compilers of the file: I.M. Bondarenko and M.V. Ulaeva

Content of the file:

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance paramenters:

MT = 151 There are no resonance parameters except potential scattering radius R = 3.7 fm.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-section up to 35 keV is equal to 1.05 b + capture cross-section. Above 35 keV, it was obtained from the analysis of existing experimental data [1].

MT = 2 The elastic scattering cross-section in the region up to 35 keV was taken as 1.05 b. For higher energies, it was obtained from the optimum description of the available set of experimental data [1].

MT = 16 The (n,2n) reaction cross-section was obtained on the basis of expermental data of Refs [2, 3].

MT = 51-53, 91 The neutron inelastic scattering cross-sections were obtained from the optimum description of the set of experimental data of Refs [1, 4].

MT = 102 The neutron radiative capture cross-section in the region up to 0.1 MeV is $7.22095/\sqrt{E_n}$(eV) + 0.00227 mb and, in the case of higher energies, it was obtained from the experimental data of Ref. [5].

MT = 104 The (n,d) reaction cross section was taken from the JENDL-3 evaluation [6].

MT = 251 $\bar{\mu}$ calculated from the evaluations made of the differential cross-sections of the scattered neutron angular distributions.

MT = 251 Calculated from the evaluations made of the angular distributions of scattered neutrons.

MF = 4 Secondary neutron angular distributions.

MT = 2 In the region up to 6.5 keV they were taken to be isotropic in the centre-of-mass system and, above this region, they were found on the basis of the description of experimental data of Refs [9-11].

MT = 24 Taken from the ENDF/B-5 evaluation [6].

MT = 51 Obtained from the description of experimental data of Ref. [9].

MT = 52, 53 Taken to be isotropic in the centre-of-mass system.

M = 91 Determined on the assumption of a two-stage reaction mechanism [12].

MF = 5 Secondary neutron energy distributions.

MT = 24 Taken from the ENDF/B-5 evaluation [6].

MT = 91 Calculated on the assumption of a two-stage reaction mechanism [12].

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5 - B-10 MAT = 0511

5 - B-10 LASL

Evaluation - 1976
Revision - 1977
Checking - 1985

Authors of evaluation: G. Hale, L. Stewart and P. Young.

The cross-sections of the (n,α) and (n,α,γ) reactions were taken as the standard in the neutron energy region up to 100 keV.

Content of the file:

MF = 1 General information:

MT = 451 Description of data.

MF = 2 Resonance parameters:

MT = 151 Effective scattering radius 4.0238 x 10^{-13} cm.

MF = 3 Neutron cross-sections:

Cross sections for 2200 m/sec:

MT = 1	3839.1 b
MT = 2	2.0344 b
MT = 102	0.5 b
MT = 103	0.000566 b
MT = 107	3836.6 b
MT = 113	0.000566 b
MT = 700	0.000566 b
MT = 780	244.25 b
MT = 781	3592.3 b

MT = 1 The total cross-section in the 0-1 MeV region was calculated from the R-matrix parameters obtained from the simultaneous description of data of reactions $^{10}B(n,n)$, $^{10}B(n,\alpha_0)$ and $^{10}B(n,\alpha_1)$. In the fitting of the cross-sections, the data measured in Refs [6, 16, 34] were used.

1-20 MeV, smooth curve from the data of Refs [6, 8, 9, 16, 17, 37].

MT = 2 Elastic scattering cross-section 0-1 MeV, calculated from the R-matrix parameters described in MT = 1. In the fitting of the cross-sections, the experimental data of Refs [3, 23] were used.

1-7 MeV, smooth curve from the data of Refs [20, 23, 28].

MF = 4 Secondary neutron angular distributions:

MT = 2 In the region up to 10 keV they were taken to be isotropic in the centre-of-mass system and, in the region above, they were obtained on the basis of the description of experimental data of Refs [7-9].

MT = 16 Taken from the JENDL-3 evaluation [6].

MT = 51-53 For MT = 51 and 53 they were taken to be isotropic in the centre-of-mass system and for MT = 52 they were obtained from the experimental data of Ref. [7].

MT = 91 Determined on the assumption of a two-stage reaction mechanism [10].

MF = 5 Secondary neutron energy distributions:

MT = 16 Taken from the JENDL-3 evaluation [6].

MT = 91 Calculated on the assumption of a two-stage reaction mechanism [10].

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MT = 780 (n,α_0) reaction cross-section.

0-1 MeV, calculated from the R-matrix parameters (see MT = 1).

In the fitting of the cross-section the experimental data of Refs [15, 24] were used. In the analysis, use was also made of the angular distributions of the inverse reaction [40].

1-20 MeV, based on the measurements of Ref. [15] with smooth extrapolation from 8 to 20 MeV. The data of Ref. [15] above 2 MeV were renormalized with a factor of 1.4.

MT = 781 (n,α_1) reaction cross-section.

0-1 MeV, calculated from the R-matrix parameters (see MT = 1). For the fitting of the cross-section, the data of Ref. [29] were used. In the analysis, the absolute differential cross-sections of Ref. [30] were also used.

1-20 MeV, smooth curve from the measurements of Refs [15, 27] with smooth extrapolation from 15 to 20 MeV. The data of Ref. [15] above 2 MeV were renormalized with a factor of 1.4.

MF = 4 Angular distributions:

MT = 2 Angular distributions of elastically scattered neutrons.

0-1 MeV, calculated from the R-matrix parameters. The experimental data were taken from Ref. [23].

1-14 MeV, Legendre coefficients obtained on the basis of the measurements of Refs [11, 19, 20, 23, 28, 38].

14-20 MeV, extrapolation by the optical model of data from the 14 MeV region.

MT = 51-81 Angular distributions of inelastically scattered neutrons.

Threshold - 20 MeV, isotropic scattering is assumed in the centre-of-mass system.

MF = 12 Photon multiplicity

MT = 102 Capture photons.

7-14 MeV, smooth curve from the data of Refs [3, 11, 20, 35, 38, 39].

14-20 MeV, calculation by the optical model with normalization to the data for 14 MeV.

MT = 4 Inelastic scattering cross-section from threshold to 20 MeV, sum of MT = 51-85.

MT = 51-61 The inelastic scattering cross-sections to discrete levels are based on the measurements of Refs [11, 13, 14, 20, 27, 28, 39]. Hauser-Feschbach calculations were used in the regions for which no experimental data were available.

MT = 62-85 Inelastic scattering cross-sections to groups of levels. These cross-sections were used in order to group the (n,n') cross-sections over 0.5 MeV-wide intervals.

From threshold to 20 MeV, integral cross-section obtained by subtracting the sum of MT = 2, 51-61, 103, 104, 107 and 113 from MT = 1. Cross-section distributed over intervals in accordance with the evaporation model using the temperature from Ref [21].

MT = 102 Radiative capture cross-section. 0-1 MeV, the dependence 1/V is assumed with the cross-section value of 0.5 b at the thermal point.

1-20 MeV, assumed to be negligibly small.

MT = 103 (n,p) reaction cross-section, sum of MT = 700-703.

MT = 104 (n,d) reaction cross-section, evaluated on the basis of measurements of the (d,n) reaction on beryllium [33, 4] and the (n,d) reaction on boron [38].

MT = 107 (n,α) reaction cross-section, sum of MT = 780 and 781.

MT = 113 (n,t2α) reaction cross-section.

0-2.3 MeV, based on the single-level description of resonances measured at 2 MeV [15].

2.3-20 MeV, smooth curve from the measurements of Refs [18, 42] taking into account the general shape of the curve from the measurements of Ref [15] in the 4-9 MeV region.

MT = 700-703 The (n,p) reaction cross-sections to discrete levels were evaluated from the calculations of Ref [28] and the measurements of Ref. [27]. The cross-section for MT = 700 is assumed to be identical with MT = 113 below 1 MeV.

6 - C-12 | MAT = 0611
6 - C-12 | ORNL

Evaluation - 1973
Revision - 1977
Checking - 1985

Authors of evaluation: C.Y. Fu and F.G. Perey

Content of the file:

MF = 1 General information

MT = 451 Comments

MF = 3 Neutron cross-sections

MT = 1 Total cross-section, 1 x 10^{-5} eV-4.81 MeV - sum of MT = 2 and MT = 102 4.81-20 MeV - Refs [2-4].

MT = 2 Elastic scattering, 1 x 10^{-5} eV-4.81 MeV - R-matrix analysis of the data of Refs [2-27]. We used the total cross-section at the thermal point from Ref. [28]: 4.746 b.

4.81-8 MeV - Refs [26, 27, 29].
8-14 MeV - Refs [29-31].
14-20 MeV - Ref. [32].

MT = 3 Inelastic scattering, 1 x 10^{-5} eV-4.81 MeV. Same as in MT = 102 4.81-20 MeV - MT = 1 minus MT = 2.

MT = 51 Inelastic scattering to the level with the energy of 4.439 MeV, 4.81 MeV-6.32 MeV - MT = 3 minus MT = 102, 6.32 MeV-8.796 MeV - MT = 3 minus MT = 102 minus MT = 107. 8.796 MeV-20 MeV - same references as for MT = 2, and data of Ref. [33].

MT = 52-91 (n,n')(n,n'3α).

MT = 52-55 Actual levels with the physical widths given in MF = 4.

MT = 56-58 Pseudo-levels with a half-width of 0.25 MeV given in MF = 4.

MT = 91 Small evaporation component with T = 0.3 for reproduction of the threshold effect and decay of level 2.43 MeV on ^9Be. The distribution of secondary neutrons agrees with Refs [34, 35]. The sum of MT = 52-91 is derived from MT = 3 and all other reaction cross-sections and agrees with Refs [35-37].

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The capture spectra and transition probabilities were obtained from the data of Ref. [36] with slight changes in the probabilities and renormalization to the level energy of Ref. [1].

MT = 781 Photon with 0.4776 MeV from the (n,α_1) reaction. Multiplicity = 1.0 at all energies.

MF = 13 Photon production cross-sections.

MT = 4 The $(n,n\gamma)$ reaction cross-sections were obtained from MT = 51-61 using the ^{10}B decay scheme [22, 31, 32].

MT = 103 The $(n,p\gamma)$ reaction cross-sections were obtained from MT = 701 703 using the ^{10}B decay scheme [22].

MF = 14 Photon angular distributions.

MT = 4 The angular distributions from the $(n,n\gamma)$ reaction are assumed to be isotropic.

MT = 102 The angular distributions from the (n,γ) reaction are assumed to be isotropic.

MT = 103 The angular distributions from the $(n,p\gamma)$ reaction are assumed to be isotropic.

MT = 781 The angular distributions from the reaction are assumed to be isotropic.

MF = 33 Covariance data

MT = 2, 780, 781 Covariance data of the (n,n), (n,α_0) and (n,α_1) reactions.

MT = 1, 107 Covariance data for the total cross-section and the (n,α) reaction.

MF = 10,	MT = 103	Cross section of the (n,p) reaction leading to activation. Same as in MF = 3, MT = 103.
MF = 12,	MT = 102	Multiplicity of capture photons [49].
MF = 13,	MT = 51	Production of 4.439 MeV photons. Same as in MF = 3, MT = 51.
MF = 14	MT = 51	Angular distribution of 4.439 MeV photons [33, 50-56].
MF = 14,	MT = 102	Angular distribution of capture photons. Isotropic in the centre-of-mass system.
MF = 33,	MT = 1-107	Errors of data for MF = 3.

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MT = 102 Radiative capture, 1 x 10^{-5} eV - 1 MeV - 1/V with 3.36 mb at the thermal point.

1 MeV-20 MeV - obtained from the (γ,n) reaction cross-section [38].

MT = 103 (n,p) reaction cross-section, see Ref [39].

MT = 104 (n,d) reaction cross-section. Obtained from (d,n) of Ref. [40].

MT = 107 The (n,α) reaction cross-section, see Refs [41-46].

MT = 203 Photon production, same as in MF = 3, MT = 103.

MT = 204 Deuteron production, same as in MF = 3, MT = 104.

MT = 207 Alpha-particle formation. Sum of MT = 52-91 (MF = 3) multiplied by 3 and added to MT = 107 (MF = 3).

MT = 251 Obtained from MF = 4, MT = 2 by the SAD program.

MT = 252 (see MF = 3, MT = 251).

MT = 253 Gamma (see MF = 3, MT = 251).

MF = 4 Angular distributions:

MT = 2 Angular distributions of elastically scattered neutrons. Same data and analysis as for MF = 3, MT = 2. Legendre expansion coefficients are given in the centre-of-mass system.

MT = 51 Inelastic scattering to the 4.439 MeV level. Same data sources as in MF = 4, MT = 2.

MT = 52 Inelastic scattering to the 7.653 MeV level. See Ref. [47].

MT = 53 Inelastic scattering to the 9.638 MeV level. See Ref. [47].

MT = 54-91 Isotropic scattering in the centre-of-mass system.

MF = 5 Energy distributions:

MT = 91 Evaporation spectrum with temperature T = 0.3 MeV.

MF = 8 MT = 103 Data of activation as a result of the (n,p) reaction [48].

7 - N-14	MAT = 0711	
7 - N-14	Power Physics Institute (USSR State Committee on Utilization of Atomic Energy)	Checking - Power Phys. Inst. 1985

Authors of evaluation: P. Young, D. Foster and G. Hale (USA, LASL)

The checking of the evaluated nuclear data for nitrogen showed that the neutron data file from the ENDF/B-4 library (MAT = 1275) was not at variance with the whole set of contemporary experimental data. Therefore this isotope file was recommended for inclusion in the BROND library. At the Nuclear Data Centre of the Power Physics Institute the isotope file was translated from the ENDF/B-4 into the ENDF/B-5 format.

The description of the file will be found in Ref. [1]. The content of neutron cross-sections in the nitrogen file is given below.

Content of the file:

MF = 1 General information:

MT = 451 Comments and dictionary.

MF = 2, MT = 151 Resonance parameters are not given except potential scattering radius R = 8.90 fm. Calculated cross-sections for 2200 m/sec: total = 11.851 b, elastic = 9.957 b, radiative capture = 0.075 b, n,p = 1.819 b.

MF = 3 The neutron cross-sections are given in the region from 10^{-5} eV to 20 MeV.

MT = 1 The total cross-sections were evaluated from different kinds of experimental data.

MT = 2 Neutron elastic scattering cross-sections. In the neutron energy region up to 10 MeV, determined as: 2 = (1) - (3); in the region above 10 MeV, the evaluation was made taking into account the existing experimental data.

MT = 4 Total neutron inelastic scattering cross-section: 4 = 41+52+...+82.

MT = 16 (n,2n) reaction cross section.

MT = 51-82 Neutron inelastic scattering cross-section with excitation of resolved levels. Given in the region E_{lev} = 2.313 - 18.75 MeV. The excitation functions for inelastic scattering were obtained by the Hauser-Feshbach model taking into account the experimental data.

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MT = 102 Fast neutron radioactive capture cross-sections.

MT = 103 (n,p) reaction cross-section: 103 = 700+...+704.

MT = 104 (n,d) reaction cross-section: 104 = 720+...+723.

MT = 105 (n,t) reaction cross-section: 105 = 740+...+741.

MT = 107 (n,α) reaction cross-section: 107 = 780+...+790

MT = 108 (n,2α) reaction cross-section - based on the Hauser-Feshbach model.

MT = 251, 252, 253 Calculated on the basis of evaluated data taken in the file.

MT = 700-704 (n,p) reaction cross-section for the ground state of the C-14 nucleus and the first four excited levels.

MT = 720-723 For (n,d) with excitation of the residual C-13 nucleus levels.

MT = 740, 741 For (n,t) with excitation of the residual C-12 nucleus levels.

MT = 780-790 For (n,α) with excitation of the levels of the residual B-11 nucleus levels.

MF = 4 Angular distributions of secondary neutrons:

MT = 2 The angular distributions of elastically scattered neutrons were obtained on the basis of experimental data in the region up to 15 MeV; for E_n > 15 MeV the optical model results were used.

MT = 16 Isotropic in the centre-of-mass system for neutrons from the (n, 2n) reaction.

MT = 51-62 Based on calculation by the Hauser-Feshbach model.

MT = 63-82 Isotropic in the centre-of-mass system.

MF = 5 The energy distributions of secondary neutrons are given only for the (n,2n) reaction.

MF = 12, MT = 102 Multiplicity of photons from the (n,γ) reaction.

MF = 13, MT = 4, 103, 104, 105, 107 Cross-sections for photon production from reactions (n,n'), (n,p), (n,d), (n,t) and (n,α), respectively.

MF = 14, MT = 4, 102, 103, 104, 105, 107 Angular distributions of photons from reactions (n,n'), (n,γ), (n,p), (n,d), (n,t) and (n,α), respectively.

In the region from 3.0 MeV to 2.0 MeV the file contains the results of evaluation from the ENDF/B-4 library [8]. This was based on the comparison of the results of this evaluation [8] with the data of the analytical review by M.N. Nikolaev et al. [1]. The comparison clarified the following:

1. In the 3.0-5.3 MeV region the ENDF/B-4 took the cross-sections recommended on the basis of the R-matrix analysis in Ref. [7]. These were the data recommended also in Ref. [1];

2. The evaluation adopted in ENDF/B-4 took into account the unpublished data on neutron inelastic scattering, which possibly permitted a more sound selection of cross-sections than in Ref. [1];

3. The evaluated data from ENDF/B-4 were quite successfully tested in an integral experiment with a 14-MeV neutron source [9];

4. The evaluation results for the cross-sections of reactions with charged-particle emission in Refs [1] and [8] are close to each other, and the (n,p) reaction cross-section data are in agreement with the evaluation of the Nuclear Data Centre [10].

MF = 4 --------------------- ANGULAR DISTRIBUTIONS ---------------------

In the region from 1.0E-5 eV to 3.0 MeV region the file contains the results of evaluation performed by M.N. Nikolaev et al [1]. The angular distributions of elastic neutron scattering are represented by a Legendre polynomial expansion in the centre-of-mass system. The energy dependences of the expansion coefficients were calculated by the multilevel (S-matrix) formula of Ref. [2] using the resonance parameters (see MF = 3). The results of calculation of anisotropicity in the neighbourhood of the first four resonances (up to ~ 1.67 MeV) agree satisfactorily with the most detailed data of Ref. [11] and are not in conflict with the data of other studies. From 1.67 MeV to 3.0 MeV there were no detailed data on the energy dependence of the anisotropy of elastic scattering.

In the neighbourhood of 3.0 MeV the data of Ref. [1] are in smooth agreement with the ENDF/B-4 evaluation data and, above 3.0 MeV, the file contains the ENDF/B-4 evaluation results.

MF = 7, 12, 13, 14 ---

The file contains the ENDF/B-4 evaluation results.

8 - 0-16 Power Phys. Inst. - GCL Eval. 1978 Dist. 1979 Mod. 1980

Scient. Head - M.N. Nikolaev
Compiler - V.N. Koshcheev
Resp. for evaluation -
L.P. Abagyan
N.O. Bazazyants
M.N. Nikolaev

OXYGEN-16

MF = 2 ---------- RESONANCE PARAMETERS

MT = 151

The potential scattering radius is taken to be 5.804 fm. Resonance parameters are not given.

MF = 3 ---------- SMOOTH CROSS-SECTIONS

For E = 0.0253 eV:
SIG TOT = 3.76 b.
SIG GAM = 0.00027 b.

In the region from 1.0E-5 eV to 3.0 MeV the file contains the results of evaluation performed by M.N. Nikolaev et al [1]. The energy dependances of the cross-sections were calculated by the multilevel (S-matrix) formula [2] using the following resonance parameters:

E (MeV)	L	J^π	GN (MeV)
-3,272	0	I/2 +	0,37
0,442	I	3/2 -	0,046
I,000	2	3/2 +	0,I00
I,3I2	I	3/2 -	0,042
I,660	3	5/2 -	0,007
I,840	2	5/2 +	0,008
I,9I0	I	I/2 -	0,030
2,350	0	I/2 +	0,I20

The radiation widths of all resonances were taken to be zero.

The results of calculation of the total cross-section for these parameters satisfactorily decribe the set of experimental data from Refs [3, 4, 5, 6].

The radiative capture cross-section in the region below 3.0 MeV is taken to be subject to law 1/V.

11 - Na-23 Power Phys.Inst. - GCL Eval.1978 Scientific Head - M.N. Nikolaev
Dist.1980 Compiler - V.N. Koshcheev
Mod. 1982 Resp. for evaluation:
N.O. Bazazyants
V.N. Koshcheev
M.N. Nikolaev

---------------------------------- SODIUM-23 ----------------------------------

MF = 2 ------------------- Resonance parameters -------------------

MT = 151

Resolved resonances region - from 465 eV to 400 keV.

Main source of resonance parameters - BNL-325 [1].

The parameters were corrected taking into consideration Refs [2-4]. Three p-resonances were added. The resonance with E = 201.1 keV was identified as a p-resonance (L = 1, J = 1).

The use of the multilevel Breit-Wigner formula is prescribed.

No unresolved resonance region.

MF = 3 ------------------- SMOOTH CROSS-SECTIONS -------------------

For E = 0.0253 eV:
SIG TOT = 3.73 b.
SIG GAM = 0.530 b.

MT = 1 Total cross-section

Up to 465 eV the results of Refs [2, 5, 6] were used in the evaluation.

In the region from 465 eV to 400 keV, a smooth positive background is given to the cross-section calculated from the resonance parameters by the GRUKON program [29].

Above 400 keV the evaluated curve was obtained on the basis of experimental studies [3, 7, 8, 9].

MT = 2 Elastic scattering

The elastic scattering cross-section was determined as the difference between the total cross-section and the inelastic interaction cross-section.

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MT = 91   Inelastic scattering to a continuum of levels

It was determined as the difference between the total inelastic scattering cross-section and the sum of inelastic scattering cross-sections to discrete levels.

MT = 102   Radiative capture

Below 4.65 eV, the cross-section energy dependence 1/V was taken.

In the region from 4.65 eV to 465 eV the curves from the thermal region and from the resonance energy region match smoothly.

In the region from 465 eV to 400 keV, to take into account the contribution of unresolved resonances, a smooth background is added to the cross-section calculated from the resonance parameters by the GRUKON program [29].

Above 400 keV the evaluated curve was obtained on the basis of the data of Refs [4, 20].

MT = 103   (n,p) reaction

The study of Bychkov et al. [16] was used as the basis. Moreover, the results of Refs [4, 21, 22, 23, 24] were taken into account in the evaluation. The cross-section resonance structure observed in the experimental studies was smoothed out for the reason indicated earlier (see MF = 3, MT = 4).

MT = 107   (n,α) reaction

The study of Bychkov et al. [16] was used as the basis. Moreover, the results of Refs [4, 21, 22, 23, 24] were taken into account in the evaluation.

MF = 4   ---------------------- ANGULAR DISTRIBUTIONS ----------------------

MT = 2   Elastic scattering

The angular distributions of elastically scattered secondary neutrons are given in the form of a Legendre polynomial expansion in the laboratory system. The expansion coefficients and their energy dependence were taken from Nikolaev and Bazazyants [25]. In the evaluation account was taken of the results of Popov and Trykov [26] and also of data from Refs [27, 28].

MT = 16, 22, 28, 51-61, 91   The angular distributions were taken to be isotropic in the centre-of-mass system.

MT = 4 Inelastic scattering

The inelastic scattering cross-section was determined on the basis of all experimental studies published up to and including the year 1977.

The resonance character of the cross-section observed in experiments up to 4 MeV was smoothed out; since the resonance structure has not been fully resolved experimentally and the correlations of the observed structure with the total cross-section structure are weak, the resonance self-shielding effect cannot therefore be taken into account with an acceptable accuracy.

At E = 14.6 MeV the cross-section was fitted to the experimental point of Degtirev et al. [10].

MT = 16 (n,2n) reaction

The results of Refs [11, 12] were used as the basis. The evaluated curve passes above the experimental data of Refs [13, 14, 15] but agrees satisfactorily with the later evaluation of Bychkov et al [16].

MT = 22 (n,αn) reaction

The reaction cross-section was taken from the data of Ref. [24]. No experimental data exist.

MT = 28 (n,pn) reaction

The reaction cross-section was taken from the data of Ref. [24]. No experimental data exist.

MT = 51-61 Inelastic scattering to discrete levels

The discrete level scheme for inelastic scattering was taken from Ref. [19].

The inelastic scattering cross-section for discrete levels was evaluated:

Up to 4 MeV, on the basis of the set of experimental data given in Ref. [17];

Above 4.0 MeV on the basis of the set of experimental data given in Ref. [18].

The resonance character of the cross-sections of the first two levels with E_x = 439 keV and E_x = 2.078 MeV was smoothed out for the reason indicated above (see MF = 3, MT = 4).

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MF = 5 ---------------------- ENERGY DISTRIBUTIONS ----------------------

MT = 16 (n,2n) reaction

The secondary neutron energy spectrum is given pointwise; it was calculated by the neutron evaporation model using the NEVA program.

MT = 22 (n,αn) reaction

An evaporation spectrum with an effective nuclear temperature of 1.0 MeV is given.

MT = 28 (n,pn) reaction

An evaporation spectrum with an effective nuclear temperature of 1.0 MeV is given.

MT = 91 Inelastic scattering to a continuum of levels:

Up to the threshold of the (n,2n) reaction, i.e. up to 12.96 MeV, the evaporation spectrum with an energy-dependent nuclear temperature is taken;

Above 12.96 MeV the scattered neutron spectrum is given pointwise on the basis of calculation by the NEVA program.

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(For original English references, see next page.)

MT = 22,28 The cross-section of (n,nα) and (n,np) reactions were calculated by the STAPRE program.

MT = 102 The neutron radiative capture cross-sections in the region from 1.56 to 6 MeV were taken on the basis of statistical calculations; above, we used the empirical systematics of experimental data in the direct-collective neutron capture model.

MT = 103 The cross-section of the (n,p) reaction was taken from the evaluation of Ref. [5].

MT = 104, 105, 106 and 107 The cross-section of reactions (n,d), (n,t), (n,^{3}He) and (n,α), respectively, were obtained from the systematics of the statistical calculations of the threshold reaction cross-sections taking into account the possible contributions of the direct processes [6].

MT = 203, 207 The proton and alpha-particle yield cross-sections were obtained as the sum of sections 28, 103, 719 and 22, 107, 799, respectively.

MT = 251 The average cosine for neutron inelastic scattering (in the laboratory system) was obtained from the data of section MF = 4, MT = 2.

MT = 252, 253 Calculated from MT = 251

MT = 700-799 Partial excitation functions for discrete levels and a continuum of residual nuclei in threshold reactions with charged-particle yield. Calculated by the STAPRE program with the addition of the direct-process contributions [6].

MF = 4 Angular distributions of secondary particles

MT = 2 The distributions of elastically scattered neutrons in the region up to 7 MeV were taken from the ENDF/B-4 evaluation [7]. In the region from 7 to 14 MeV, they were determined from the description of experimental data [8] and, above, they were obtained from calculations by the optical model [1].

MT = 16, 22, 28 Taken to be isotropic in the laboratory system.

MT = 51-72 The angular distributions were obtained from statistical calculations taking into account the contribution of neutron direct inelastic scattering to low-lying collective levels [1].

MT = 700-799 Angular distributions of charged particles evaluated as the superposition of the contributions of the statistical and direct reaction mechanisms. For the continuum regions, isotropic angular distributions were taken.

14 - Si-00 | MAT = 1402

14 - Si-00 | Dresden Tech. Univ. | Evaluation - 1985
Power Phys. Inst.

Authors of evaluation: D. Hermsdorf, A.I. Blokhin and A.V. Ignatyuk
Compiler of the file: D. Hermsdorf

Content of the file:

MF = 1 General information

MT = 451 History, dictionary, comments on evaluations and references.

The previous version of the silicon file was prepared at Dresden Technical University in 1981 [1]. The cross-sections for the resolved resonance region, the fast-neutron capture cross-sections and the (n,p) reaction cross-sections have been revised in the present new version.

MF = 2 Resonance parameters

Resolved resonances: 10^{-5} eV-1.56 MeV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [2]. Includes negative resonances with parameters describing the neutron thermal capture cross-sections [2].

Calculated cross-sections for 2200 m/sec:

Total = 2.34 b, elastic = 2.17 b, capture = 0.17 b.

Capture resonance integral above 0.5 eV = 0.12 b.

MF = 3 Neutron cross-sections:

MT = 1 In the region up to 1.56 MeV the background is zero. Above, the cross-sections are taken from Cierjacks' data [3].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-72, 91 The inelastic scattering cross-sections were obtained from the statistical description of the set of experimental data taking into account the direct mechanism of excitation of low-lying levels [1]. For the continuum (MT = 91), account was taken of the pre-equilibrium emission of neutrons [1].

MT = 16 The cross-section of the (n,2n) reaction was obtained on the basis of statistical calculations by the STAPRE program [4] with parameters fitted to experimental data [1].

24 - Cr-000	MAT = 2400	
24 - Cr-000	Power Physics Inst. (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1984 Checking - 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, V.V. Vozyakov, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin, A.B. Pashchenko and V.I. Popov.

Compilers of the file: A.I. Blokhin, N.N. Buleeva and O.A. Pakhomova.

Content of the file:

MF = 1 General Information

MT = 451 Comments and dictionary.

MF = 2 Resonance parameters

MT = 151 Resonance parameters are given in the 10^{-5} eV-642.8 keV region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p-resolved resonances are known in different energy regions, for the correct representation of cross-sections in the resonance region the following representation was used: in the 10^{-5} eV-642.8 keV region the resonance parameters are given for each chromium isotope separately; each chromium isotope was regarded as a mixture of two pseudoisotopes with identical isotopic mass and concentration, ABN of the isotope in natural chromium. The first pseudoisotope contains data for the s-wave and the second for the p- and d-waves. Table 1 gives the main parameters for the chromium isotopes ^{50}Cr, ^{52}Cr, ^{53}Cr and ^{54}Cr. The parameters of the resolved s- and p-resonances (NC is the number of resonances) are given in the 10^{-5} eV-E^{ℓ}_{bound} region. In the E^{ℓ}_{bound}-642.8 keV region the unresolved resonance parameters for the s-, p- and d-waves are given.

In this approach it was possible without using a background in the cross-sections to introduce different energy regions E^{1}_{bound} for the resolved s- and p-waves. The evaluation procedure is given in Ref. [1]. In the resolved resonance region mainly the resonance parameters from Ref. [2] were used. The average resonance parameters, whose values are given in Table 1, were used in the unresolved resonance region. In the description of thermal cross-sections, negative s-resonances with energies E_{neg} were employed (see Table 1).

For calculation of cross-sections in the 10^{-5} eV-642.8 keV region the multi-level Breit-Wigner formalism is recommended.

MF = 5 Energy distributions of secondary particles

MT = 16, 22, 28, 29 The secondary neutron spectra were obtained with allowance for the pre-equilibrium processes on the basis of the STAPRE program [1].

MT = 718, 719, 738, 798, 799 The charged-particle spectra were obtained from calculations by the STAPRE program [6].

MF = 13 Photon yields

MT = 4 Convention on the Physical Protection of Nuclear Material the evaluated excitation functions for discrete levels and gamma transitions in the continuous spectrum calculated by the STAPRE program.

MT = 16, 22, 28, 103, 107, 719, 799 The photon yields for the corresponding threshold reactions were obtained on the basis of the STAPRE program.

MF = 14 Angular distributions of photons.

Taken to be isotropic for all transitions.

MF = 15 Energy distributions of photons

The photon spectra were taken from calculations by the STAPRE program.

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MT = 4 Total neutron inelastic scattering cross-section: 4 = 51 + ... + 90 + 91.

MT = 16, 28, 103, 107 Cross-sections of reactions (2,2n), (nnp + npn), (n,p) and (n,α), respectively. The excitation function data were calculated for each chromium isotope separately by the generalized superfluid model [4] with allowance for the pre-equilibrium processes. Then the cross-sections of these reactions were obtained for natural chromium.

MT = 22, 104, 105, 106 The (n$n\alpha$), (nd), (n,t) and (n,^{3}He) reaction cross-sections were taken from ENDF/B-4.

MT = 51-90 and 91 Neutron inelastic scattering cross-sections with excitation of resolved levels and through the continuum (MT = 91).

The energies of the resolved levels are given in the 564 keV-3.30 MeV region. The continuum energy is equal to 3.22 MeV. For MT = 51-74 and 91, the results of Refs [5, 6] obtained for different chromium isotopes were used.

MT = 102 The fast-neutron radiative capture cross-sections in the 642.8 keV-2 MeV region were calculated by the statistical approach for each isotope. For energies E_n = 2-20 MeV the cross-sections were obtained with allowance for the contribution of the direct capture mechanism and the systematics of data for 14.5 MeV.

MT = 251 The average cosine of neutron elastic scattering was calculated from the angular distributions taken.

MT = 252, 253 Calculated from the evaluated data taken in the file.

MF = 4 Secondary neutron angular distributions:

MT = 2 The angular distributions of elastically scattered neutrons are represented in the form of Legendre coefficients. In the region below 1 MeV and above 14 MeV the data were taken from ENDF/B-4. In the 1-14 MeV region our evaluation of angular distributions was obtained by the phenomenological approach, in which the theoretical calculations of cross-sections by the optical model [1, 4] were then corrected on the basis of experimental data.

MT = 16, 22, 28, 51-91 The angular distributions of secondary neutrons from the (n,2n), (n,nα), (n,np) and (n,n') reactions were taken to be isotropic.

Table 1. Parameters used for the chromium isotopes

Parameters	^{50}Cr	^{52}Cr	^{53}Cr	^{54}Cr
R, fm	5,0	5,2	5,4	5,3
$S_0 \cdot 10^4$	3,6	5,2	5,0	2,8
$S_1 \cdot 10^4$	0,33	0,5	0,5	0,7
$S_2 \cdot 10^4$	3,6	2,5	2,6	2,8
$S_3 \cdot 10^4$	0,33	0,5	0,5	0,7
$\Gamma_{\gamma 0}$, eV	1.5	1,85	2,3	2,5
$\Gamma_{\gamma 1}$, eV	0,6	0,31	0,35	0,28
$\Gamma_{\gamma 2}$, eV	0,8	0,95	1,0	1,0
$\Gamma_{\gamma 3}$, eV	0,6	0,31	0,35	0,28
D_0, keV	15	42	7,1	26
D_1, keV	4,1	14	4,8	7,5
D_2, keV	3,0	8,4	1,42	5,2
D_3, keV	2,1	6	1,01	3,6
$E^{l=0}_{bound}$, keV	500	500	200	300
$E^{l=1}_{bound}$, keV	150	270	70	80
$E^{l=0}_{neg}$, keV	-0,509	-6,78	-1,6 -0,91	-10,23
ABN, %	4,35	83,79	9,50	2,36
$NC^{l=0}$	43	16	36	17
$NC^{l=1}$	47	50	41	16

Calculated cross-sections for 2200 m/sec:

Total = 6.48 b, elastic = 3.51 b, capture = 2.97 b.

MF = 3 Neutron cross-sections:

In the 10^{-5} eV-642.8 keV region, the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the 642.8 keV-20 MeV region, the experimental data of Perrey [3] were used. These were also used in fitting the parameters of the generalized optical model [4].

MT = 2 Elastic scattering cross-section = total - (cross-sections of all other processes).

MT = 3 Sum of cross-sections of all partial processes except elastic scattering: 3 = 4 + 16 + 22 + 28 + 102 + 103 + 104 + 105 + 106 + 107.

24 - Cr-50   MAT = 2411

24 - Cr-50   Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)   Evaluation - 1984

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko

Compilers of the file: A.I. Blokhin, N.N. Buleeva and O.A. Pakhomova

Content of the file:

MF = 1 General information

MT = 451 Comments and dictionary

MF = 2 Resonance parameters

MT = 151 Resonance parameters are given in the 10^5eV-642.8 keV region.

The neutron resonance energy region is given with the help resolved and unresolved resonance parameters for the s-, p- and d-waves. Since s- and p-resolved resonances are known in different energy regions, to represent cross-sections correctly in the resonance energy region we used the representation of two pseudoisotopes: the ^{50}Cr nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second for the p- and d-waves. It was thus possible without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The evaluation procedure is given in Ref. [1].

The first pseudoisotope is for consideration of the conttribution of the s-wave. The resolved resonance region from 10^{-5} eV to 500 keV contains data for 43 s-resonances up to the energy of 590.7 keV.

The unresolved parameters are given in the 500-642.8 keV region at four energy points.

The second pseudoisotope is for consideration of the contribution of the p- and d-waves. In the resolved resonance region (10^{-5} eV-150 keV) 47 p-resonances are given up to the energy of 472 keV. The unresolved parameters are given in the 150-642.8 keV region for the p- and d-waves at eight energy points.

In the resolved resonance region, mainly the resonance parameters from Ref. [2] were used. In the unresolved resonance region we employed the following average resonance parameters:

MF = 5 Secondary neutron energy distributions:

MT = 16, 22, 28, 91 The neutron spectra from the (n,2n), (n,nα), (n,np) and (n,n') reactions were represented on the basis of the evaporation model with a temperature approximation.

MF = 12 MT = 102 Multiplicity of photons from the (n,γ) reaction.

MF = 13 MT = 3 Photon production cross-section in non-elastic reactions.

MF = 14 MT = 3, 102

MF = 15 MT = 3, 102 Angular and energy distributions, respectively, of photons from reactions from MT = 3, 102.

The data for MF 12, 13, 14 and 15 were taken from ENDF/B-4 and corrected for the corresponding evaluated data taken in the present evaluation.

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Korzh, I.A. et al., ibid. p. 60.

(For original English references, see below.)

I. Т.С.Беланова и др. Материалы 6-ой Всесоюзной конференции по не тронной физике. (Киев, 2-6 октября 1983г.), М., 1984, т.3, с.54 См. также INDC(NDS) - 152/L, 1984.
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Корж И.А. и др. Там же, с.60.

MT = 51-70 Neutron inelastic scattering cross-section with excitation of resolved levels.

For MT = 51-55 the results of the evaluation of Ref. [5] were used, and MT = 56-70 were taken from JENDL-2.

MT = 91 Inelastic scattering cross-section through a continuum. A continuum of levels above 4.066 MeV. Data taken from JENDL-2.

MT = 102 The neutron radiative capture cross-section was calculated by the statistical approach taking into account the contributions of the direct capture mechanism.

MT = 251 Average cosine of neutron elastic scattering. Taken from JENDL-2.

MF = 4 The secondary neutron angular distributions are given with the help of coefficients.

MT = 2 The angular distributions of elastically scattered neutrons were calculated by the optical model in the centre-of-mass system.

MT = 16, 28 Isotropic in the laboratory system of co-ordinates.

MT = 51-70, 91 Symmetrical in the laboratory system of co-ordinates.

MF = 5 Secondary neutron energy distributions:

MT = 16, 28, 91 The evaporation spectra were taken from the JENDL-2 library.

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Radius of the nucleus: R = 5.0 fm

Neutron strength functions:

$S_0 = 3.6 \times 10^{-4}$
$S_1 = 0.33 \times 10^{-4}$
$S_2 = 3.6 \times 10^{-4}$
$S_3 = 0.33 \times 10^{-4}$

Average resonance widths:

$\Gamma_{\gamma 0} = 1.5$ eV
$\Gamma_{\gamma 1} = 0.6$ eV
$\Gamma_{\gamma 2} = 0.8$ eV
$\Gamma_{\gamma 3} = 0.6$ eV

Neutron resonance density:

$D_0 = 15$ keV
$D_1 = 4.1$ keV
$D_2 = D_0/5 = 3$ keV
$D_3 = D_0/7 = 2.14$ keV

For calculation of the cross-sections in the 10^{-5} eV-642.8 keV region the multilevel Breit-Wigner formalism is recommended.

Calculated cross-sections for 2200 m/sec:

Total = 20.48 b, elastic = 2.90 b, capture = 17.58 b.

MF = 3 Neutron cross-sections:

In the 10^{-5} eV-642.8 keV region the background in the cross-sections is zero.

MT = 1 The total cross-sections were calculated by the optical model with the parameters from Ref. [3].

MT = 2 Elastic scattering cross-sections = total - (cross-sections of all other processes).

MT = 4 Total neutron inelastic scattering cross-sections:

4 = 51 + ... + 70 = 91.

MT = 16, 103, 107 The (n,2n), (n,p) and (n,α) reaction cross-sections were calculated by the generalized superfluid model with allowance for the pre-equilibrium processes [4].

MT = 28 The (n,np) + (n,pn) reaction cross-sections were calculated by the statistical model and normalized to experimental data in the region of $E_n = 14.5$ MeV.

In the resolved resonance region, mainly the resonance parameters from Ref. [2] were used. In the unresolved resonance region the following average resonance parameters were employed: R = 5.2 fm, neutron strength functions:

$s_0 = 2.5 \times 10^{-4}$,
$s_1 = 0.5 \times 10^{-4}$,
$s_2 = 2.5 \times 10^{-4}$,
$s_3 = 0.5 \times 10^{-4}$,

average radiation widths:

$\Gamma_{\gamma 0} = 1.85$ eV
$\Gamma_{\gamma 1} = 0.31$ eV,
$\Gamma_{\gamma 2} = 0.95$ eV,
$\Gamma_{\gamma 3} = 0.31$ eV,

neutron resonance density:

$D_0 = 42$ keV,
$D_1 = 14$ keV,
$D_2 = D_0/5 = 8.4$ keV,
$D_3 = D_0/7 = 6$ keV

For calculation of cross-sections in the 10^{-5} eV-642.8 keV region the multilevel Breit-Wigner formalism is recommended. In the description of the thermal cross-sections, a negative s-resonance with -6.87 keV energy is used [2].

Calculated cross-sections for 2200 m/sec:

total = 3.78 b, elastic = 3.05 b, capture = 0.73 b.

MF = 3 Neutron cross-sections:

In the region up to 642.8 keV the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the region of E_n = 642.8 keV, they were obtained by the generalized optical model with parameters from Ref. [3].

MT = 2 Neutron elastic scattering cross-sections = total - (sum of the cross-sections of the other processes).

MT = 4, 51-73, 91 Neutron inelastic scattering cross-sections. For 51-57 the results of Refs [4, 5] were used, and 58-73 and 91 were taken from JENDL-2.

24 - Cr-52
24 - Cr-52

MAT = 2421
Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy) Evaluation - 1984

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko
Compilers of the file: A.I. Blokhin, N.N. Buleeva and O.A. Pakhomova

Content of the file

MF = 1 General information

MT = 451 Comments and dictionary

MF = 2 Resonance parameters:

MT = 151 Resonance paramaters are given in the 10^{-5} eV-642.8 keV region.

The region of neutron resonance energies is given with the help of the resolved and unresolved resonance parameters for the s- , p- and d-waves. Since the s- and p-resolved resonances are known in different energy regions, to represent the cross-sections correctly in the resonance energy region, we used the representation of two pseudoisotopes: the ^{52}Cr nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second for the p- and d-waves. In this manner it was possible without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The evaluation method is given in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV to 500 keV contains the data for 16 s-resonances up to 628.5 keV. The unresolved parameters are given in the 500-642.8 keV region at four energy points.

The second pseudoisotope was used to take into account the p- and d-waves. In the resolved resonance region (10^{-5} eV-270 keV) 50 p-resonances are given up to 442 keV. The unresolved parameters are given in the 270-642.8 keV region for the p- and d-waves at eight energy points.

24 - Cr-53 MAT = 2431

24 - Cr-53 Nuclear Data Centre, (USSR State Committee on the Utilization of Atomic Energy) Evaluation - 1984

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko

Compilers of the file: A.I. Blokhin, N.N. Buleeva and O.A. Pakhomova

Content of the file:

MF = 1 General information

MT = 451 Comments and dictionary

MF = 2 Resonance parameters:

MT = 151 Resonance parameters are given in the 10^{-5} eV-642.8 keV region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p-resolved resonances are known in different energy regions, to represent the cross-sections correctly in the resonance energy region, we used the representation of two pseudoisotopes: the ^{53}Cr nucleus was regarded as the mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second for the p- and d-waves. In this manner it was possible without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The method of evaluation is given in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV to 200 keV contains the data for 36 s-levels up to 246 keV. The unresolved parameters are given in the 200-642.8 keV region at seven energy points.

MT = 16, 28, 103, 107 The cross-sections of reactions (n,2n), (nnp + npn), (n,p), (n,α) were obtained by the generalized superfluid model with allowance for the contribution of non-statistical processes [6].

MT = 102 The radiative capture cross-section for fast neutrons up to 2 MeV was obtained on the basis of the statistical description, and above 2 MeV, it was based on the systematics of experimental data and the direct-collective model of neutron capture.

MT = 251 The average cosine of the angle of neutron elastic scattering was obtained from the angular distributions taken.

MF = 4 Secondary neutron angular distributions

MT = 2, 51-73, 91 Taken from JENDL-2.

MF = 5 Secondary neutron energy distributions

MT = 16, 28, 91 A temperature approximation of evaporation spectra was used.

REFERENCES

1. Balanova, T.S., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1982) Moscow 3 (1984) 54 (in Russian).

2. Mughabghab, S.F., et al., Neutron Cross Sections, Vol. 1, part. A, Academic Press (1981).

3. Lunev, V.P., Ignatyuk, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

4. Vozyakov, V.V., Lunev, V.P., Popov, V.I., ibid., No. 4(48) (1982) 44.

5. Pravdivyj, N.M., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983) 3 (1984) 78 (in Russian).

6. Blokhin, A.I., et al., Izv. Akad. Nauk. SSSR, Ser. Fiz. 49(5) (1985) 962.

MT = 1 Total cross-sections:

In the region of E_n = 642.8 keV-20 MeV the total cross-sections were calculated by the generalized optical model with parameters from Ref. [3].

MT = 2 Neutron elastic scattering cross-section = total - (sum of the cross-sections of the other processes).

MT = 4,51-72,91 Neutron inelastic scattering cross-sections. For 51-54 we used the results of Refs [4, 5], and 58-72 and 91 were taken from JENDL-2.

MT = 16,28,103,107 The cross-sections of reactions (n,2n), (nnp + npn), (n,p), (n,α) were obtained by the generalized superfluid model with allowance for the contribution of non-statistical processes [6].

MT = 102 The fast neutron radiative capture cross-section up to 2 MeV was obtained on the basis of the statistical description, and above 2 MeV, the evaluation was based on the systematics of experimental data in the direct-collective model of neutron capture.

MT = 251 The average cosine of the neutron elastic scattering angle was obtained from the direct angular distributions.

MF = 4 Secondary neutron angular distributions:

MT = 2,51-72,91 Taken from JENDL-2.

MF = 5 Secondary neutron energy distributions:

MT = 16,28,91 A temperature approximation of the evaporation spectra was used.

REFERENCES

1. Belanova, T.S., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983), Moscow 3 (1984) 54 (in Russian).

2. Mughabghab, S.F., et al., Neutron Cross-Sections, Vol. 1, part. A, Academic Press (1981).

3. Lunev, V.P., Ignatyuk, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

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6. Blokhin, A.I., et al., Izv. Akad. Nauk. SSSR, Ser. Fiz. 49 (5) (1985) 962.

The second pseudoisotope was used to take into account the p- and d-waves. In the resolved resonance region (10^{-5} eV-70 keV) 41 p-levels are given up to 264.3 keV. The unresolved parameters are given in the 70-642.8 keV region for the p- and d-waves at ten energy points.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region, the following average resonance parameters were used:

radius of the nucleus R = 5.4 fm,

neutron strength functions:

$s_0 = 5 \times 10^{-4}$,
$s_1 = 0.5 \times 10^{-4}$,
$s_2 = 2.6 \times 10^{-4}$,
$s_3 = 0.5 \times 10^{-4}$,

average radiation widths:

$\Gamma_{\gamma 0} = 2.3$ eV,
$\Gamma_{\gamma 1} = 0.35$ eV,
$\Gamma_{\gamma 2} = 1.0$ eV,
$\Gamma_{\gamma 3} = 0.35$ eV,

neutron resonance density:

$D_0 = 7.1$ keV,
$D_1 = 4.8$ keV
$D_2 = D_0/5 = 1.42$ keV,
$D_3 = D_0/7 = 1.01$ keV

It is recommended that the cross-sections in the 10^{-5} eV-642.8 keV region should be calculated on the basis of the multi-level Breit-Wigner formalism. In order to describe the thermal cross-sections we used two negative s-resonances at -1.6 keV and -0.91 keV [2].

Calculated cross-sections at 2200 m/sec:

total = 24.86 b, elastic = 8.06 b, capture = 16.8 b.

MF = 3 Neutron cross-sections:

In the 10^{-5} eV-642.8 keV region the background in the cross-sections is zero.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region the following average resonance parameters were used:

radius of the nucleus R = 5.3 fm,

neutron strength functions:

$s_0 = 2.8 \times 10^{-4}$,
$s_1 = 0.7 \times 10^{-4}$,
$s_2 = 2.8 \times 10^{-4}$,
$s_3 = 0.7 \times 10^{-4}$,

average radiation widths:

$\Gamma_{\gamma 0} = 2.5$ eV,
$\Gamma_{\gamma 1} = 0.28$ eV,
$\Gamma_{\gamma 2} = 1.0$ eV,
$\Gamma_{\gamma 3} = 0.28$ eV,

neutron resonance density:

$D_0 = 26$ keV.
$D_1 = 7.5$ keV,
$D_2 = D_0/5 = 5.2$ keV,
$D_3 = D_0/7 = 3.6$ keV

For calculation of cross-sections in the 10^{-5} eV-642.9 keV region the multilevel Breit-Wigner formalism is recommended. In order to describe the thermal cross-sections, we used a negative s-resonance at -10.23 keV [2].

Calculated cross-sections for 2200 m/sec:

total = 3.15 b, elastic = 0.33 b, capture = 2.82 b.

MF = 3 Neutron cross-sections:

In the region up to 642.8 keV the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the region of E = 642.8 keV-20 MeV the total cross-sections were calculated by the generalized optical model with parameters from Ref. [3].

MT = 2 Neutron elastic scattering cross-section = total - (sum of the cross-sections of the other processes).

24 - Cr-54	MAT - 2441	
24 - Cr-54	Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1984

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashehenko
Compilers of the file: A.I. Blokhin, N.N. Buleeva and O.A. Pakhomova

Content of the file

MF = 1 General information

MT = 451 Comments and dictionary

MF = 2 Resonance parameters:

MT = 151 Resonance parameters are given the 10^{-5} eV-642.8 keV region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p-resolved levels are known in different energy regions, to represent the cross-sections correctly in the resonance energy region, we used the representation of two pseudoisotopes: the ^{54}Cr nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0).

The first pseudoisotope contains the data for the s-wave and the second for the p- and d-waves. Thus, it was possible without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The evaluation method is described in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV to 300 keV contains the data for 17 s-levels up to 393.5 keV. The unresolved parameters are given in the 300-642.8 keV region at six energy points.

The second pseudoisotope was used to take into account the p-and d-waves. In the resolved resonance region (10^{-5}eV-80 keV), 16 p-levels are given up to 387.5 keV. The unresolved parameters are given in the 80-642.8 keV region for the p- and d-waves at nine energy points.

26 - Fe-000 | MAT = 2601
26 - Fe-000 | Nuclear Data Centre | Evaluation - 1985

Authors of evaluation: V.G. Pronyaev, T.S. Belanova, A.V. Ignatyuk, V.N. Manokhin, A.B. Pashchenko and M.V. Skripova

Content of the file

The file for the natural mixture of iron isotopes was obtained in a consistent manner on the basis of the files for individual isotopes:

26 - Fe-54	MAT = 2611	5.8%
26 - Fe-56	MAT = 2621	91.72%
26 - Fe-57	MAT = 2631	2.2%
26 - Fe-58	MAT = 2641	0.28%

MF = 1 General information:

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonance region from 10^{-5} eV to E_{max} different for different isotopes and waves:

Isotope	L	R, fm	E_{max}, keV
26 - Fe-56	0	5.0	850
	1,2	5.0	350
26 - Fe-54	0	5.0	500
	1,2	5.0	200
26 - Fe-57	0,1,2	5.9	200
26 - Fe-58	0,1	5.0	200

A more detailed description is given in Ref. [2].

Unresolved resonance region:

Isotope	L	R, fm	E_{min}, keV	E_{max}, keV
26 - Fe-56	0	lacking		
	1,2	5.0	350	850
26 - Fe-54	0	lacking		
	1,2	5.0	200	500
26 - Fe-57	0,1,2	5.0	200	500
26 - Fe-58	0,1,2	5.0	200	500

The selection of the average resonance parameters for the individual isotopes is given in Ref. [2].

MT = 4, 51-72, 91 Neutron inelastic scattering cross-sections. For MT = 51-54 the results of Refs [4, 5] were used and 55-71, 91 were taken from JENDL-2.

MT = 16, 103, 107 The cross-sections of reactions (n,2n), (n,p) and (n,α) were obtained by the generalized superfluid model with allowance for the contribution of non-statistical processes [6].

MT = 102 The fast neutron radiative capture cross-section up to 2 MeV was obtained on the basis of the statistical description, and above 2 MeV, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 The average cosine of the neutron elastic scattering angle was obtained from the direct angular distributions.

MF = 4 Secondary neutron angular distributions:

MT = 2, 51-71, 91 Taken from JENDL-2.

MF = 5 Secondary neutron energy distributions:

MT = 16, 91 A temperature approximation of the evaporation spectra was used.

REFERENCES

1. Belanova, T.S., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983), Moscow 3 (1984) 54 (in Russian).

2. Mughabghab, S.F., et al., Neutron Cross-Sections, Vol. 1, part. A, Academic Press (1981).

3. Lunev, V.P., Ignatyuk, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

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5. Pravdivyj, N.M., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983), Moscow 3 (1984) 78.

6. Blokhin, A.I., et al., Izv. Akad. Nauk. SSSR, Ser. Fiz. 49 (5) (1985) 962.

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2. Pronyaev, V.G., Ignatyuk, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 2 (1986) (in Russian).

3. Pronyaev, V.G. in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 3 (1986) (in Russian).

Calculated cross-sections for 2200 m/sec:

total = 14.03 b, elastic = 11.44 b, capture = 2.59 b.

MF = 3 Neutron cross-sections

MT = 1 Total cross-sections

For the 850 keV-2.12 MeV region, the experimental data of Ref. [1] were taken.

For 2.12 MeV-20 MeV, superposition of the contribution from individual isotopes.

MT = 2 Elastic scattering cross-section = total - sum of all inelastic reactions.

MT = 4 Inelastic scattering:

Sum of the contributions from individual isotopes.

MT = 51-90 The evaluation includes the contributions from the levels of individual isotopes partially combined into level groups.

MT = 16, 22, 28, 102, 107 The cross-sections of reactions (n,2n), $(n,\alpha n)$, (n,pn), (n,γ), (n,p), (n,α) were obtained as the sum of the contributions of the cross-sections of individual isotopes.

MF = 4 Secondary neutron angular distributions:

MT = 2 The ENDF/B-4 evaluation for natural iron was used.

MT = 57-90 The same angular distributions are given as in the files for individual isotopes.

MT = 91, 16, 22, 28 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16 Gives the evaporation spectrum for the secondary neutron and a tabulated representation taking into account the superposition of the direct and compound processes for the primary neutron.

MT = 91 Gives a tabulated representation taking into account the superposition of the direct and compound processes.

V_o = 52.16-0.36·E, W_s = 5.0 + 0.16·E,
V_{so} = 6.2 MeV
R_o = R_s = R_{so} = 1.24 fm
a_o = a_x = a_{so} = 0.48 fm for E < 2 MeV
a_o = a_s = a_{so} = 0.58 fm for E > 3.35 MeV.

The diffusivities change smoothly between 2 and 3.35 MeV.

MT = 2 The elastic scattering cross-section was calculated by the optical-statistical model

MT = 4 Difference between the total cross-sections of all inelastic processes and the sum of the cross-sections of (n,p), (n,α), (n,np), (n,2n) and (n,γ).

MT = 16, 103, 107 The cross-sections of reactions (n,2n), (n,p), (n,α) were calculated by the statistical model with allowance for the pre-equilibrium processes.

MT = 28 Cross-section of reactions (n,np) + (n,pn). Obtained from empirical evaluation.

MT = 57-70, 91 The inelastic scattering cross-sections were calculated by the ABAREX program with the addition of the contribution of the direct processes [6]. The following level schemes and deformation parameters were used:

No.	Energy (MeV)	Spin-parity	β_λ	Structure
G.S.	0,0	0 +		
I	I,4082	2 +	0,I3	IPH
2	2,53,82	4 +	0,05	IPH
3	2,56I3	0 +	0,I3x0,I3	2PH,IxI
4	2,9499	6 +		
5	2,9590	2 +	0,098	IPH
6	3,I66I	2 +	0,I3x0,I3	2PH,IxI
7	3,2952	4 +	0,I3x0,I3	2PH,IxI
8	3,3450	3 -		
9	[illegible],8338	4 +	0,052	IPH
I0	4,033	4 +		
II	4,047	4 +		
I2	4,072	3 +		
I3	4,263	4 +	0,045	IPH
I4	4,29I6	0 +		
I5	4,578	2 +		
I6	4,655	2 +		
I7	4,696	4 +		
I8	4,700	3 +		
I9	4,780	3 -	0,069	IPH
20	4,949	4 +		

26 - Fe-54 MAT = 2611
26 - Fe-54 Nuclear Data Centre Evaluation - 1985

Authors of evaluation: V.G. Pronyaev, T.S. Belanova, A.V. Ignatyuk, V.N. Manokhin, A.B. Pashchenko and M.V. Skripova

Content of the file:

MF = 1 General information

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-500 keV for the s-wave, 10^{-5} eV-200 keV for the p- and d-waves. In order to take into account the differences in the energy regions, we used the representation of pseudoisotopes. The resonance parameters were taken from Refs [1-3]. The Reich-Moore description is recommended for pointwise calculation of the cross-sections (the use of the multilevel Breit-Wigner formalism will distort the interference of resonances). The potential scattering radius was taken as 5.0 fm, and widely separated s-resonances were introduced to take into account the energy changes in the radius.

Unresolved resonances: 200-500 keV for the p- and d-waves. We used the energy-dependent average resonance widths calculated by the EVPAR program [4]. The initial parameters were determined from the resolved resonance region [5]:

S1 = 0.43×10^{-4} S2 = 1.67×10^{-4} Sg1 = 1.62×10^{-4}

Sg2 = 1.09×10^{-4} D_1 = 3.43 keV D_2 = 4.14 keV R = 5 fm.

Calculated cross-sections for 2200 m/sec:

Total = 4.30 b, elastic = 2.16 b, capture = 2.14 b.

Capture resonance integral above 0.5 eV = 1.2 b.

MF = 3 Neutron cross-sections:

In the energy region up to 500 keV there is no background in the cross-sections.

MT = 1 The total cross-sections were calculated by the spherical model with the potential parameters:

26 - Fe-56 | MAT = 2621
26 - Fe-56 | Nuclear Data Centre | Evaluation - 1985

Authors of evaluation: V.G. Pronyaev, T.S. Belanova, A.V. Ignatyuk, V.N. Manokhin, A.B. Pashchenko and M.V. Skripova

Content of the file:

MF = 1 General information

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters

Resolved resonances: 10^{-5} eV-850 keV for the s-wave, 10^{-5} eV-350 keV for the p- and d-waves. The representation of pseudoisotopes was used to take into account the difference in the energy regions. The resonance parameters were taken from Refs [1-3]. The Reich-Moore description is recommended for pointwise calculation of cross-sections (the use of the multilevel Breit-Wigner formalism will distort the interference of resonances). The potential scattering radius was taken as 5.0 fm, and widely separated s-resonances were introduced to make allowance for energy changes in the radius.

Unresolved resonances: 350-800 keV for the p- and d-waves. The energy-dependent average resonance widths calculated by the EVPAR program [4] were used. The initial parameters were determined from the resolved resonance region [5]:

$S1 = 0.19 \times 10^{-4}$, $S2 = 1.68 \times 10^{-4}$, $S_{g1} = 0.864 \times 10^{-4}$,

$S_{g2} = 0.65 \times 10^{-4}$

$D_1 = 4.4$ keV, $D_2 = 4.2$ keV, $R = 5.0$ fm.

The radiation width for the d-wave was increased slightly in order to take into account the contribution of the f-wave to the capture cross-section.

Calculated cross-sections for 2200 m/sec:

Total = 14.9 b, elastic = 12.27 b, capture = 2.63 b.

Capture resonance integral above 0.5 MeV = 1.20 b.

MF = 3 Neutron cross-sections:

MT = 1 Total cross-sections. For the 850 keV-2.12 MeV region the experimental data for natural iron obtained with a high resolution [6] were taken for evaluation.

The continuum levels are assumed to be above 5.0 MeV with level density in the Gilbert-Cameron form and with parameters:

$T = 1.45$ MeV, $E_0 = 0.8$ MeV; $a = 6.15$ MeV^{-1}, $\sigma = 2.9$

MT = 102 The capture cross-sections in the 500 keV-5 MeV region were calculated by the ABAREX program with the radiation strength function selected from the description of the capture cross-section in the unresolved resonance region. Above 5 MeV the evaluation was based on the systematics of experimental data and the direct-collective capture model.

MT = 251 $\langle\mu\rangle$ - taken from ENDF/B-4 for natural iron.

MF = 4 Secondary neutron angular distributions:

MT = 2 Taken from the ENDF/B-4 library for natural iron.

MT = 51-70 Sum of the contributions of the direct and compound processes.

MT = 16, 28, 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 91 JENDL-2 evaporation spectra were taken.

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1. Mughabghab S.F., Divadeenam M., Holden N.E. Neutron Cross Sections, Vol.1, Part A, Academic Press, 1981.
2. Moxon M.C., Brisland J.B., Proc.of Specialist Meeting on Neutron Data of Structural Materials for Fast Reactors, Geel, 1977,p.689.
3. Brusegan A., Corvi F., Shelley R. et al. Proc. of Intern Conf. on Nuclesr Data for Science and Technology (Antwerp,1982), Brussels and Luxemburg, 1983, p. 135.
4. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technolgy, Ser. Nuclear Constants No. 1(50) (1983)50 (in Russian).
5. Pronyaev, V.G., Ignatyuk, A.V., ibid. No.2 (1986).
6. Pronyaev, V.G., ibid No.3 (1986).

No.	Energy (MeV)	Spin-parity	β_λ	Structure
G.S	0,0	0 +		
I	0,8468	2 +	0,23	IPH
2	2,085I	4 +	0,23x0,23	2PH, I⊗I
3	2,6576	2 +	0,08	IPH
4	2,94I7	0 +	0,23x0,23	2PH, I⊗I
5	2,9600	2 +	0,23x0,23	2PH, I⊗I
6	3,1200	(I +)		
7	3,1299	4 +	0,I	IPH
8	3,3702	2 +	0,05	IPH
9	3,3884	6 +	0,03	IPH
I0	3,4454	3 +		
II	3,4493	I +		
I2	3,6009	2 +		
I3	3,60I9	2 +	0,05	IPH
I4	3,6070	0 +		
I5	3,7480	2 +	0,08	IPH
I6	3,7558	6 +		
I7	3,832	2 +	0,05	IPH
I8	3,8565	3 +		
I9	4,0940	(3 +)		
20	4,I003	(3 +)		
2I	4,I200	(4 +)	0,07	IPH
22	4,2982	4 +		
23	4,302	(0 +)		
24	4,3950	4 +	0,05	IPH
25	4,40I	(2 +)		
26	4,4584	4 +	0,07	IPH
27	4,5I00	3 -	0,I7	IPH

The continuum of levels is assumed to be above 4.6 MeV with level density in the Gilbert-Cameron form and with parameters T = 1.26 MeV, E_0 = 0.8 MeV, a = 6.15 MeV^{-1}, σ = 2.9.

MT = 102 Capture cross-section in the region from 850 keV to 4.6 MeV. Calculated by the ABAREX program with the radiation strength function selected from the description of the capture cross-section in the unresolved resonance region. Above 4.6 MeV, the evaluation was based on the systematics of experimental data in the direct-collective capture model.

MT = 103, 107 The cross-sections of reactions (n,p) and (n,α) were calculated by the statistical model with allowance for pre-equilibrium processes.

For the 2.12 MeV-20 MeV region, results are given of optical model calculations with the following parameters of the Woods-Saxon potential:

Vo = 52.16-0.36•En, Vso = 6.2, Ws = 5 + 0.16•En MeV
Vo = Vso = Vs = 1.24 fm
ao = aso = as = 0.35 fm for En < 1 MeV
ao = aso = as = 0.58 fm for En > 4.0 MeV.

The diffusivities change smoothly between 1 and 4 MeV.

MT = 2 Elastic scattering:

Difference between the total and the sum of inelastic capture for En = 850-2.12 MeV. Results of calculation by the optical model for En = 2.12 MeV-20 MeV.

MT = 4 Inelastic scattering:

Data of Ref. [7] obtained with a high resolution for energies from 862.07 keV to 2.12 MeV. Difference between the total inelastic cross-section predicted by the optical and statistical model calculations and the sum of the cross-sections of reactions (n,p), (n,2n), (nα), (n,γ), (n,pn) + (n,n'p) and (n,αn) + (n,n'α).

MT = 16 The (n,2n) reaction cross-section was calculated by the statistical model with allowance for the pre-equilibrium processes.

MT = 22 (n,n'α) + (n,αn) reaction cross-section. Obtained from empirical evaluation.

MT = 28 (n,n'p) + (n,pn) reaction cross-section. Obtained from empirical evaluation.

MT = 51-77, 91 The inelastic scattering cross-sections were calculated with the addition of the contribution of the direct processes [8]. The following level scheme and deformation parameters were used:

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8. Проняев В.Г. - ВАНТ, сер. Ядерные константы, 1986, вып.3.

MT = 251 < μ > - taken from ENDF/B-4 for natural iron.

MF = 4 Secondary neutron angular distributions:

MT = 2 Taken from the ENDF/B-4 library for natural iron.

MT = 51-77 Sum of the contributions of the direct and compound processes.

MT = 16, 22, 28, 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16 Gives a tabulated representation for primary neutron emission and an evaporation spectrum for secondary neutron emission.

MT = 22, 28 Evaporation spectra are given.

MT = 91 Gives a tabulated representation obtained with allowance for the direct and compound processes and with the fitting of their contributions to the inelastic scattering cross-section; the following approximations were used:

(a) The primary neutron emission by the compound mechanism was approximated by an evaporation spectrum with $T = 0.3992 \cdot (E_0 - 1.7)$ MeV;

(b) The contribution of the direct processes to the spectra was assumed to be table-shaped;

(c) It was assumed that if secondary neutron emission was energetically possible, it occurred with a probability of 1 (photon competition was neglected).

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(For original English references, see next page.)

$a_o = a_s = a_{so} = 0.42$ fm for $E_n < 0.3$ MeV
$a_o = a_s = a_{so} = 0.58$ fm for $E_n > 4.0$ MeV

The diffusivities change smoothly between 0.3 MeV and 4.0 MeV.

MT = 2 The elastic scattering cross-section was calculated by the optical-statistical model with allowance for the contribution of the direct processes to inelastic scattering.

MT = 4 Difference between the total cross-section of all inelastic processes calculated by the ABAREX program and the sum of reactions (n,α), $(n,2n)$, (n,p) and (n,γ). It contains the contribution of reactions $(n,\alpha n)$ for energies above 7.5 MeV and (n,pn) for energies above 10.8 MeV.

MT = 16, 103, 107 The $(n,2n)$, (n,p) and (n,α) reaction cross-sections were calculated by the statistical model with allowance for the pre-equilibrium processes.

MT = 51-64, 91 The inelastic scattering cross-sections were calculated by the ABAREX program with the addition of the contribution of the direct processes [4]. The following level scheme and deformation parameters were used:

No.	Energy (MeV)	Spin-parity	Structure
G,S,	0,0	I/2 -	
I	0,0I44	3/2 -	
2	0,I366	5/2 -	0,23 IPxIPH $((I/2-)\otimes(2^+))$
3	0,3667	3/2 -	0,23 IP⊗IPH $((I/2-)\otimes(2^+))$
4	0,7067	5/2 -	
5	I,008	7/2 -	
6	I,I98	9/2 -	
7	I,265I	I/2 -	
8	I,3568	(I/2 -)	
9	I,6277	3/2 -	
I0	I,7257	3/2 -	
II	I,975	(I/2 -)	
I2	I,9894	9/2 -	
I3	2,II7	5/2 -	
I4	2,207	5/2 -	

26 - Fe-57 | MAT = 2631
26 - Fe-57 | Nuclear Data Centre | Evaluation - 1985

Authors of evaluation: V.G. Pronyaev, T.S. Belanova, A.V. Ignatyuk, V.N. Manokhin, A.V. Pashchenko and M.V. Skripova

Content of the file:

MF = 1 General information:

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-200 keV. Multilevel Breit-Wigner formula. Potential scattering radius - 5.9 fm. The resonance parameters were chosen on the basis of Refs [1, 2].

Unresolved resonances: from 200 keV to 500 keV. The average resonance parameters were obtained from the resolved resonance region [3]:

$S0 = 7.98 \times 10^{-4}$ $S1 = 1.13 \times 10^{-4}$ $S2 = 2.32 \times 10^{-4}$ $D_0 = 8.40$ keV $D_1 = 2.92$ keV $D_2 = 3.33$ keV

$S_{go} = 2.42 \times 10^{-4}$ $S_{g1} = 2.16 \times 10^{-4}$ $S_{g2} = 3.93 \times 10^{-4}$

R = 5.0 fm

Calculated cross-sections for 2200 m/sec:

Total = 4.57 b, elastic = 2.13 b, capture = 2.44 b.

Capture resonance integral for energies above 0.5 MeV = 1.45 b.

MF = 3 Neutron cross-sections

MT = 1 The total cross-section for the 14.65 keV-500 keV region contains a background equal to the inelastic scattering cross-section with excitation of the first levels. For energies from 500 keV - results are given of calculation by the spherical optical model with parameters:

$V_o = 51.16 - 0.36 \cdot E_n$, $W_s = 5.0 + 0.16 \cdot E_n$,
$V_{so} = 6.2$ MeV
$V_o = V_s = V_{so} = 1.24$ fm

26 - Fe-58 MAT = 2641
26 - Fe-58 Nuclear Data Centre Evaluation - 1985

Authors of evaluation: V.G. Pronyaev, T.S. Belanova, A.V. Ignatyuk, V.N. Manokhin, A.V. Pashchenko and M.V. Skripova

Content of the file:

MF = 1 General information

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: resolved resonance region 10^{-5} eV-200 keV for the s- and p-waves; the d-wave is absent. Multilevel Breit-Wigner formula. Parameters taken from Ref. [1].

Unresolved resonances: 200-500 keV. Energy-dependent average resonance widths calculated by the EVPAR program [2] were used. The initial parameters were determined from the resolved resonance region [3]:

So = 3.22×10^{-4} S1 = 0.6×10^{-4} S2 = 0.988×10^{-4}
D_o = 21.5 D_1 = 6.0 D_2 = 4.28 keV
Sg_o = 0.449×10^{-4} Sg_1 = 0.534×10^{-4} Sg_2 = 0.394 $\times 10^{-4}$

R = 5.0 fm.

Calculated cross-sections for 2200 m/sec:

Total = 4.46 b, elastic = 3.19 b, capture = 1.27 b.

Capture resonance integral above 0.5 eV = 1.56 b.

MF = 3 Neutron cross-sections:

In the region up to 500 keV there is no background in the cross-sections.

MT = 1 The total cross-sections were calculated by the spherical-optical model with the following potential parameters:

$V_o = 52.16 - 0.36 \cdot E_n$, $V_{so} = 6.2$, $W_s = 5.0 + 0.16 \cdot E_n$ MeV
$V_o = V_s = V_{so} = 1.24$ fm
$a_o = a_{so} = a_s = 0.38$ fm for E < 0.5 MeV
$a_o = a_{so} = a_s = 0.58$ fm for E > 4.0 MeV

The diffusivities change smoothly between 0.5 and 4.0 MeV.

The continuum of levels was assumed to be above 2.21 MeV with level density in the Gilbert-Cameron form and with parameters T = 1.26 MeV, E_0 = 0.4 MeV, a = 6.15 MeV^{-1}, σ = 2.9.

MT = 102 The capture cross-section in the 500 keV-2.21 MeV region was calculated by the ABAREX program with the radiation strength function selected from the condition of description of the capture cross-section in the unresolved resonance region. Above 2.21 keV, the evaluation was based on the systematics of experimental data and the direct-collective capture model.

MT = 251 < μ > - taken from ENDF/B-4 for natural iron.

MF = 4 Secondary neturon angular distributions:

MT = 2 Taken from the ENDF/B-4 library for natural iron.

MT = 51-64 Sum of the contributions of the direct and compound processes.

MT = 16, 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 91 Evaporation spectra were taken.

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2. Rohr, G., Müller, K.N., Z. Physik, 227, 1969, p. 1.

3. Pronyaev, V.G. Ignatyuk, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 2 (1986) (in Russian).

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region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region we used average resonance parameters, whose values are given in Table 1. In the description of the thermal cross-sections we employed negative s-resonances with energies E_{neg} (see Table 1).

Table 1. Parameters used for nickel isotopes

Parameters	^{58}Ni	^{60}Ni	^{61}Ni	^{62}Ni	^{64}Ni
R, fm	7,5	6,7	6,5	6,2	7,55
$S_0 \cdot 10^4$	2,8	2,7	3,2	2,8	2,9
$S_1 \cdot 10^4$	0,5	0,3	0,3	0,3	0,6
$S_2 \cdot 10^4$	2,8	2,7	3,2	2,8	2,9
$S_3 \cdot 10^4$	0,5	0,3	0,3	0,3	0,6
$\Gamma_{\gamma 0}$, eV	2,6	I,70	2,2	2,0	2,4
$\Gamma_{\gamma 1}$, eV	I,0	0,90	I,0	0,I7	0,2
$\Gamma_{\gamma 2}$, eV	0,55	0,24	0,36	0,I9	0,I4
$\Gamma_{\gamma 3}$, eV	0,50	0,48	0,49	0,I7	0,2
D_0, keV	I3,7	I6,0	I,8	I9,I	I9,9
D_1, keV	4,I	4,3	I,23	7,5	7,2
D_2, keV	2,74	3,2	0,36	3,82	3,98
D_3, keV	1,96	2,28	0,26	2,73	2,84
$E_{bound}^{l=0}$, keV	600	590	65	590	550
$E_{bound}^{l=1}$, keV	200	I50	30	I20	I50
$E_{neg}^{l=0}$, keV	-50,0 -28,5	-14,5	-0,0095	-0,077	-
ABN, %	68,27	26,10	1,13	3,59	0,91
$NC^{l=0}$	40	37	32	33	26
$NC^{l=1}$	I2I	69	24	49	37

The multilevel Breit-Wigner formalism is recommended for calculation of cross-sections in the 10^{-5} eV-690.0 keV region.

Calculated cross-sections for 2200 m/sec:

Total = 21.54 b, elastic = 17.60 b, capture = 3.94 b.

28 - Ni-000	MAT = 2800	
28 - Ni-000	Power Physics Institute (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1984 Checking - Power Phys. Inst., 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin, A.B. Pashchenko, V.I. Popov and V.V. Vozyakov

Compilers of the file: A.I. Blokhin, N.N. Buleeva and M.V. Deniskina

Content of the file

MF = 1 General information

MT = 451 Comments and dictionary.

MF = 2 Resonance parameters

MT = 151 The resonance parameters are given in the 10^{-5} eV-690 keV region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p-resolved resonances are known in different energy regions, to represent the cross-sections correctly in the neutron resonance region, we used the following representation:

- in the 10^{-5} eV-690.0 keV region the resonance parameters are given for each nickel isotope separately;

- each nickel isotope was regarded as a mixture of two pseudoisotopes with an identical isotope mass and concentration, ABN of the isotope in natural nickel. The first pseudoisotope contains the data for the s-wave and the second for the p- and d-waves. Table 1 gives the basic parameters for ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni and ^{64}Ni. The parameters of the resolved s- and p-resonances (NC_{ℓ} is the number of resonances) are given in the 10^{-5} eV - E^{ℓ}_{bound} region. In the E^{ℓ}_{bound}-690.0 keV region the unresolved resonance parameters are given for the s-, p- and d-waves.

By this approach, it was possible without using a background in the cross-sections, to introduce different E^{ℓ}_{bound} energy regions for the resolved s- and p-waves. The method of this evaluation is similar to that described in Ref. [1]. In the resolved resonance

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4. Pronyaev, V.G., in: Problems of Nuclear Science and Technology, Ser. Nuclear Constants, No. 3 (1986) (in Russian).

MT = 2 The elastic scattering cross-section was calculated by the optical-statistical model.

MT = 4, 51-58, 91 The inelastic scattering cross-sections were calculated by the ABAREX program with addition of the contribution of the direct processes [4]. They contain the contribution of reactions (n,pn) and (n,αn).

Level schemes and deformation parameters:

No.	Energy (MeV)	Spin-parity	Structure	β_λ
0	0,0000	0 +	G.S.	
I	0,8106	2 +	I-PH	0,23
2	I,6745	2 +	2-PH, I⊗I	0,23 x 0,23
3	2,I33	3 +		
4	2,257	0 +	2-PH, I⊗I	0,23 x 0,23
5	2,596	4 +	2-PH, I⊗I	0,23 x 0,23
6	2,782	I +		
7	2,876	2 +		
8	3,084	2 +		

The continuum of levels was assumed to be above 3.15 MeV with level density in the Gilbert-Cameron form and with parameters: T = 1.45 MeV, E_0 = 0.8 MeV, a = 6.15 MeV^{-1}, σ = 2.9.

MT = 16, 103, 107 The cross-sections of reactions (n,2n), (n,p) and (n,α) were calculated by the statistical model with allowance for the pre-equilibrium processes. For energies above 18 MeV the (n,2n) reaction contains the contribution of the (n,3n) reaction.

MT = 102 The capture cross-sections in the region from 500 keV to 3.2 MeV were calculated by the ABAREX program. Above 3.2 MeV, the evaluation was based on the systematics of experimental data and the direct-collective capture model.

MF = 4 Secondary neutron angular distributions:

MT = 2 Taken from the ENDF/B-4 library for natural iron.

MT = 51-58 Sum of contributions of the direct and compound processes.

MT = 16, 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 91 JENDL-2 evaporation spectra were taken.

MF = 3 Neutron cross-sections:

In the 10^{-5} eV - 690.0 keV region the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the 690.0 keV-10 MeV region, the experimental data of R. Schwartz [3] and F. Perey [5] were used. For E_n = 10-20 MeV, the data of Cierjacks [4] and F. Perey [5] were taken as the basis. The experimental data from Refs [3-5] were also used in the fitting of the parameters of the generalized optical model [6].

MT = 2 Elastic scattering cross-sections = total - (cross-sections of the other processes).

MT = 4 Total neutron inelastic scattering cross-section 4 = 51 + ... + 65 + 91.

MT = 16, 28, 103, 107 Cross-sections of reactions (n,2n), (nnp + npn), (n,p) and (nα), respectively. The excitation function data were calculated for each nickel isotope separately by the generalized superfluid model [7] with allowance for the pre-equilibrium processes. Then the cross-sections of these reactions were obtained for natural nickel.

MT = 51-65 and 91 Neutron inelastic scattering cross-section with excitation of resolved levels and through a continuum (MT = 91).

The energies of the resolved levels are given in the 1.19 MeV-3.47 MeV region. The continuum energy is 3.50 MeV. For MT = 51-65 and 91 we used the results of Refs [8, 9] obtained for different chromium isotopes.

MT = 102 The fast neutron radiative capture cross-section in the 690.0 keV-2 MeV region were calculated by the statistical approach for each nickel isotope. For E_n = 2-20 MeV the cross-sections were obtained with allowance for the contribution of the direct capture mechanism and the systematics of data for 14.5 MeV.

MT = 251 The average cosine of neutron elastic scattering was calculated from the angular distribution taken.

MT = 252, 253 Calculated from the evaluated data taken in the chromium file.

MF = 4 Secondary neutron angular distributions

MT = 2 The angular distributions of elastically scattered neutrons are represented in the form of Legendre coefficients. The evaluated angular distributions were taken from Ref. [10].

MT = 16, 28, 51-59 The angular distributions of secondary neutrons from reactions (n,2n), (n,np) and (n,n') were taken to be isotropic.

MF = 5 Secondary neutron energy distributions

MT = 16, 28, 91 The neutron spectra from reactions (n,2n), (n,np) and (n,n') are represented on the basis of the evaporation model with the help of a temperature approximation.

MF = 12, MT = 102 Multiplicity of photons from the (n,γ) reaction

MF = 13, MT = 3 Photon production cross-section in non-elastic reactions.

MF = 14, MT = 3,102

MF = 15, MT = 3, 102 Angular and energy distributions, respectively, of photons from reactions MT = 3,102.

The data for MF = 12, 13, from 14 and 15 are taken from Ref. [10] and corrected for the corresponding evaluated data taken in the present evaluation.

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2. Mughabghab S.F. et al. Neutron Cross-Sections, vol.1, part A, Academic Press, 1981.
3. Schwartz R., Heaton H. NBS-MONO-138 (1974), EXFOR 10416 (1974).
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7. Блохин А.И. и др. ж.Изв. АН СССР,сер.физ., 1985, т.49(5), с.962.
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<u>28 - Ni-58</u>	<u>MAT = 2811</u>	
28 - Ni-58	Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1985 Checking - Power Phys. Inst., 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko

Compilers of the file: A.I. Blokhin, N.N. Buleeva and M.V. Deniskina

<u>Content of the file</u>:

MF = 1 General information:

MT = 451 Comments and dictionary

MF = 2 Resonance parameters

MT = 151 The resonance parameters are given in the 10^{-5} eV-690 keV region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p- resolved levels are known in different energy regions, to represent the cross-sections correctly in the resonance energy region we used the representation of two pseudoisotopes: the ^{58}Ni nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second the data for the p- and d-waves. Thus, it was possible without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The evaluation procedure is described in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV-600 keV contains the data for 40 s-levels up to 636.1 keV. The unresolved parameters are given in the 600-690 keV region at two energy points.

The second pseudoisotope was used to take into account the p- and d-waves. In the resolved resonance region (10^{-5} eV-200 keV) 121 p-levels are given up to 649.8 keV. The unresolved parameters are given in the 200-690 keV region for the p- and d-waves at six energy points.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region the following average resonance parameters were used:

Radius of the nucleus: R = 7.5 fm

Neutron strength functions:

$s_0 = 2.8 \times 10^{-4}$
$s_1 = 0.5 \times 10^{-4}$
$s_2 = 2.8 \times 10^{-4}$
$s_3 = 0.5 \times 10^{-4}$

Average radiation widths:

$\Gamma_{\gamma 0} = 2.60$ eV
$\Gamma_{\gamma 1} = 1.00$ eV
$\Gamma_{\gamma 2} = 0.55$ eV
$\Gamma_{\gamma 3} = 0.50$ eV

Neutron resonance density:

$D_0 = 14.7$ keV
$D_1 = 4.1$ keV
$D_2 = D_0/5 = 2.74$ keV
$D_3 = D_0/7 = 1.96$ keV

The multilevel Breit-Wigner formalism is recommended for calculation of cross-sections in the 10^{-5} eV-690 keV region. In the description of the thermal cross-sections we used negative s-levels with - 50 keV and - 28.5 keV energies [2].

Calculated cross-sections for 2200 m/sec:

Total = 30.58 b, elastic = 26.08 b, capture = 4.50 b

MF = 3 Neutron cross-sections:

In the 10^{-5} eV-690 keV region the background in the cross-sections is zero.

MT = 1 The total cross-sections were calculated by the optical model with parameters from Ref. [3].

MT = 2 Elastic scattering cross-sections = total - (cross-sections of all other processes).

MT = 4 Total neutron inelastic scattering cross-section:

4 = 51 + ... + 72 + 91.

MT = 16, 103, 107 The cross-sections of reactions (n,2n), (n,p) and (n,α) were calculated by the generalized superfluid model with allowance for the pre-equilibrium processes [4].

MT = 22 and 28 The cross-sections of reactions (n,α) and ((n,np) + (n,pn)) were calculated by the statistical model and normalized to experimental data in the E_n = 14.5 MeV region.

MT = 51-72 Neutron inelastic scattering cross-sections with excitation of resonance levels. For MT = 51-56 the results of the evaluation of Ref. [5] were used and MT = 56-72 were taken from JENDL-2.

MT = 91 Inelastic scattering cross-section through a continuum. The continuum of levels is above 4.066 MeV. The data were taken from JENDL-2.

MT = 102 The neutron radiative capture cross-section was calculated by the statistical approach with allowance for the contribution of the direct capture mechanism.

MT = 251 The average cosine of neutron elastic scattering - from the angular distributions taken.

MF = 4 The secondary neutron angular distributions are given by the Legendre coefficients.

MT = 2 The angular distributions of elastically scattered neutrons were calculated by the optical model in the centre-of-mass system.

MT = 16, 22, 28 Isotropic in the laboratory system of co-ordinates.

MT = 51-72, 91 90° symmetrical in the laboratory system of co-ordinates.

MF = 5 Secondary neutron energy distributions:

MT = 16, 22, 28, 91 A temperature approximation of evaporation spectra was used.

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4. BLOKHIN, A.I., et al., Izv. Akad. Nauk. SSSR, Ser.Fiz. 49(5) (1985) 962.

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28 - Ni-60	MAT = 2821	
28 - Ni-60	Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1985 Checking - Power Phys. Inst., 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko

Compilers of the file: A.I. Blokhin, N.N. Buleeva and M.V. Deniskina

Content of the file:

MF = 1 General information

MT = 451 Comments and dictionary

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are given in the 10^{-5} eV-690 keV energy region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p-resolved levels are known in different energy regions, to represent the cross-section correctly in the resonance energy region we used the representation of two pseudoisotopes: the ^{60}Ni nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second the data for the p- and d-waves. In this way, it was possible without using a background in the cross-sections, to introduce different energy regions for the resolved s- and p-waves. The evaluation procedure is described in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave, The resolved resonance region from 10^{-5} eV to 590 keV contains data for 37 s-levels up to 594.8 keV. The unresolved parameters are given in the 590-690 keV region at two energy points.

The second pseudoisotope was used to take into account the contribution of the p- and d-waves. In the resolved resonance region (10^{-5} eV-150 keV) 69 p-levels are given up to 566 keV. The unresolved parameters are given in the 150-690 keV region for the p- and d-waves at seven energy points.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region the following average resonance parameters were used:

Radius of the nucleus R = 6.7 fm,

Neutron strength functions:

S_o = 2.7×10^{-4}
S_1 = 0.3×10^{-4}
S_2 = 2.7×10^{-4}
S_3 = 0.3×10^{-4},

Average radiation widths:

$\Gamma_{\gamma qo}$ = 1.70 eV

$\Gamma_{\gamma 1}$ = 0.9 eV

$\Gamma_{\gamma 2}$ = 0.24 eV

$\Gamma_{\gamma 3}$ = 0.48 eV

neutron resonance density:

D_o = 16.0 keV
D_1 = 4.3 keV
D_2 = $D_o/5$ = 3.2 keV
D_3 = $D_o/7$ = 2.28 keV

The multilevel Breit-Wigner formalism is recommended for calculation of cross-sections in the 10^{-5} eV-690 keV region. In the description of the thermal cross-sections we used a negative s-level with -14.5 keV energy [2].

Calculated cross-sections for 2200 m/sec:

total = 3.96 b, elastic = 1.03 b, capture - 2.93 b.

MF = 3 Neutron cross-sections:

In the region up to 690.0 keV the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the E_n = 690.0 keV-20 MeV region the total cross-sections were calculated by the generalized optical model with parameters from Ref. [3].

MT = 2 Neutron elastic scattering cross-sections = total - (sum of the cross-sections of the other processes).

MT = 4, 51-72, 91 Neutron inelastic scattering cross-sections. For 51-56 the results of Ref [5] were used; 57-72 and 91 were taken from JENDL-2.

MT = 16, 28, 103, 107 The cross-sections of reactions (n,2n), (nnp + npn), (n,p), (n,α) were obtained by the generalized superfluid model with allowance for the contribution of the non-statistical processes [4].

MT = 102 The fast neutron radioactive capture cross-section up to 2 MeV was obtained on the basis of the statistical description, and above 2 MeV, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 The average cosine of the angle of elastically scattered neutrons was obtained from the angular distributions taken.

MF = 4 Secondary neutron angular distributions:

MT = 2, 51-72, 91 Taken from JENDL-2.

MF = 5 Secondary neutron energy distributions:

MT = 16, 28, 91 A temperature approximation of evaporation spectra was used.

REFERENCES

1. BELANOVA, T.S., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983), Moscow, 3 (1984) 54 (in Russian). See also INDC(NDS)-152/L (1984).

2. MUGHABGHAB, S.F., et al., Neutron Cross-Sections, vol.1, part A, Academic Press, 1981.

3. LUNEV, V.P., IGNATYUK, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

4. BLOKHIN, A.I. et al., Izv. Akad. Nauk. SSSR, Ser.Fiz. 49(5) (1985) 962.

5. PRAVDIVYJ, N.M., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983). Moscow, 3 (1984) 78 (in Russian)

28 - Ni-61	MAT = 2831	
28 - Ni-61	Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1985 Checking - Power Phys. Inst., 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.V. Pashchenko

Compilers of the file: A.I. Blokhin, N.N. Buleeva and M.V. Deniskina

Content of the file:

MF = 1 General information:

MT = 451 Comments and dictionary.

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are given in the 10^{-5} eV-690 keV energy region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p- resolved levels are known in different energy regions, to represent the cross-section correctly in the resonance energy region we used the representation of two pseudo-isotopes: the ^{61}Ni nucleus was regarded as a mixture of two pseudo-isotopes of identical mass and concentration (ABN = 1.0). The first pseudo-isotope contains the data for the s-wave and the second the data for the p- and d-waves. In this way, it was possible without using a background in the cross-sections, to introduce different energy regions for the resolved s- and p-waves. The evaluation procedure is described in Ref. [1].

The first pseudo-isotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV to 65 keV contains the data for 32 s-levels up to 68.7 keV. The unresolved parameters are given in the 65-690 keV region at eight energy points.

The second pseudo-isotope was used to take into account the contribution of the p- and d-waves. In the resolved resonance region (10^{-5} eV-30 keV) 24 p-levels are given up to 30.1 keV. The unresolved parameters are given in the 30-690 keV region for the p- and d-waves at nine energy points.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region the following average resonance parameters were used:

radius of the nucleus R = 6.5 fm,

neutron strength functions:

$S_0 = 3.2 \times 10^{-4}$
$S_1 = 0.3 \times 10^{-4}$
$S_2 = 3.2 \times 10^{-4}$
$S_3 = 0.3 \times 10^{-4}$,

average radiation widths:

$\Gamma_{\gamma 0} = 2.2$ eV
$\Gamma_{\gamma 1} = 1.00$ eV
$\Gamma_{\gamma 2} = 0.36$ eV
$\Gamma_{\gamma 3} = 0.49$ eV

neutron resonance density:

$D_0 = 1.8$ keV
$D_1 = 2.23$ keV
$D_2 = D_0/5 = 0.36$ keV
$D_3 = D_0/7 = 0.26$ keV

The multilevel Breit-Wigner formalism is recommended for calculation of cross-sections in the 10^{-5} eV-690 keV region. In the description of the thermal cross-sections we used a negative s-level with -0.0095 keV energy [2].

Evaluated cross-sections for 2200 m/sec:
total = 11.60 b, elastic = 9.07 b, capture = 2.53 b.

MF = 3 Neutron cross-sections:

In the 10^{-5} eV-690 keV region the background in the cross-sections is zero.

MT = 1 The total cross-sections were calculated by the optical model with parameters from Ref. [3].

MT = 2 Elastic scattering cross-section = total - (cross-section of all other processes).

MT = 4 Total neutron inelastic scattering cross-section:
4 = 51+...+70+91.

MT = 16, 103, 107 The cross-sections of the (n,2n), (n,p) and (n,α) reactions were calculated by the generalized superfluid model with allowance for the pre-equilibrium processes [4].

MT = 28 The ((n,np) + (n,pn)) cross-section reactions were calculated by the statistical model and normalized to the systematics of experimental data in the E_n = 14.5 MeV region.

MT = 51-70, 91 The neutron inelastic scattering cross-sections with excitation of residual nucleus levels. For MT = 51-57 the cross-sections were evaluated with allowance for the contribution of the direct processes. The contribution of the direct processes calculated for ^{60}Ni from Ref. [5] was taken into account for the ^{61}Ni nucleus in the weak spin-binding model. For MT = 58-70 and 91 the data were taken from JENDL-2.

MT = 102 The fast neutron radiative capture cross-section in the 690 keV-20 MeV region was calculated by the statistical model; in the region above 2 MeV, the contribution of the direct capture mechanism was added.

MT = 251 The average cosine of neutron elastic scattering was calculated from the angular distributions taken.

MF = 4 Secondary neutron angular distributions: connected with the help of Legendre coefficients.

MT = 2 The secondary neutron angular distributions were calculated by the optical model.

MT = 16, 28 Isotropic in the laboratory system of co-ordinates.

MT = 51-70, 91 90° symmetrical in the centre-of-mass system.

MF = 5 Secondary neutron energy distributions.

MT = 16, 28, 91 A temperature approximation of evaporation spectra was used.

REFERENCES

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2. MUGHABGHAB, S.F., et al., Neutron Cross-Sections, vol.1, part A, Academic Press, 1981.

3. LUNEV, V.P., IGNATYUK, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

4. BLOKHIN, A.I. et al., Izv. Akad. Nauk. SSSR, Ser.Fiz. 49(5) (1985) 962.

5. PRAVDIVYJ, N.M., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983). Moscow, 3 (1984) 78 (in Russian)

28 - Ni-62	MAT = 2841	
28 - Ni-62	Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1985 Checking - Power Phys. Inst., 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko
Compilers of the file: A.I. Blokhin, N.N. Buleeva and M.V. Deniskina

Content of the file:

MF = 1 General information

MT = 451 Comments and dictionary.

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are given in the 10^{-5}eV-690 keV energy region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p- resolved levels are known in different energy regions, to represent the cross-sections correctly in the resonance energy region, we used the representation of two pseudoisotopes: the ^{62}Ni nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second the data for the p- and d-waves. In this way it was possible, without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The evaluation procedure in described in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV to 590 keV contains the data for 33 s-levels up to 590.5 keV. The unresolved parameters are given in the 590-690 keV region at two energy points.

The second pseudoisotope was used to take into account the contribution of the p- and d-waves. In the resolved resonance region (10^{-5} eV-120 keV) 49 p-levels are given up to 599.5 keV. The unresolved parameters are given in the 120-690 keV region for the p- and d-waves at seven energy points.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region the following average resonance parameters were used:

Radius of the nucleus R = 6.2 fm,

Neutron strength functions:

$S_0 = 2.8 \times 10^{-4}$
$S_1 = 0.3 \times 10^{-4}$
$S_2 = 2.8 \times 10^{-4}$
$S_3 = 0.3 \times 10^{-4}$

Average radiation widths:

$\Gamma_{\gamma 0} = 2.0$ eV
$\Gamma_{\gamma 1} = 0.17$ eV
$\Gamma_{\gamma 2} = 0.19$ eV
$\Gamma_{\gamma 3} = 0.17$ eV

Neutron resonance density:

$D_0 = 19.1$ keV
$D_1 = 7.5$ keV
$D_2 = D_0/5 = 3.82$ keV
$D_3 = D_0/7 = 2.73$ keV

The multilevel Breit-Wigner formalism is recommended for calculation of the cross-sections in the 10^{-5} eV-690 keV region. In the description of the thermal cross-sections we used a negative s-level with -0.077 keV energy [2].

Calculated cross-sections for 2200 m/sec:

Total = 23.48 b, elastic = 9.06 b, capture - 14.42 b.

MF = 3 Neutron cross-sections:

In the 10^{-5} eV-690 keV region the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the E_n = 690.0 keV-20 MeV region the total cross-sections were calculated by the generalized optical model with parameters from Ref. [3].

MT = 2 Neutron elastic scattering cross-section = total - (sum of the cross-sections of the other processes).

MT = 4, 51-71, 91 Neutron inelastic scattering cross-sections. For 51-56 the results of Ref. [5] were used; 55-71 and 91 were taken from JENDL-2.

MT = 16, 28, 103, 107 The cross-sections of reactions (n,2n), (nnp+npn), (n,p) and (n,α) were obtained by the generalized superfluid model with allowance for the contribution of the non-statistical processes [4].

MT = 102 The fast neutron radiative capture cross-section up to 2 MeV was obtained on the basis of the statistical description; above 2 MeV, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 The average cosine of the neutron elastic scattering angle was obtained from the angular distributions taken.

MF = 4 Secondary neutron angular distributions:

MT = 2, 16, 28, 51-71, 91 Taken in accordance with JENDL-2.

MF = 5 Secondary neutron energy distributions:

MT = 16, 28, 91 A temperature approximation of evaporation spectra was used.

REFERENCES

1. BELANOVA, T.S., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983), Moscow, 3 (1984) 54 (in Russian). See also INDC(NDS)-152/L (1984).

2. MUGHABGHAB, S.F., et al., Neutron Cross-Sections, vol.1, part A, Academic Press (1981).

3. LUNEV, V.P., IGNATYUK, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

4. BLOKHIN, A.I., et al., Izv. Akad. Nauk. SSSR, Ser.Fiz. 49(5) (1985) 962.

5. PRAVDIVYJ, N.M., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983). Moscow, 3 (1984) 78 (in Russian)

28 - Ni-64 MAT = 2851
28 - Ni-64 Nuclear Data Centre (USSR State Committee on the Utilization of Atomic Energy)

Evaluation - 1985
Checking - Power Phys. Inst., 1985

Authors of evaluation: T.S. Belanova, A.I. Blokhin, A.V. Ignatyuk, V.P. Lunev, V.N. Manokhin and A.B. Pashchenko

Compilers of the file: A.I. Blokhin, N.N. Buleeva and M.V. Deniskina

Content of the file:

MF = 1 General information

MT = 451 Comments and dictionary.

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are given in the 10^{-5}eV-690 keV region.

The neutron resonance energy region is given with the help of the resolved and unresolved resonance parameters for the s-, p- and d-waves. Since the s- and p- resolved levels are known in different energy regions, to represent the cross-sections correctly in the resonance energy region, we used the representation of two pseudoisotopes: the ^{64}Ni nucleus was regarded as a mixture of two pseudoisotopes of identical mass and concentration (ABN = 1.0). The first pseudoisotope contains the data for the s-wave and the second the data for the p- and d-waves. In this way it was possible without using a background in the cross-sections to introduce different energy regions for the resolved s- and p-waves. The evaluation procedure is described in Ref. [1].

The first pseudoisotope was used to take into account the contribution of the s-wave. The resolved resonance region from 10^{-5} eV to 550 keV contains data for 26 s-levels up to 583 keV. The unresolved parameters are given in the 550-690 keV region at two energy points.

The second pseudoisotope was used to take into account the contribution of the p- and d-waves. In the resolved resonance region (10^{-5} eV-150 keV) 37 p-levels are given up to 565 keV. The unresolved parameters are given in the 150-690 keV region for the p- and d-waves at seven energy points.

In the resolved resonance region we mainly used the resonance parameters from Ref. [2]. In the unresolved resonance region the following average resonance parameters were used:

Radius of the nucleus R = 7.55 fm,

Neutron strength functions:

S_0 = 2.9×10^{-4}
S_1 = 0.6×10^{-4}
S_2 = 2.9×10^{-4}
S_3 = 0.6×10^{-4}

Average radiation widths:

$\Gamma_{\gamma 0}$ = 2.4 eV
$\Gamma_{\gamma 1}$ = 0.2 eV
$\Gamma_{\gamma 2}$ = 0.14 eV
$\Gamma_{\gamma 3}$ = 0.2 eV

Neutron resonance density:

D_0 = 19.9 keV
D_1 = 7.2 keV
$D_2 = D_0/5$ = 3.98 keV
$D_3 = D_0/7$ = 2.84 keV

The multilevel Breit-Wigner formalism is recommended for calculation of the cross-sections in the 10^{-5} eV-690 keV energy region.

Calculated cross-sections for 2200 m/sec:

Total = 1.49 b, elastic = 0.0016 b, capture = 1.47 b.

MF = 3 Neutron cross-sections:

In the region up to 690.0 keV the background in the cross-sections is zero.

MT = 1 Total cross-sections. In the E_n = 690.0 keV-20 MeV region the total cross-sections were calculated by the generalized optical model with parameters from Ref. [3].

MT = 2 Neutron elastic scattering cross-sections = total - (sum of the cross-sections of the other processes).

MT = 4, 51-70, 91 Neutron inelastic scattering cross-sections. For MT = 51-56 the results of Ref. [5] were used; 57-70 and 91 were taken from JENDL-2.

MT = 16, 17, 103, 107 The cross-sections of reactions (n,2n), (n,p) and (n,α) were obtained by the generalized superfluid model with allowance for the contribution of the non-statistical processes [4].

MT = 102 The fast neutron radiative capture cross-section up to 2 MeV was obtained on the basis of the statistical description; above 2 MeV, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 The average cosine of the neutron elastic scattering angle was obtained from the direct angular distributions.

MF = 4 Secondary neutron angular distributions:

MT = 2, 51-70, 91 Taken from JENDL-2.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The temperature approximation of evaporation spectra was used.

REFERENCES

1. BELANOVA, T.S., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983), Moscow, 3 (1984) 54 (in Russian). See also INDC(NDS)-152/L (1984).

2. MUGHABGHAB, S.F., et al., Neutron Cross-Sections, vol.1, part A, Academic Press (1981).

3. LUNEV, V.P., IGNATYUK, A.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants (1986) (in Russian).

4. BLOKHIN, A.I., et al., Izv. Akad. Nauk. SSSR, Ser.Fiz. 49(5) (1985) 962.

5. PRAVDIVYJ, N.M., et al., in: Proceedings of the Sixth All-Union Conference on Neutron Physics (Kiev, 2-6 October 1983). Moscow, 3 (1984) 78 (in Russian)

41 - Nb-93	MAT = 4101	
41 - Nb-93	Dresden Technical Univ. - IAEA	Evaluation - 1985

Authors of evaluation: D. Hermsdorf, G. Kiessig and V. Goulo
Compiler of the file: V. Goulo

Content of the file

MF = 1 General information

MT = 451 History, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-7 keV. Multilevel Breit-Wigner formalism with resonance parameters from JENDL-2 [1]. A negative resonance with -105.4 eV energy was introduced to describe the thermal cross-sections [2]. For resonances with unidentified parameters the average radiation width of 172 meV was used; for the assumed doublets a radiation width of 212 meV was taken.

Unresolved resonances: 7-50 keV. The following energy-independent resonance parameters were used [1]:

SO = 0.374E-4, S1 = 5.84E-4, S2 = 3.65E-4, Γg = 0.160 eV,
DO = 80.5 eV, R = 6.70 fm.

Calculated cross-sections for 2200 m/sec:

Total = 7.477 b, elastic = 6.326 b, capture = 1.152 b.
Capture resonance integral above 0.5 eV = 9.59 b.

MF = 3 Neutron cross-sections:

The background is zero for neutron energies below 30 keV - excitation threshold for the first isomeric level. Above 30 keV, the neutron cross-section evaluations given in Ref. [3] were used.

MT = 1 The total neutron cross-section was obtained from the optical model calculations, which optimally describe the set of experimental data [3].

MT = 2 Elastic scattering cross-section = total - partial cross-sections of all inelastic processes. Above 11 MeV, the evaluation was fitted to calculations by the optical model.

MT = 4, 51-59, 91 The inelastic scattering cross-sections were determined on the basis of the optical-statistical calculations fitted to available experimental data.

MT = 16 The (n,2n) reaction cross-section was taken from the statistical calculations describing the experimental data for 14.5 MeV [3].

MT = 17, 22, 28 Cross-sections of reactions (n,3n), (n,nα) and (n,np), respectively - taken from statistical calculations.

MT = 102 The neutron radiative capture cross-section was obtained from calculations by the FISPRO program [4] fitted to available experimental data [3].

MT = 103, 104, 105, 106 and 107 The cross-sections of reactions (n,p), (n,d), (n,t), (n,3He) and (n,α), respectively, were taken from calculations by the pre-equilibrium model. For the (n,α) reaction, the model parameters - γ-particle formation factors - were fitted to the set of experimental data [3]. The calculated excitation functions for the (n,t) reaction were normalized to experimental data [5].

MF = 4 Secondary neutron angular distributions:

MT = 2 For elastic scattering, the coefficients of the polynomial description of angular distributions were taken from the ENDF/B-4 evaluation [6].

MT = 16, 17, 91 Taken to be isotropic in the laboratory system.

MT = 51-59 Obtained on the basis of statistical calculations.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The neutron spectra in the (n,2n), (n,3n) and (n,n') reactions were obtained from calculations by the STAPRE program [7] with parameters found from the description of experimental spectra for 14.5 MeV primary neutron energy.

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42 - Mo-95	MAT = 4251	Evaluation - 1982
42 - Mo-95	JENDL-2	Checking - Power Phys. Inst., 1985

Authors of evaluation: Y. Kikuchi, O. Togawa, T. Watanake, T. Auki, Y. Kanda and S. Iijime

Content of the file

MF = 1 General information:

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters: 10^{-5}eV-2 keV. Multilevel Breit-Wigner formalism, resonance parameters taken from Refs [1,2]. Radiation widths taken: 150 meV for s-resonances, 180 meV for p-resonances. A negative resonance of -20 eV was added.

Unresolved resonances: 2 keV-100 keV,

The following energy-independent parameters were used:

$S0 = 0.37 \times 10^{-4}$, S1 = 5.48E-4, S2 = 3.65E-4, DO = 80 eV, Γ_γ = 232 meV, R = 6.70 fm.

Calculated cross-sections for 2200 m/sec:

Total = 19.58 b, elastic = 5.59 b, capture = 13.99 b.

Capture resonance integral above 0.5 eV = 119 b.

MF = 3 Neutron cross-sections:

In the 40-100 keV region a background was used to make a small correction in the total and capture cross-sections. Above 100 keV, the following approaches were employed:

MT = 1 The total cross-section was calculated by the optical model and with parameters [3]:

V = 46.0-0.25E, Ws = 7.0, Vso = 7.0 MeV
Ro = Rso = 5.89, Rs = 6.39 fm
ao = aso = 0.62, b = 0.35 fm

MT = 2 Elastic scattering cross-section = total cross-section - partial cross-sections of all other reactions.

MT = 16, 17, 103, 107 Cross-sections of reactions (n,2n), (n,3n), (n,p) and (n,α). Calculated with allowance for the pre-equilibrium processes by the GNASH program [4].

MT = 51-69, 91, 102 Inelastic scattering and capture cross-sections.

Calculated by the CASTHY program [5] taking into consideration corrections for width fluctuations. Account was taken of the target nucleus discrete levels up to 1.938 MeV [6]; above 2.0 MeV, we used the statistical description in the constant temperature + Fermi-gas model with parameters [7]:

Isotope Mo	93	94	95
a (MeV^{-1})	11.25	11.80	13.60
Delta (MeV)	1.28	2.0	1.28
Ex (MeV)	3.14	6.228	5.835
T (MeV)	0.605	0.76	0.715

The radiation strength function Sg = 2,9E-3 was obtained from the fit to the capture cross-sections [8].

MT = 251 <μ> - calculated by the optical model.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated by the optical model.

MT = 16, 17 Isotropic in the laboratory system.

MT = 51-69 90° symmetrical in the centre-of-mass system.

MT = 91 90° symmetrical in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The spectrum evaporation model was used.

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42 - Mo-97	MAT = 4271	Evaluation - 1982
42 - Mo-97	JENDL-2	Checking - Power Phys. Inst., 1985

Authors of evaluation: Y. Kikuchi, O. Togawa, T. Watanake, T. Auki, Y. Kanda and S. Iijime

Content of the file

MF = 1 General information:

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 1.0E-5 eV-1.8 keV. Multilevel Breit-Wigner formalism, resonance parameters taken from Refs [1, 2]. Radiation widths taken: 130 meV for s-resonances and 150 meV for p-resonances. A negative resonance of -20 eV was added.

Unresolved resonances: 1.8 keV-100 keV. The following energy-independent parameters were used:

S0 = 0.37E-4, S1 = 5.48E-4, S2 = 3.65E-4, D0 = 80 eV,
Γ_γ = 0.180 eV, R = 6.67 fm.

Calculated cross-sections for 2200 m/sec:

Total = 7.953 b, elastic = 5.853 b, capture = 2.100 b.

Capture resonance integral above 0.5 eV = 17.3 b.

MF = 3 Neutron cross-sections:

In the 20-100 keV region a background was used to make a small correction in the total and capture cross-sections. Above 100 keV, the following approaches were employed:

MT = 1 The total cross-section was calculated by the optical model with parameters [3]:

V = 46.0-0.25E, Ws = 7.0, Vso = 7.0 MeV
Ro = Rso = 5.89, Rs = 6.39 fm
ao = aso = 0.62, b = 0.35 fm

MT = 2 Elastic scattering cross-section = total cross-section - partial cross-sections of all other reactions.

MT = 16, 17, 103, 107 Cross-sections of reactions (n,2n), (n,3n), (n,p) and (n,α).

Calculated with allowance for the pre-equilibrium processes by the *GNASH* program [4].

MT = 51-70, 91, 102   Inelastic scattering and capture cross-sections.

Calculated by the CASTHY program [5] taking into consideration corrections for width fluctuations. Account was taken of the target nucleus discrete levels up to 1.5651 MeV [6]; above 1.58 MeV, we used the statistical description in the constant temperature + Fermi-gas model with parameters [7]:

Isotope Mo	95	96	97	98
a (1/Mev)	13.60	14.03	15.17	15.94
Delta (MeV)	1.28	2.40	1.28	2.57
Ex (MeV)	5.835	7.645	4.988	7.53
T (MeV)	0.715	0.741	0.618	0.671

The radiation strength function S_γ = 2.9E-3 was obtained from the fit to the capture cross-sections [8].

MT = 251 $<\mu>$ - calculated by the optical model.

MF = 4   Secondary neutron angular distributions:

MT = 2   Calculated by the optical model.

MT = 16, 17   Isotropic in the laboratory system.

MT = 51-70   90° symmetrical in the centre-of-mass system.

MT = 91   90° symmetrical in the laboratory system.

MF = 5   Secondary neutron energy distributions:

MT = 16, 17, 91   The spectrum evaporation model was used.

REFERENCES

1. Shwe H. and Cote R.E.: Phys,Rev,179,1148 (1969),
2. Weigmann H. et al.: 1971 Knoxville Conf., CONF-710301, p.749,
3. Iijima S. and Kawai M.: J.Nucl.Sci.Technol., 20, 77 (1983).
4. Young P.G. and Arthur E.D.: LA-6947 (1977).
5. Igarasi S. : J.Nucl.Technol. 12,67 (1975).
6. Matumoto Z. et al, : JAERI-M 7734 (1978).
7. Iijima S. et al. : to be published in J.Nucl.Sci.Technol.
8. Musgrove A.R. de.L. et al. : Nucl.Phys., A270, 108 (1976).

42 - Mo-98	MAT = 4281	Evaluation - 1982
42 - Mo-98	JENDL-2	Checking - Power Phys. Inst., 1985

Authors of evaluation: Y. Kikuchi, O. Togawa, T. Watanake, T. Auki, Y. Kanda and S. Iijime

Content of the file

MF = 1 General information:

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters

Resolved resonances: 1.0E-5 keV-32 keV. Multilevel Breit-Wigner formalism, resonance parameters taken from Refs [1, 2, 3]. Radiation widths taken: 85 meV for s-resonances and 120 meV for p-resonances. A negative resonance of -980 eV was added.

Unresolved resonances: 32 keV-100 keV. The following energy-independent parameters were used:

S0 = 0.37E-4, S1 = 5.48E-4, S2 = 3.65E-4, D0 = 950 eV, Γ_γ = 0.133 eV, R = 6.66 fm.

Calculated cross-sections for 2200 m/sec:

Total = 5.772 b, elastic = 5.642 b, capture = 0.1300 b.

Capture resonance integral above 0.5 eV = 6.56 b.

MF = 3 Neutron cross-sections:

In the 32-100 keV region a background was used to make a small correction in the total and capture cross-sections. Above 100 keV, the following approaches were employed:

MT = 1 The total cross-section was calculated by the optical model with parameters [4]:

V = 46.0-0.25E, Ws = 7.0, Vso = 7.0 MeV
Ro = Rso = 5.89, Rs = 6.39 fm
ao = aso = 0.62, b = 0.35 fm

MT = 2 Elastic scattering cross-section = total cross-section - partial cross-sections of all other reactions.

MT = 16, 17, 103, 107 Cross-sections of reactions (n,2n), (n,3n), (n,p) and (n,α).

Calculated with allowance for the pre-equilibrium processes by the GNASH program [5].

MT = 51-69, 91, 102 Inelastic scattering and capture cross-sections.

Calculated by the CASTHY program [6] taking into consideration corrections for width fluctuations. Account was taken of the target nucleus discrete levels up to 2.5063 MeV [7]; above 2.53 MeV, we used the statistical description in the constant temperature + Fermi-gas model with parameters [8]:

Isotope Mo	96	97	98	99
a (1/Mev)	14.03	15.17	15.94	17.74
Delta (MeV)	2.40	1.28	2.57	1.28
Ex (MeV)	7.645	4.988	7.53	5.775
T (MeV)	0.741	0.618	0.671	0.605

The radiation strength function S_γ = 1.4E-4 was obtained from the fit to the capture cross-sections [3].

MT = 251 $\langle\mu\rangle$ - calculated by the optical model.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated by the optical model.

MT = 16, 17 Isotropic in the laboratory system.

MT = 51-68 90° symmetrical in the centre-of-mass system.

MT = 91 90° symmetrical in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The spectrum evaporation model was used.

REFERENCES

1. Chrien R.E. et al.: Phys.Rev., C13, 578 (1976).
2. Weigmann H. et al. : 1971 Knoxville Conf., CONF-710301, p.749.
3. Musgrove A.R. de.L. et al. : Nucl.Phys. A270, 108 (1976).
4. Iijima S. and Kawai M. : J.Nucl.Sci.Technol., 20, 77 (1983).
5. Young P.G. and Arthur E.D. : LA-6947 (1977).
6. Igarasi S. : J.Nucl.Sci.Technol., 12,67 (1975).
7. Matumoto Z. et al.: JAERI-M 7734 (1978).
8. Iijima S. et al.: to be published in J.Nucl.Sci.Technol.

42 - Mo-100 | MAT = 4291 | Evaluation - 1982
42 - Mo-100 | JENDL-2 | Checking - Power Phys. Inst., 1985

Authors of evaluation: Y. Kikuchi, O. Togawa, T. Watanake, T. Auki, Y. Kanda and S. Iijime

Content of the file

MF = 1 General information:

MT = 451 History, dictionary, comments on evaluations and references.

MF = 2 Resonance parameters

Resolved resonances: 1.0E-5 eV-26 keV. Multilevel Breit-Wigner formalism, resonance parameters taken from Refs [1, 2, 3]. Radiation widths taken: 65 meV for s-resonances and 80 meV for p-resonances. A negative resonance of -172 eV was added.

Unresolved resonances: 26 keV-100 keV. The following energy-independent parameters were used:

S0 = 0.37E-4, S1 = 5.48E-4, S2 = 3.65E-4, D0 = 620 eV,
Γ_γ = 0.85 eV, R = 6.64 fm.

Calculated cross-sections for 2200 m/sec:

Total = 5.499 b, elastic = 5.300 b, capture = 0.199 b.

Capture resonance integral above 0.5 eV = 3.92 b.

MF = 3 Neutron cross-sections:

In the 26-100 keV region a background was used to make a small correction in the total and capture cross-sections. Above 100 keV, the following approaches were employed:

MT = 1 The total cross-section was calculated by the optical model with parameters [4]:

V = 46.0-0.25E, Ws = 7.0, Vso = 7.0 MeV
Ro = Rso = 5.89, Rs = 6.39 fm
ao = aso = 0.62, b = 0.35 fm

MT = 2 Elastic scattering cross-section = total cross-section - partial cross-sections of all other reactions.

MT = 16, 17, 103, 107 Cross-sections of reactions (n,2n), (n,3n), (n,p) and (n,α).

Calculated with allowance for the pre-equilibrium processes by the GNASH program [5].

MT = 51-66, 91, 102 Inelastic scattering and capture cross-sections.

Calculated by the CASTHY program [6] taking into consideration corrections for width fluctuations. Account was taken of the target nucleus discrete levels up to 2.59 MeV [7]; above 2.62 MeV, we used the statistical description in the constant temperature + Fermi-gas model with parameters [8]:

Isotope Mo	98	99	100	101
a (1/Mev)	15.97	17.74	19.35	20.85
Delta (MeV)	2.57	1.28	2.22	1.28
Ex (MeV)	7.53	5.775	6.795	5.766
T (MeV)	0.671	0.605	0.600	0.549

The radiation strength function S_{γ} = 1.4E-4 was obtained from the fit to the capture cross-sections [3].

MT = 251 $\langle\mu\rangle$ - calculated by the optical model.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated by the optical model.

MT = 16, 17 Isotropic in the laboratory system.

MT = 51-66 90° symmetrical in the centre-of-mass system.

MT = 91 90° symmetrical in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The spectrum evaporation model was used.

REFERENCES

1. Weigmann H. et al.: Phys.Rev., C20, 115 (1969).
2. Weigmann H. et al.: 1971 Knoxville Conf., CONF-710301, p.749.
3. Musgrove A.R. be.L. et al.: Nucl.Phys., A270, 108 (1976).
4. Iijima S. and Kawai M.: J.Nucl.Sci.Technol., 20,77 (1983).
5. Young P.G. and Arthur E.D.: LA-6947 (1977).
6. Igarasi S.: J.Nucl.Sci.Technol., 12,67 (1975).
7. Matumoto Z. et al.: JAERI-M 7734 (1978).
8. Iijima S. et al.: to be published in J.Nucl.Sci.Technol.

43 - Tc-99	MAT = 4311	Evaluation - 1984
43 - Tc-99	Nuclear Data Centre - Power Physics Inst.	Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, Zh.A. Korchagina, I.V. Kravchenko, G.N. Manturov and M.N. Nikolaev

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.382 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The spins of the unidentified resonances were assigned by the method of random numbers. The average radiation width of 160 meV was taken.

Unresolved resonances: 1.382 keV-141.4 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were determined from an analysis of the set of experimental data on neutron capture cross-sections [3]:

S0 = 0.48E-4, S1 = 6.6E-4, S2 = 0.2E-4, Sg = 8.0E-3, D0 = 26.0 eV and R = 60 fm.

Calculated cross-sections for 2200 m/sec:

Total = 24.58 b, elastic scattering = 5.09 b, capture = 19.49 b.

Capture resonance integral above 0.5 eV = 350.1 b.

MF = 3 Neutron cross-sections:

In the region up to 141.4 keV the background is zero. Above, for all cross-sections except capture, the evaluation of ENDF/B-5 [4] was used.

MT = 1 The total cross-sections were calculated by the optical model [5] describing the experimental data above 2 MeV [6].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-61, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [7].

MT = 16 The (n,2n) reaction cross-section was obtained on the basis of systematics [8].

MT = 102 The capture cross-section up to 1.2 MeV was obtained from the statistical description of the set of experimental data [3]. In the 1.2-7 MeV region, the ENDF/B-5 evaluation was taken, and above, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 <μ> - calculated from the angular distributions taken.

MT = 252 STI - calculated from <μ>.

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 The description of differential elastic scattering cross-sections for Ag was used.

MT = 16 Taken to be isotropic in the laboratory system.

MT = 51-61, 91 Taken to be isotropic.

MF = 5 Secondary neutron energy distributions [4]:

MT = 16, 91 A temperature approximation of evaporation spectra was used.

MF = 8 Data of decay probability [4].

REFERENCES

2. Manturov, G.N., Lunev, V.P. Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

3. Belanova, T.S., et al., At. Ehnerg. 57 (1984) 243.

(For original English Refs, see below.)

1. Mughabghab S.F., Divadeeman M. , Holden N.E. - Neutron Cross Sections v.1, part A. NY - London, Academic Press, 1981.
2. Мантуров Г.Н., Лунев В.П., Горбачева Л.В. - ВАНТ, сер.Ядерные константы, 1983, вып.I(50), с.50.
3. Беланова Т.С. и др. - АЭ, 1984, т.57, с.243.
4. Schenter et al. - ENDF/B-5 Summary Documentation. BNL-NCS-17541, 3rd Ed., 1979, MAT 1308.
5. Auerbach E.N. ABACUS, BNL-6562 (1964).
6. Foster W. - SCISARS FILE, BNW (1967).
7. Dunford C.L. AI-AEC-12931 (1970).
8. Pearlstein S. - Nucl. Data, 1967, v.3A, p.327

44 - Ru-101	MAT = 4411	Evaluation - 1984
44 - Ru-101	Nuclear Data Centre - Power Physics Inst.	Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, Zh.A. Korchagina, I.V. Kravchenko, G.N. Manturov and M.N. Nikolaev

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.382 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The spins of the unidentified resonances were assigned by the method of random numbers. The average radiation width taken was 180 meV.

Unresolved resonances: 1.0 keV-120 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were determined from an analysis of the set of experimental data on neutron capture cross-sections [3]:

S0 = 0.59E-4, S1 = 6.1E-4, S2 = 0.25E-4, Sg = 1.0E-2, D0 = 15 eV and R = 6.4 fm.

Calculated cross-sections for 2200 m/sec:

Total = 7.68 b, elastic = 4.28 b, capture = 3.40 b.

Capture resonance integral above 0.5 eV = 111.7 b.

MF = 3 Neutron cross-sections:

In the region up to 120 keV the background is zero. Above, for all cross-sections except capture, the ENDF/B-5 evaluation [4] was used.

MT = 1 The total cross-sections were calculated by the optical model with potential from Ref. [5].

MT = 2 Elastic scattering cross-sections = total - cross-section of all inelastic reactions.

MT = 4, 51-69, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [6].

MT = 102 The capture cross-sections in the region up to 0.35 MeV were taken from the statistical description of experimental data [3]. In the region from 0.3 to 7 MeV, the ENDF/B-5 [4] evaluation was taken, and above, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 <μ> - calculated by the optical model with potential from Ref. [5].

MT = 252 STI - calculated from <μ>.

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 Calculated by the optical model with the potential from Ref. [5].

MT = 51-69, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 91 A temperature approximation of evaporation spectra was used.

REFERENCES

2. Manturov, G.N., Lunev, V.P. Gorbacheva, L.V. in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

3. Belanova, T.S., et al., At. Ehnerg. 57 (1984) 243.

(For original English Refs, see below.)

1. Mughabghab S.F., Divadeenam M., Holden N.E. Neutron Cross Sections v.1, part A. N.Y.: Academic Press, 1981.
2. Мантуров Г.Н., Лунев В.П., Горбачева Л.В. - ВАНТ, сер.Ядерные константы, 1983, вып,1(50), с.50.
3. Беланова Т.С. и др. - АЭ, 1984, т. 57, с.243.
4. Schenter R.E., Schmittroth F. - ENDF/B-5, MAT = 9330.
5. Moldauer P.A. - Nucl.Phys., 1963, v.47, p.65.
6. Dunford C.L. AI-AEC-12931 (1970).

44 - Ru-102	MAT = 4421	Evaluation - 1984
44 - Ru-102	Nuclear Data Centre - Power Physics Inst.	Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko and G.N. Manturov

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.3 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. A negative resonance for -146 eV was included. The average radiation width taken was 90 meV.

Unresolved resonances: 1.3 keV-100 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were determined from an analysis of the experimental neutron capture cross-sections [3]:

S0 = 0.55E-4, S1 = 5.0E-4, S2 = 0.45E-4, Sg = 3.24E-4, D0 = 88 eV and R = 7.2 fm.

Calculated cross-sections for 2200 m/sec:

Total = 8.08 b, elastic = 6.90 b, capture = 1.18 b.

Capture resonance integral above 0.5 eV = 6.28 b.

MF = 3 Neutron cross-sections:

In the region up to 100 keV the background is zero. Above, for all cross-sections except capture, the JENDL-1 evaluation [4] was used.

MT = 1 The total cross-sections were calculated by the optical model with the parameters from [4] obtained from the global description of total cross-sections for nuclei in the mass region of $90 < A < 150$.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-64, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach [4].

MT = 102 The capture cross-sections in the region up to 3.0 MeV were taken from the statistical description of experimental data [3]. In the region from 3 to 8 MeV, the JENDL-1 evaluation [4] was taken, and above, the evaluation based on the systematics of experimental data in the direct-collective neutron capture model was used.

MT = 251 $\langle\mu\rangle$ - calculated by the optical model with potential from Ref. [5].

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 Calculated by the optical model.

MT = 51-64, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 91 A temperature approximation of evaporation spectra was used.

REFERENCES

1. Mughabghab, S.F., Divadeenam, M., Holden, N.E., Neutron Cross-sections, V. 1, Part A, N.Y.: Academic Press, 1981.

2. Manturov, G.N., Lunev, V.P. Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

3. Belanova, T.S., et al., At. Ehnerg. 57 (1984) 243.

4. Kikuchi, Y. et al., JAERI-1268 (1981), MAT = 4402.

44 - Ru-104	MAT = 4441	Evaluation - 1984
44 - Ru-104	Nuclear Data Centre - Power Physics Inst.	Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko, G.N. Manturov and M.N. Nikolaev

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.2 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. A negative resonance for -884 eV was included. The average radiation width taken was 85 eV.

Unresolved resonances: 1.2 keV-360 keV. We used energy-dependent average resonance parameters calculated from the statistical description of neutron capture cross-sections by the EVPAR program [2]. The initial parameters were determined from an analysis of the experimental data on neutron capture [3]:

S0 = S2 = 0.326E-4, S1 = 6.04E-4, Sg = 2.81E-4, D0 = 30 eV and R = 6.7 fm.

Calculated cross-sections for 2200 m/sec:

Total = 8.61 b, elastic = 8.28 b, capture = 0.33 b.

Capture resonance integral above 0.5 eV = 5.98 b.

MF = 3 Neutron cross-sections:

In the region up to 100 keV the background is zero. Above, for all cross-sections except capture, the JENDL-1 evaluation [4] was used.

MT = 1 The total cross-sections were calculated by the optical model with the parameters from Ref. [4] obtained from the global description of total cross-sections for nuclei in the mass region of 90 < A < 150.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-54, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach [4].

MT = 102 The capture cross-sections in the region from 0.36 to 5 MeV were taken from the ENDF/B-5 evaluation [5], and above, the evaluation based on the systematics of experimental data in the direct-collective capture model was used.

MT = 251 <μ> - calculated by the optical model.

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 Calculated by the optical model.

MT = 51-54 Isotropic in the centre-of-mass system.

MT = 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 91 A temperature approximation of evaporation spectra was used.

REFERENCES

2. Manturov, G.N., Lunev, V.P. Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

3. Belanova, T.S., et al., At. Ehnerg. 57 (1984) 243.

(For original English Refs, see below.)

1. Mughabghab S.F., Divadeenam H., Holden N.E. Neutron Cross Sections v.1, part A. N.Y.: Academic Press, 1981.
2. Мантуров Г.Н., Лунев В.П., Горбачева Л.В. - ВАНТ, сер.Ядерные константы, 1983, вып. 1(50), с.50.
3. Беланова Т.С. и др. - АЭ, 1984, т.57, с.243.
4. Kikuchi Y. et al. JAERI-1268 (1981), MAT = 4404.
5. Schenter R.E., Smittroth F. ENDF/B-5, MAT = 9333.

44 - Ru-106 | MAT = 4461 | Evaluation - 1985
44 - Ru-106 | Nuclear Data Centre - JENDL

Authors of evaluation: A.V. Ignatyuk and I.V. Kravchenko

Content of the file

MF = 1 General information

MT = 451 Dictionary, comments on evaluations and references.

For all cross-sections the JENDL-1 evaluation [1] was taken but the capture cross-sections above 1 MeV were changed in accordance with the systematics of the fast neutron capture cross-sections.

MF = 2 Resonance parameters:

No resonance parameters except R = 6.4 fm. To describe the thermal cross-sections we used a background in MF = 3.

Calculated cross-sections for 2200 m/sec:

Total = 5.30 b, elastic = 5.15 b, capture = 0.15 b.

Capture resonance integral above 0.5 eV = 2.09 b.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-sections were calculated on the basis of the optical model with the parameters from Ref. [1] obtained from the global description of total neutron cross-sections for nuclei in the $90 < A < 150$ mass region.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-56, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [1].

MT = 102 In the region up to 500 eV the 1/V background was taken and, in the region from 500 eV to 1 MeV, the JENDL-1 evaluation [1]. Above 1 MeV, the evaluation based on statistical calculations and the systematics of experimental data in the direct-collective capture model was used.

MT = 251 $\langle\mu\rangle$ - calculated by the optical model.

MF = 4 Secondary neutron angular distributions [1]:

MT = 2 Calculated by the optical model.

MT = 51-56 Isotropic in the centre-of-mass system.

MT = 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distribution [1]:

MT = 91 The temperature description of evaporation spectra was used.

REFERENCES

1. Kikuchi, Y. et al., JAERI-1268 (1981), MAT = 4406, JENDL-FP.

<u>45 - Rh-103</u> <u>MAT-4501</u>
45 - Rh-103 Nuclear Data Centre - Power Physics Inst.

Evaluation - 1984
Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko and G.N. Manturov

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

<u>Content of the file</u>

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.0 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 160 meV.

Unresolved resonances: 2-93.0 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The average parameters were obtained from an analysis of the set of experimental data on neutron capture cross-sections [3]:

S0 = 0.53E-4, S1 = 5.50E-4, S2 = 0.53E-4, S_g = 0.60E-2, Do = 16.0 eV and R = 6.2 fm.

Calculated cross-sections for 2200 m/sec:

Total = 149.5 b, elastic = 3.3 b, capture = 146.2 b.

Capture resonance integral above 0.5 eV = 1033.2 b.

MF = 3 Neutron cross-sections:

In the region up to 93 keV the background is zero. Above, for the total cross-sections and inelastic scattering cross-sections we used the JENDL-1 evaluation [4] and for the (n,2n) reaction cross-sections the ENDF/B-5 evaluation [5].

MT = 1 The total cross-sections were calculated by the optical model with the potential from Ref. [4].

MT = 2 Elastic scattering cross-sections = total - cross-section of all inelastic reactions.

MT = 4, 51-63, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach [4].

MT = 16 The (n,2n) reaction cross-section was calculated by the *THRESH program [6].*

MT = 102 The capture cross-sections in the region up to 0.8 MeV were taken from the statistical description of experimental data [3]. In the region from 0.8 to 8.0 MeV, the ENDF/B-5 [5] evaluation was taken, and above, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 $<\mu>$ - calculated by the optical model with the potential from Ref. [4].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model with the potential from Ref. [4].

MT = 61, 51-63, 91 Taken to be isotopic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 16, 91 A temperature approximation of evaporation spectra was used. [4, 5].

REFERENCES

1. Mughahghab, S.F., Divadeenam, H., Holden, N.E., Neutron Cross-sections, V. 1, part A., N.Y.: Academic Press, 1981.

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1(50) (1983) 50 (in Russian).

3. Belanova, T.S., et al., At.Ehnerg. 57 (1984) 243.

4. Kikuchi, Y. et al., JAERI - 1268 (1981), MAT = 4503.

5. Schenter, R.E., Schmittroth, F. - ENDF/B-5, MAT = 1310.

6. Pearlstein, S. - J. Nucl. Energy, 1973, V. 27, p. 81.

46 - Pd-105	MAT-4651	
44 - Ru-101	Nuclear Data Centre - Power Physics Inst.	Evaluation - 1984 Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, Zh.A. Korchagina, I.V. Kravchenko, G.N. Manturov and M.N. Nikolaev

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-2 keV. Multilevel Breit-Wigner formalism with resonance parameters from Refs [1, 2]. The spins of the unidentified resonances were assigned by the method of random numbers. The average radiation width taken was 148 meV.

Unresolved resonances: 2 keV-283.2 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [3]. The initial parameters were obtained from an analysis of the set of experimental data on neutron capture cross-sections [4]:

S0 = 0.54E-4, S1 = 5.60E-4, S2 = 0.54E-4, Sg = 1.40E-2, D0 = 10.0 eV and R = 6.1 fm.

Calculated cross-sections for 2200 m/sec:

Total = 26.3 b, elastic = 4.3 b, capture = 22.0 b.

Capture resonance integral above 0.5 eV = 109.3 b.

MF = 3 Neutron cross-sections:

In the region up to 283.2 keV the background is zero. Above, for all cross-sections except capture, the ENDF/B-5 evaluation [5] was used.

MT = 1 The total cross-sections were calculated by the optical model with the potential from Ref. [6].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-63, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [7].

MT = 102 The capture cross-sections in the region up to 0.7 MeV were taken from the statistical description of experimental data [4]. In the region from 0.7 to 2.0 MeV - smooth interpolation to the JENDL-1 evaluation; in the 2.0-8.0 MeV region the JENDL-1 evaluation [8] was taken, and above, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 <μ> - calculated by the optical model with the potential from Ref. [6].

MT = 252 STI - calculated from <μ>.

MF = 4 Secondary neutron angular distributions [5]:

MT = 2 Calculated on the basis of the optical model with the potential from Ref. [6].

MT = 51-63, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [5]:

MT = 91 A temperature approximation of evaporation spectra was used.

REFERENCES

1. Mughabghab, S.F., Divadeenam, H., Holden, N.E. Neutron Cross-sections, V. 1, part A. N.Y.: Academic Press, 1981.

2. Cornelis, E. et al. - In: Proc. Meeting on Neutron Cross-sections of Fission Product Nuclei (Bologna, 1979), p. 53.3.

3. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

4. Belanova, T.S., et al., At.Ehnerg. 57 (1984) 243.

5. Schenter, R.E., Schmittroth, F. - ENDF/B-5, MAT = 9382.

6. Moldaner, P.A. - Nucl. Phys., 1963, V. 47, p. 65.

7. Dunford, C.L., AI-AEC-12931 (1970)

8. Kikuchi, Y. et al. JAERI-1268 (1981). MAT = 4605.

46 - Pd-107	MAT-4671	
46 - Pd-107	Nuclear Data Centre - Power Physics Inst.	Evaluation - 1985

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko, G.N. Manturov and M.V. Skripova

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-700 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 125 meV.

Unresolved resonances: 700 eV-300 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were obtained from an analysis of experimental data [1] on neutron capture cross-sections:

S0 = 0.60E-4, S1 = 5.80E-4, S2 = 0.60E-4, Sg = 1.70E-2, D0 = 11.4 eV and R = 6.6 fm.

Calculated cross-sections for 2200 m/sec:

Total = 6.5 b, elastic = 4.1 b, capture = 2.4 b.

Capture resonance integral above 0.5 eV = 121.4 b.

MF = 3 Neutron cross-sections:

In the region up to the inelastic scattering threshold the background is zero. Above, for all cross-sections except capture, the ENDF/B-5 evaluation [3] was used.

MT = 1 The total cross-sections were calculated by the optical model with the potential from Ref. [4].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-65, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [5].

MT = 16 The threshold reaction cross-sections were calculated by the THRESH program [6].

MT = 102 The capture cross-sections in the region up to 500 keV were taken from the statistical description of experimental data [1]. In the region from 0.6 to 7 MeV, the JENDL-1 evaluation [7] was taken, and above, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 <μ> - calculated on the basis of the optical model [3].

MT = 252 STI - calculated from <μ>.

MF = 4 Secondary neutron angular distributions [3]:

MT = 2 Calculated by the optical model.

MT = 16, 51-65, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [3]:

MT = 16, 91 A temperature description of evaporation spectra [6] was used.

REFERENCES

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V. in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

(For original English Refs, see below.)

I. Macklin R.L. - Nucl. Sci. Engig., 1985, v. p.
2. Мантуров Г.Н., Лунев В.Н., Горбачева Л.В. - ВАНТ, сер.Ядерные константы, I983, вып. I(50), с.50.
3. Schenter R.E., Schmittroth F., Reich C.ENDF/B-5, MAT=9384.
4. Moldauer P.A. - Nucl.Phys., 1963, v.47, p.65.
5. Dunford C.L. - AI-AEC-12931 (1970).
6. Pearlstein S. - J.Nucl.Energy, 1973, v.27. p.81.
7. Kikuchi Y. et al. JAERI-1268 (1981), MAT=4607.

47 - Ag-109	MAT-4791	
47 - Ag-109	Nuclear Data Centre - Power Physics Inst.	Evaluation - 1984 Checking - Power Phys. Inst., 1985

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko and G.N. Manturov

Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file:

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.0 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 130 meV.

Unresolved resonances: 1.0 keV-90 keV. We used energy-dependent average resonance widths calculated by the EVPAR program [2]. The initial parameters were obtained from an analysis of the set of experimental data on neutron capture cross-sections [3]:

S0 = 0.68E-4, S1 = 3.80E-4, S2 = 0.68E-4, Sg = 0.50E-2, D0 = 18.7 eV and R = 6.6 fm.

Calculated cross-sections for 2200 m/sec:

Total = 92.3 b, elastic = 1.8 b, capture = 90.5 b.

Capture resonance integral above 0.5 eV = 1467 b.

MF = 3 Neutron cross-sections:

In the region up to 90 keV the background is zero. Above, for all cross-sections except capture, the ENDF/B-5 evaluation [4] was used.

MT = 1 The total cross-sections above 90 keV were calculated on the basis of the optical model with the potential from Ref. [5].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-55, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach by the COMNUC-3 program [6].

MT = 16, 103, 107 The cross-sections of reactions (n,2n), (n,p) and (n,α) were calculated by the THRESH program [7].

MT = 102 The capture cross-sections in the region up to 800 keV were calculated by the statistical model [3]. In the region from 800 keV to 8 MeV, they were taken from the empirical description of experimental data. Above, the evaluation based on the systematics of experimental data in the direct-collective neutron capture model was used.

MT = 251 <μ> - calculated by the optical model [4].

MT = 252 STI - calculated from <μ>.

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 Calculated on the basis of the optical model.

MT = 16, 51-55, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 16, 91 A temperature approximation of evaporation spectra was used.

REFERENCES

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V. in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

3. Belanova, T.S. et al., At.Ehnerg. 57 (1984) 243.

(For original English Refs, see below.)

I. Mughabghab S.F., Divadeenam H., Holden N.E. Neutron Cross Sec - tions, v. 1, part A. N.Y.: Academic, 1981
2. Мантуров Г.Н., Лунев В.П., Горбачева Л.В. - ВАНТ, сер.Ядерные константы, 1983, вып. I(50), с.50.
3. Беланова Т.С. и др. - Атомная энергия, 1984, т.57, с.243.
4. Schenter R.E. et al. ENDF/B-5, MAT = 1373.
5. Hodson P.E. - Ann. Rev. Nucl. Sci., 1967, v. 17, p. 1.
6. Dunford C. AI - AEC - 12931 (1970).
7. Pearlstein S. - J. Nucl. Energy, 1973, v. 27, p. 81.

53 - I-129 | MAT-5391
53 - I-129 | Nuclear Data Centre - | Evaluation - 1985
Power Physics Inst.

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko and M.V. Skripova

Content of the file:

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-2.0 keV. Multilevel Breit-Wigner formalism with resonance parameters from Refs [1, 2]. The average radiation width taken was 100 meV. A negative resonance of energy -6.367 eV was used to describe the thermal cross-sections.

Unresolved resonances: 2.0-500 keV. We used the energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [3]. The initial parameters were obtained from an analysis of experimental data [2] on neutron capture cross-sections:

S0 = 0.80E-4, S1 = 2.0E-4, S2 = 0.80E-4, Sg = 4.0E-3, D0 = 25.0 eV and R = 5.65 fm.

Calculated cross-sections for 2200 m/sec:

Total = 33.9 b, elastic = 7.0 b, capture = 26.9 b.

Capture resonance integral above 0.5 eV = 28.3 b.

MF = 3 Neutron cross-sections:

In the region up to 500 keV the background is zero. Above, for all cross-sections except capture, the JENDL-1 evaluation [4] was used.

MT = 1 The total cross-sections were calculated by the optical model [4].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-61, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach [4].

MT = 102 The capture cross-section in the region up to 800 keV was taken from the statistical description of experimental data [2]. In the region from 1 to 8 MeV, the JENDL-1 evaluation was taken, and above, the evaluation was based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 <μ> - calculated on the basis of the optical model [4].

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 Calculated on the basis of the optical model [4].

MT = 51-61, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 91 A temperature description of evaporation spectra [4] was used.

REFERENCES

3. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V. in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1 (50) (1983) 50 (in Russian).

(For original English Refs, see below.)

I. Mughabghab S.F., Divadeenam H., Holden N.E. Neutron Cross Sections. v.1, part A. N.Y: Academic, 1981.
2. Macklin R.L. - Nucl.Sci. Engng., 1983, v.85, p.350.
3. Мантуров Г.Н., Лунев В.П., Горбачева Л.В. - ВАНТ, сер.Ядерные константы, I983, вып. I(50), с.50.
4. Kikuchi Y. et al. JAERI-1268 (1981), MAT = 5329.

54 - Xe-131	MAT-5411	
54 - Xe-131	Nuclear Data Centre - Power Physics Inst.	Evaluation - 1985

Authors of evaluation: A.V. Ignatyuk, I.V. Kravchenko, G.N. Manturov and M.V. Skripova

Content of the file

MF = 1 General information

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.0 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 115 meV. A negative resonance with an energy of - 84 eV was introduced to describe the thermal cross-sections [1].

Unresolved resonances: 1.0-364 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were obtained from an analysis of the resolved resonance parameters and the systematics of neutron capture cross-sections for 30 keV [3]:

S0 = 1.20E-4, S1 = 1.80E-4, S2 = 1.20E-4, Sg = 2.30E-3, D0 = 50 eV and R = 6.6 fm.

Calculated cross-sections for 2200 m/sec:

Total = 90.6 b, elastic = 4.3 b, capture = 86.3 b.

Capture resonance integral above 0.5 eV = 912 b.

MF = 3 Neutron cross-sections:

In the region up to the inelastic scattering threshold the background is zero. Above, for all cross-sections except capture, the ENDF/B-5 evaluation [4] was used.

MT = 1 The total cross-sections were calculated by the optical model with the potential from Ref. [5].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-65, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [6].

MT = 16 The threshold reaction cross-sections were calculated by the THRESH programme [7].

MT = 102 The capture cross-sections in the region up to 600 keV were taken from statistical calculations [3]. In the region from 0.6 to 8 MeV, the ENDF/B-5 [4] evaluation was taken, and above, the evaluation based on the systematics of experimental data in the direct-collective neutron capture model was used.

MT = 251 <μ> - calculated on the basis of the optical model [4].

MT = 252 STI - calculated from <μ>.

MF = 4 Secondary neutron angular distributions [4]:

MT = 2 Calculated on the basis of the optical model.

MT = 16, 51-65, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [4]:

MT = 16, 91 A temperature description of evaporation spectra [7] was used.

REFERENCES

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1(50) (1983) 50 (in Russian).

3. Belanova, T.S., et al., At.Ehnerg. 57 (1984) 243.

(For original English Refs, see below.)

I. Mughabghab S.F., Divadeenam M., Holden N.E. Neutron Cross Sections. v.1, p.A. N.Y.: Academic, 1981.
2. Мантуров Г.Н., Лунев В.П., Горбачева Л.В. - ВАНТ, сер. Ядерные константы, I983, вып. I(50), с.50.
3. Беланова Т.С. и др. - Атомная энергия, I984, т.57т с.243.
4. Schenter R.E., Schmittroth F. - ENDF/B-5, MAT=1351.
5. Moldauer P.A. - Nucl. Phys., 1963, v.47, p.65.
6. Dunford C.L. - AI-AEC-12931 (1970).
7. Pearlstein S. - J.Nucl.Energy, 1973, v.27, p.81.

55 - Cs-133 MAT-5531
55 - Cs-133 JENDL-1

Evaluation - 1981
Checking - Power Phys. Inst., 1985

Authors of the evaluation: Y. Kikuchi, T. Nakagawa, G. Matsunobu, M. Kawai, S. Igarasi, and S. Iijima

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-1.29 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 118 meV and the potential scattering radius 5.2 fm. To obtain the thermal cross-section [1], a background of 1/V was added to the capture cross-section.

Calculated cross-sections for 2200 m/sec:

Total = 31.0 b, elastic = 2.0 b, capture = 29.0 b.

Capture resonance integral above 0.5 eV = 398 b.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-sections were calculated on the basis of the optical model with the potential:

$V = 46.0-0.25\ E,\ W1 = 0.125\ E-0.0004\ E^2,$ MeV

$WS = 7.0 \qquad V_{sc} = 7.0$ MeV

$R_v = R_{wi} = R_{so} = 1.16\ A^{1/3} + 0.6,\ av = aso = 0.62$ fm

$R_{ws} = 1.16\ A^{1/3} = 1.3, \qquad B_w = 0.35$ fm

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-63, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach by the (??) program [2].

MT = 102 The capture cross-sections were taken from the statistical description of experimental data with the strength functions [2]:

$S0 = 1.42E-4,\ S1 = 1.39E-4,\ Sg = 1.18E-2,\ D_o = 23.2.$

MT = 251 <μ> - calculated on the basis of the optical model.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated by the optical model.

MT = 51-63, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 91 A temperature description of evaporation spectra was used.

REFERENCES

1. Mughabghab, S.F., Garber, D.I., BNL-325, 3-ed., 1973.

2. Kikuchi, Y. et al., JAERI 1268 (1981).

55 - Cs-135	MAT-5551	
55 - Cs-135	Nuclear Data Centre - JENDL	Evaluation - 1985

Compilers of the file: A.V. Ignatyuk and I.V. Kravchenko

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

For all cross-sections the JENDL-1 evaluation [1] was taken but the capture cross-sections above 30 eV were re-normalized in accordance with the systematics of the neutron capture cross-sections for 30 keV and 14 MeV.

MF = 2 Resonance parameters:

There are no resonance parameters except R = 5.2 fm. To describe the thermal cross-sections, we used a background in MF = 3.

Calculated cross-sections for 2200 m/sec:

Total = 12.1 b, elastic = 3.4 b, capture = 8.7 b.

Capture resonance integral above 0.5 eV = 62.0 b.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-sections were calculated on the basis of the optical model with the parameters of Ref. [1] obtained from the global description of total neutron cross-sections for nuclei in the mass region of $90 < A < 150$.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-56, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach [1].

MT = 102 In the region up to 30 eV, a background of 1/V was taken [1]; in the region from 30 eV to 2 MeV, the JENDL-1 evaluation was decreased by a factor of 0.555 in accordance with the systematics of neutron capture cross-sections for 30 keV [2]. Above 2 MeV, we used the evaluation based on statistical calculations and the systematics of experimental data in the direct-collective capture model.

MT = 251 $\langle\mu\rangle$ - calculated by the optical model.

MF = 4 Secondary neutron angular distributions [1]:

MT = 2 Calculated on the basis of the optical model.

MT = 51-56 Isotropic in the centre-of-mass system.

MT = 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [1]:

MT = 91 A temperature description of evaporation spectra was used.

REFERENCES

1. Kikuchi, Y. et al., JAERI-1268 (1981), MAT = 5535, JENDL-FP.

2. Belanova, T.S. et al., At.Ehnerg. 57 (1984) 243.

58 - Ce-144 | MAT = 5841

58 - Ce-144 | Nuclear Data Centre - JENDL | Evaluation - 1985

Compilers of the file: A.V. Ignatyuk and I.V. Kravchenko

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

For all cross-sections the evaluation of JENDL-1[1] was taken but the capture cross-sections above 500 eV were re-normalized in accordance with the systematics of neutron capture cross-sections for 30 keV and 14 MeV.

MF = 2 Resonance parameters:

There are no resonance parameters except R = 4.6 fm. To describe the thermal cross-sections, we used a background in MF = 3.

Calculated cross-sections for 2200 m/sec:

Total = 3.66 b, elastic = 2.66 b, capture = 1.00 b.

Capture resonance integral above 0.5 eV = 1.55 b.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-sections were calculated on the basis of the optical model with parameters from Ref. [1] obtained from the global description of total neutron cross-sections for nuclei in the mass region of $90 < A < 150$.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-52, 91 The inelastic scattering cross-sections were calculated on the basis of the optical-statistical approach [1].

MT = 102 In the region up to 500 eV, a background of 1/V [1] was taken. In the 500 eV-5 MeV region, the JENDL-1 evaluation was reduced by a factor of 0.429 in accordance with the systematics of neutron capture cross-sections for 30 keV [2]. Above 6 MeV, we used the evaluation based on the systematics of experimental data in the direct-collective capture model.

MT = 251 $\langle\mu\rangle$ - calculated by the optical model.

MF = 4 Secondary neutron angular distributions [1]:

MT = 2 Calculated by the optical model.

MT = 51, 52 Isotropic in the centre-of-mass system.

MT = 91 Isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions [1]:

MT = 91 A temperature description of evaporation spectra was used.

REFERENCES

1. Kikuchi, Y., et al., JAERI-1268 (1981), MAT = 5844, JENDL-FP.

2. Belanova, T.S., et al., At. Ehnerg. 57 (1984) 243.

59 - Pr-141 MAT = 5901

59 - Pr-141

Evaluation - 1980
Checking - Power Phys. Inst., 1984

Authors of evaluation: R.E. Schenter and F. Schmittroth

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-9.991 keV. Single-level Breit-Wigner formalism with resonance parameters from Ref. [3]. The average radiation width taken was 83 meV. A 1/V background was added to the capture cross-section to obtain the thermal cross-section [3].

Calculated cross-sections for 2200 m/sec:

Total = 13.7 b, elastic = 2.2 b, capture = 11.5 b.

Capture resonance integral above 0.5 eV = 19.1 b.

MF = 3 Neutron cross-sections:

MT = 1 The total cross-sections were calculated by the optical model with the potential from Ref. [4].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-60, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [5].

MT = 16 (n,2n), 17 (n,3n), 22 (n,nd), 28 (n,np), 103 (n,p), 104 (n,d), 105 (n,t), 106 (n,^{3}He), 107 (n,α).

The threshold reaction cross-sections were calculated by the THRESH program [6].

MT = 102 The capture cross-sections in the region above 9.03 keV were obtained from the optimum description of the differential and integral experimental data [1, 2].

MT = 251 $\langle\mu\rangle$ - calculated by the optical model.

MT = 252 STI - calculated from $\langle\mu\rangle$.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model with the potential from Ref. [4].

MT = 16, 17, 51-60, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 22, 28, 91 Evaporation spectra with temperature form Ref. [7] were taken.

REFERENCES

I. Schmittroth F., Schenter P.E. Report HENDL TME-77-51 (1977).
2. Schmittroth F. Report HEDL TME-73-79 (Nov.1973).
3. Mughabghab S.F., Garber D.I. BNL-325, 3-ed, 1973.
4. Moldauer D. - Nucl. Phys., 1963, v.47, p.65.
5. Dunford C.L. Report AI-AEC-12931, (1970).
6. Pearlstein S. - J.Nucl.Energy, 1973, v.27, p.81.
7. Gilbert A., Cameron A. - Can.J.Phys., 1965, v.43, p.1446.

60 - Nd-143 | MAT = 6031

60 - Nd-143 Nuclear Data Centre - Power Physics Institute   Evaluation - 1985

Authors of evaluation: M.V. Bokhovko, A.V. Ignatyuk, V.N. Kononov and I.V. Kravchenko
Compilers of the file: I.V. Kravchenko and M.V. Skripova

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-2.5 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 80 meV. To describe the thermal cross-sections, we used a negative resonance with an energy of -6.367 eV.

Unresolved resonances: 2.5-30 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were obtained from an analysis of the set of experimental data on neutron capture cross-sections:

S0 = 3.2E-4, S1 = 0.80E-4, S2 = 1.60E-4, Sg = 2.5E-3, D0 = 36.0 eV, R = 5.8 fm.

Calculated cross-sections for 2200 m/sec:

Total = 415.5 b, elastic = 92.6 b, capture = 322.9 b.

Capture resonance integral above 0.5 eV = 129.2 b.

MF = 3 Neutron cross-sections:

In the region up to 30 keV the background is zero. Above, for total cross-sections and inelastic scattering cross-sections we used the JENDL-1 evaluation [3] and for the (n,2n) and (n,3n) reaction cross-sections the ENDF/B-5 evaluation [4].

MT = 1 The total cross-sections were calculated by the optical model [3].

MT = 2 Inelastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-64, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [3].

MT = 16, 17 The (n,2n) and (n,3n) reaction cross-sections were calulated by the THRESH program [5].

MT = 102 The capture cross-section in the 30 keV-3.0 MeV region was taken from the empirical description of experimental data [6]; above, we took the evaluation based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 $\langle\mu\rangle$ - Calculated on the basis of the optical model [3].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model [3].

MT = 4, 16, 17, 51-64, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 A temperature approximation of evaporation spectra [3, 5] was used.

REFERENCES

1. Mughabghab, S.F., Divadeenam, H., Holden, N.E., Neutron Cross-Section 1 part A., N.Y. Academic (1981).

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 1(50) (1983) 50 (in Russian).

3. Kikuchi, Y., et al., JAERI-1268 (1981).

4. Schenter, R.E., Schmittroth, F., ENDF/B-5, MAT = 9764.

5. Pearlstein, S., I. Nucl. Energy, (1973) 27 81.

6. Bokhovko, M.V., et al., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 3 (1985) 12 (in Russian).

<u>60 - Nd-145</u> <u>MAT = 6051</u>

60 - Nd-145 Nuclear Data Centre - Power Physics Institute Evaluation - 1985

Authors of evaluation: M.V. Bokhovko, A.V. Ignatyuk, V.N. Kononov and I.V. Kravchenko

Compilers of the file: I.V. Kravchenko and M.V. Skripova

<u>Content of the file</u>

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-2.0 keV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [1]. The average radiation width taken was 75 meV. To describe the thermal cross-sections, we used a negative resonance with an energy of -28.18 eV.

Unresolved resonances: 2.0-30 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were obtained from an analysis of the set of experimental data on neutron capture cross-sections:

SO = 4.40E-4, S1 = 0.70E-4, S2 = 2.20E-4, Sg = 4.5E-3,
DO = 17.0 eV, R = 6.5 fm.

Calculated cross-sections for 2200 m/sec:

Total = 69.2 b, elastic = 27.4 b, capture = 41.8 b.

Capture resonance integral above 0.5 eV = 230.3 b.

MF = 3 Neutron cross-sections:

In the region up to 30 MeV the background is zero. Above, for the total and inelastic scattering cross-sections we used the JENDL-1 evaluation [3] and for the (n,2n) and (n,3n) reaction cross-sections the ENDF/B-5 evaluation [4].

MT = 1 The total cross-sections were calculated by the optical model [3].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-64, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [3].

MT = 16, 17 The (n,2n) and (n,3n) reaction cross-sections were calculated by the THRESH program [5].

MT = 102 The capture cross-section in the 30 keV-3.0 MeV region was taken from the empirical description of experimental data [6]; above, we took the evaluation based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 $\langle\mu\rangle$ - calculated on the basis of the optical model [3].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model [3].

MT = 4, 16, 17, 51-64, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 A temperature description of evaporation spectra [3, 5] was used.

REFERENCES

1. Mughabghab, S.F., Divadeenam, H., Holden, N.E., Neutron Cross-Section 1 part A., N.Y. Academic (1981).

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 1(50) (1983) 50 (in Russian).

3. Kikuchi, Y., et al., JAERI-1268 (1981).

4. Schenter, R.E., Schmittroth, F., ENDF/B-5, MAT = 9766.

5. Pearlstein, S., J. Nucl. Energy, (1973) 27 81.

6. Bokhovko, M.V., et al., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 3 (1985) 12 (in Russian).

61 - Pm-147	MAT = 6171	
61 - Pm-147	Nuclear Data Centre - Power Physics Institute	Evaluation - 1985 Checking - Power Phys. Inst., 1985

Authors of evaluation: S.M. Zakharova, A.V. Ignatyuk, I.V. Kravchenko and G.N. Manturov
Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5}-300 eV. Multilevel Breit-Wigner formalism with resonance parameters recommended in Ref. [1]. The average radiation width taken was 69 meV. To describe the thermal cross-sections, we introduced a negative resonance with an energy of -1.80 eV.

Unresolved resonances: 300 eV-100 keV. We used energy-dependent average resonance widths calculated by the EVPAR program [2]. The initial parameters were obtained from an analysis of the resolved resonance parameters:

SO = 3.0E-4, S1 = 0.60E-4, S2 = 3.0E-4, Sg = 1.90E, DO = 3.7 eV, R = 7.1 fm.

Calculated cross-sections for 2200 m/sec:

Total = 186.0 b, elastic = 2.9 b, capture = 183.1 b.

Capture resonance integral above 0.5 eV = 2178 b.

MF = 3 Neutron cross-sections:

In the region up to 91.7 keV the background is zero. Above 100 keV, for the total and inelastic-scattering cross-sections we used the JENDL-1 evaluation [3] and for the (n,2n) and (n,3n) reaction cross-sections the ENDF/B-5 evaluation [4].

MT = 1 The total cross-sections above 100 keV were calculated on the basis of the optical model [3].

MT = 2 Elastic scattering cross-sections = total - cross-section of all inelastic reactions.

MT = 4, 51-56, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [3].

MT = 16, 17 The (n,2n) and (n,3n) reaction cross-sections were calculated by the THRESH program [5].

MT = 102 The capture cross-sections in the region up to 700 keV were calculated by the statistical model [6] and, in the region from 700 keV to 8 MeV, were taken from the JENDL-1 evaluation [3]. Above, we used the evaluation based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 <μ> - Calculated on the basis of the optical model [3].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model [3].

MT = 16, 17, 51-56, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The temperature approximation of evaporation spectra [3,4] was used.

REFERENCES

1. Zakharova, S.M., Abagyan, L.P., Kapustina, V.F., The Isotopes of Promethium. Review OB 120, Power Physics Institute (FEhI) (1981) (in Russian).

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 1(50) (1983) 50 (in Russian).

3. Kikuchi, Y., et al., JAERI-1268 (1981), MAT = 6147.

4. Schenter, R.E., Schmittroth, F., ENDF/B-5, MAT = 9783.

5. Pearlstein, S., J. Nucl. Energy, (1973) 27 81.

6. Belanova, T.S., et al., At. Ehnerg. 57 (1984) 243.

62 - Sm-147	MAT = 6271	
62 - Sm-147	Nuclear Data Centre - Power Physics Institute	Evaluation - 1984 Checking - Power Phys. Inst., 1985

Authors of evaluation: S.M. Zakharova, A.V. Ignatyuk and I.V. Kravchenko
Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-600 eV. Multilevel Breit-Wigner formalism with resonance parameters recommended in Ref. [1]. The average radiation width taken was 55 meV. To describe the thermal cross-sections, we introduced a negative resonance with an energy of -2.20 eV.

Unresolved resonances: 0.6-600 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the EVPAR program [2]. The initial parameters were obtained from an analysis of the set of experimental data on neutron capture cross-sections [1]:

S0 = 4.70E-4, S1 = 1.0E-4, S2 = 2.0E-4, Sg = 1.50E-2, D0 = 5.1 eV, R = 8.3 fm.

Calculated cross-sections for 2200 m/sec:

Total = 53.79 b, elastic = 1.85 b, capture = 51.94 b.

Capture resonance integral above 0.5 eV = 735.1 b.

MF = 3 Neutron cross-sections:

In the region up to 122 keV the background is zero. Above, for the total and inelastic scattering cross-sections we used the JENDL-1 evaluation [3] and for the (n,2n) and (n,3n) reaction cross-sections the ENDF/B-5 evaluation [4].

MT = 1 The total cross-sections above 600 keV were calculated on the basis of the optical model [3].

MT = 2 Elastic scattering cross-sections = total - cross-section of all inelastic reactions.

MT = 4, 51-64, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [3].

MT = 16, 17 The (n,2n) and (n,3n) reaction cross-sections were calculated by the THRESH program [5].

MT = 102 The capture cross-section in the 0.6-8 MeV region was taken from the JENDL-1 evaluation [1, 3]; above, we used the evaluation based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 $\langle\mu\rangle$ - Calculated on the basis of the optical model [3].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model [3].

MT = 16, 17, 51-64, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 A temperature description of evaporation spectra [3, 5] was used.

REFERENCES

1. Zakharova, S.M., Abagyan, L.P., Kapustina, V.F., The Isotopes ^{147}Sm and ^{149}Sm. Review FEhI-0189. TsNIIAtominform (1984) (in Russian).

2. Manturov, G.N., Lunev, V.P. Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 1 (50) (1983) 50 (in Russian).

3. Kikuchi, Y., et al., JAERI-1268 (1981).

4. Schenter, R.E., Schmittroth, F., ENDF/B-5, MAT = 9806.

5. Pearlstein, S., J. Nucl. Energy, (1973) 27 81.

62 - Sm-149	MAT = 6291	
62 - Sm-149	Nuclear Data Centre - Power Physics Institute	Evaluation - 1984 Checking - Power Phys. Inst., 1985

Authors of evaluation: S.M. Zakharova, A.V. Ignatyuk and I.V. Kravchenko
Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-120 eV. Multilevel Breit-Wigner formalism with resonance parameters recommended in Ref. [1]. The average radiation width taken was 64 meV. To describe the thermal cross-sections, we introduced a negative resonance with an energy of -0.285 eV.

Unresolved resonances: 120 eV-520 keV. We used energy-dependent average resonance widths calculated by the EVPAR program [2]. The initial parameters were obtained from an analysis of the resolved resonance parameters [1]:

SO = 4.8E-4, S1 = 0.50E-4, S2 = 4.8E-4, Sg = 3.37E-2, DO = 1.9 eV, R = 7.5 fm.

A background was added to the capture cross-sections in order to describe the available set of experimental data.

Calculated cross-sections for 2200 m/sec:

Total = 39452 b, elastic = 169 b, capture = 39283 b.

Capture resonance integral above 0.5 eV = 3472 b.

MF = 3 Neutron cross-sections:

In the region up to 120 eV the background is zero. In the 120 eV-520 keV region there is a background in the capture cross-sections. Above 520 keV, for the total and inelastic scattering cross-sections we used the JENDL-1 evaluation [3] and for the threshold reactions the ENDF/B-5 evaluation [4].

MT = 1 The total cross-sections above 520 keV were calculated on the basis of the optical model [3].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-59, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [3].

MT = 16, 17, 103, 107 The (n,2n), (n,3n), (n,p) and (n,α) reaction cross-sections were calculated by the THRESH program [5].

MT = 102 The capture cross-sections in the 120 eV-8 MeV region were taken from the evaluation of Ref. [1]. Above, we used the evaluation based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 $\langle\mu\rangle$ - Calculated on the basis of the optical model [3].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model [3].

MT = 16, 17, 51-59, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 A temperature approximation of evaporation spectra [3, 4] was used.

REFERENCES

1. Zakharova, S.M., Abagyan, L.P., Kapustina, V.F., The Isotopes ^{147}Sm and ^{149}Sm. Review FEhI-0189. TsNIIAtominform (1984) (in Russian).

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants, No. 1(50) (1983) 50 (in Russian).

3. Kikuchi, Y., et al., JAERI-1268 (1981).

4. Schenter, R.E., Schmittroth, F., ENDF/B-5, MAT = 1319.

5. Pearlstein, S., J. Nucl. Energy, (1973) 27 81.

62 - Sm-151	MAT = 6211	
62 - Sm-151	Nuclear Data Centre - Power Physics Institute	Evaluation - 1984 Checking - Power Phys. Inst., 1985

Authors of evaluation: S.M. Zakharova, A.V. Ignatyuk, I.V. Kravchenko and G.N. Manturov
Compilers of the file: I.V. Kravchenko and M.V. Ulaeva

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-100 eV. Multilevel Breit-Wigner formalism with resonance parameters recommended in Ref. [1]. The average radiation width taken was 95 meV. To describe the thermal cross-sections, we introduced a negative resonance with an energy of -0.12 eV.

Unresolved resonances: 100 ev-100 keV. We used energy-dependent average resonance widths calculated from the statistical description of neutron cross-sections by the [EVPAR?] program [2]. The initial parameters were obtained from the systematics of the resolved resonance parameters [1]:

SO = 3.4E-4, S1 = 0.5E-4, S2 = 2.0E-4, Sg = 9.50E-2, DO = 1.0 eV, R = 8.0 fm.

Calculated cross-sections for 2200 m/sec:

Total = 1254 b, elastic = 33 b, capture = 12621 b.

Capture resonance integral above 0.5 eV = 3523 b.

MF = 3 Neutron cross-sections:

In the region up to 100 keV the background is zero. Above, for the total inelastic scattering cross-sections we used the JENDL-1 evaluation [3] and for the threshold reaction cross-sections the ENDF/B-5 evaluation [4].

MT = 1 The total cross-sections were calculated on the basis of the optical model [3].

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-61, 91 The inelastic scattering cross-sections were calculated by the optical-statistical approach [3].

MT = 16 (n,2n), 17 (n, 3n), 103 (n,p), 104 (n,d), 105 (n,t), 106 (n,^{3}He) and 107 (n,α). The threshold reaction cross-sections were calculated by the THRESH program [5].

MT = 102 The capture cross-section in the region up to 350 keV was calculated by the statistical model and, in the region from 350 keV to 8 MeV, was taken from the JENDL-1 evaluation [1, 3]. Above, we used the evaluation based on the systematics of experimental data in the direct-collective neutron capture model.

MT = 251 $\langle\mu\rangle$ - Calculated on the basis of the optical model [3].

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model [3].

MT = 16, 17, 51-64, 91 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 The temperature approximation of evaporation spectra [3, 4] was used.

REFERENCES

1. Zakharova, S.M., Abagyan, L.P., Yudkevich, M.S., Manturov, G.N., The Isotopes ^{151}Sm and ^{153}Sm. Review FEhI-0174. TsNIIAtominform (1983) (in Russian).

2. Manturov, G.N., Lunev, V.P., Gorbacheva, L.V., in: Problems of Atomic Science and Technology, Ser. Nuclear Constants No. 1(50) (1983) 50 (in Russian).

3. Kikuchi, Y., et al., JAERI-1268 (1981), MAT = 6251.

4. Schenter, R.E., Schmittroth, F., ENDF/B-5, MAT = 9810.

5. Pearlstein, S., J. Nucl. Energy, (1973) 27 81.

63 - Eu-151 MAT = 6311
63 - Eu-151 BNL (ENDF/B-5)

Evaluation - 1979
Checking - Power Phys. Inst., 1985

Author of evaluation: S.F. Mughabghab

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5}-98.81 eV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [2]. The spins of the unidentified resonances were assigned by the method of random numbers, taking into account the law (2J + 1) for level density and the non-dependence of strength functions on angular momentum. A negative resonance with an energy of -3.61E-3 eV was introduced to describe the thermal cross-sections.

Unresolved resonances: 98.81 eV-70 keV. The following energy-independent average neutron resonance parameters were used:

SO = 4.07E-4, S1 = 0.80E-4, Γ_g0 = 98 meV, Γ_gI = 92 meV, DO = 0.591 eV and R = 8.8 fm.

Calculated cross-sections for 2200 m/sec:

Total = 9200 b, elastic = 3.4 b, capture = 9197 b.

Capture resonance integral above 0.5 eV = 3305 b.

MF = 3 Neutron cross-sections:

MT = 1 The total neutron cross-sections in the region up to 10 keV were determined by the resonance parameters given above. In the 10 keV-2.3 MeV region the total cross-sections were calculated on the basis of the optical model with the potential from Ref. [3]. Above 2.3 MeV, the experimental data for natural europium [4] were taken.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-59, 91 The inelastic scattering cross-sections were calculated on the basis of statistical approach by the [COMNUC-3??] program.

MT = 16 (n,2n), 17 (n, 3n), 22 (n,n'p), 28 (n,n'α), 103 (n,p), 104 (n,d), 105 (n,t), 106 (n,^{3}He) and 107 (n,α). The threshold reaction cross-sections were obtained on the basis of statistical calculations by the GROGI-3 [6] and THRESH [7] programs normalized to the available experimental data [1].

MT = 102 The capture cross-sections in the region up to 10 keV were determined by the resonance parameters. In the 10 keV-2.5 MeV region the cross-sections were obtained from the empirical description of the available set of experimental data [1]. Above 2.5 MeV, the evaluation was based on statistical calculations normalized to the value of 1 mb for 14.7 MeV.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model with the potential from Ref. [3].

MT = 16, 17, 22, 28, 51-59, 91 Taken to be isotropic in the centre-of- mass system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 A temperature description of evaporation spectra was used.

MF = 12 Distribution of photon multiplicities and transition probabilities [1].

MF = 14 The photon angular distribution is taken to be isotropic in the laboratory system.

MF = 15 Secondary photon energy distributions [1].

REFERENCES

1. Mughabghab S.F. - ENDF/B-5, MAT=1357.
2. Mughabghab S.F., Garber D.I. BNL-325, 3-rd Ed., 1973.
3. Becchetti F.D., Greenlees G.W. - Phys.Rev.,1969, v.182, p.1190,
4. Foster D.G., Glasgow D.W. - Phys.Rev., 1971, v.C3, p.576.
5. Dunford C. Report AI-AEC-12931 (1970).
6. Gilet G. Repotr BNL-50246 (1969).
7. Pearlstein S. - J.Nucl.Energy. 1973, v.27, p.81.

63 - Eu-153   MAT = 6331
63 - Eu-153   BNL (ENDF/B-5)

Evaluation - 1979
Checking - Power Phys. Inst., 1985

Author of evaluation: S.F. Mughabghab

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5}-97.22 eV. Multilevel Breit-Wigner formalism with resonance parameters from Ref. [2]. The spins of the unidentified resonances were assigned by the method of random numbers taking into account the law (2J + 1) for level density and the non-dependence of strength functions on angular momentum. A negative resonance with an energy of -0.40 eV was introduced to describe the thermal cross-sections.

Unresolved resonances: 97.22 eV-10 keV. The following energy-independent average neutron resonance parameters were used:

S0 = 2.50E-4, S1 = 0.60E-4, Γg = 95.8 meV, D0 = 1.31 eV and R = 8.8 fm.

Calculated cross-sections for 2200 m/sec:

Total = 306.6 b, elastic = 6.7 b, capture = 299.9 b.

Capture resonance integral above 0.5 eV = 1448 b.

MF = 3 Neutron cross-sections:

MT = 1 The total neutron cross-sections in the region up to 10 keV were determined by the resonance parameters given above. In the 10 keV-2.3 MeV region the total cross-sections were calculated on the basis of the optical model with the potential from Ref. [3]. Above 2.3 MeV, the experimental data for natural europium [4] were taken.

MT = 2 Elastic scattering cross-section = total - cross-section of all inelastic reactions.

MT = 4, 51-61, 91 The inelastic scattering cross-sections were calculated on the basis of the statistical approach by the COMNUC-3 program [5].

MT = 16 (n,2n), 17 (n, 3n), 22 (n,n'p), 28 (n,n'α), 103 (n,p), 104 (n,d), 105 (n,t), 106 (n,^{3}He) and 107 (n,α). The threshold reaction cross-sections were obtained on the basis of statistical calculations by the GROGI-3 [6] and THRESH [7] programs normalized to the available experimental data [1].

MT = 102 The capture cross-sections in the region up to 10 keV were determined by the resonance parameters. In the 10-360 keV region the cross-sections were obtained from the empirical description of the available set of experimental data [1]. Above, the evaluation was based on statistical calculations normalized to the value of 1 mb for 14.7 MeV.

MF = 4 Secondary neutron angular distributions:

MT = 2 Calculated on the basis of the optical model with the potential from Ref. [3].

MT = 16, 17, 22, 28, 51-61, 91 Taken to be isotropic in the centre-of-mass system.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 91 A temperature description of evaporation spectra was used.

MF = 12 Distribution of photon multiplicities and transition probabilities [1].

MF = 14 The photon angular distribution is taken to be isotropic in the laboratory system.

MF = 15 Secondary photon energy distributions [1].

REFERENCES

1. Mughabghab S.F. - ENDF/B-5, MAT=1359.
2. Mughabghab S.F., Gerber D.I. BNL-325, 3-rd Ed., 1973.
3. Becchetti F.D., Greenlees G.W. - Phys.Rev., 1969, v.182, p.1190.
4. Foster D.G., Glasgow D.W. - Phys.Rev., 1971, v.C3, p.576.
5. Dunford C. Report AI-AEC-12931 (1970).
6. Gilet G. Report BNL-50246 (1969).
7. Pearlstein S. -J.Nucl.Energy, 1973, v.27, p.81.

82 - Pb-00 | MAT = 8202
82 - Pb-00 | Dresden Tech. Univ. - Power Phys. Inst. | Evaluation - 1985

Authors of evaluation: D. Hermsdorf, G. Kalka, D. Seelinger, A.I. Blokhin, A.V. Ignatyuk and V.P. Lunev
Compilers of the file: D. Hermsdorf, A.I. Blokhin and M.V. Deniskina

Content of the file

MF = 1 General information:

MT = 451 Dictionary, comments on evaluations and references.

MF = 2 Resonance parameters:

Resolved resonances: 10^{-5} eV-600 keV. Single-level Breit-Wigner formalism with resonance parameters from Ref. [1]. For ^{204}Pb the upper limit of the resolved resonance region is 60 keV. Negative resonances with parameters describing the thermal cross-sections [1] were included.

Unresolved resonances: 60-600 keV for ^{204}Pb and for the d-wave of ^{207}Pb. We used energy-dependent resonance widths obtained from an analysis of the average neutron resonance parameters and the statistical description of neutron cross-sections.

Calculated cross-sections for 2200 m/sec:

Total = 11.37 b, elastic = 11.20 b, capture = 0.17 b.

Capture resonance integral above 0.5 eV = 0.15 b.

MF = 3 Neutron cross-sections:

MT = 1 Total neutron cross-section. In the region up to 600 keV the background is zero. Above, it is taken on the basis of experimental data [2].

MT = 2 The elastic scattering cross-section was obtained on the basis of calculations by the optical model with subsequent correction of the results considering the evaluations of the total cross-sections and the cross-sections of all inelastic reactions [3].

MT = 4, 51-91 The inelastic scattering cross-sections to discrete levels for neutron energies up to 4 MeV were taken from ENDF/B-4 [4]. Above 4 MeV, inelastic scattering to low-lying levels was included in MT = 91 and the corresponding neutron spectra. The inelastic scattering cross-section to continuous spectrum levels was obtained on the basis of statistical calculations by the STAPRE [5] and AMAPRE [6] programs with the addition of the direct process contributions. The model parameters were fitted to the experimental data on the scattering spectra for 14 MeV neutrons [7].

MT = 10 The primary neutron emission cross-section was determined as the sum of cross-sections of sections MT = 4, 16 and 17.

MT = 16 The (n,2n) reaction cross-section was obtained from calculations by the STAPRE program fitted to experimental data [8].

MT = 17 The (n,3n) reaction cross-section was obtained from calculations by the STAPRE program.

MT = 101 The neutron disappearance cross-section was determined as the sum of cross-sections of MT = 102, 103 and 107.

MT = 102 The neutron radiative capture cross-section up to 600 keV was determined by the resonance parameters, and above, it was obtained from calculations by the FISPRO program [9] normalized to experimental data [10, 11].

MT = 103 The (n,p) reaction cross-section was obtained from the fitting of the STAPRE program calculations to experimental data [12].

MT = 107 The (n,α) reaction cross-section was obtained from calculations by the STAPRE program taking into account the results of the (N-Z)/A systematics of the reaction cross-sections for 14 MeV neutrons.

MT = 251 The average cosine of the neutron scattering angle in the laboratory system was obtained from the data of section MF = 4, MT = 2.

MT = 252, 253 Calculated from MT = 251.

MT = 719, 799 The (n,pn) and (n,αn) reaction cross-sections were obtained by the STAPRE program.

MF = 4 Secondary neutron angular distributions:

MT = 2 In the region up to 1 MeV the coefficients of polynomial description of angular distributions were taken from the analysis of experimental data [4]. Above 1 MeV, the angular distributions were taken from the optical model calculations [3].

MT = 16, 17, 719, 799 Taken to be isotropic in the laboratory system.

MF = 5 Secondary neutron energy distributions:

MT = 10 The spectra of inelastically scattered neutrons were obtained from calculations by the AMAPRE program with parameters fitted to the experimental data on the spectra of 14 MeV neutrons [7].

MT = 16, 17 The (n,2n) and (n,3n) reaction spectra were obtained from calculations by the STAPRE amd AMAPRE programs consistent with section MT = 10.

MT = 719, 799 Taken from calculations by the STAPRE program.

MF = 6 Angular distributions of inelastically scattered neutrons.

MT = 10 The coefficients of polynomial description of the double differential neutron inelastic scattering cross-sections were taken from calculations by the AMAPRE program.

MF = 33 Covariance error matrix of the evaluation of the integral cross-section.

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92 - U-235	MAT = 9235		
92 - U-235	Nuclear Power Institute (Byelorussian Academy of Sciences)	Evaluation	- 1985
		Checking and correction	- 1985

Authors of evaluation: V.A. Kon'shin, G.V. Antsipov, E.Sh. Sukhovitskij, A.B. Klepatskij, V.M. Maslov and G.B. Morogovskij

Content of the file

MF = 1 General information:

MT = 451 Gives a short description of the evaluation for 92 - U-235. For full description see Ref. [1].

MT = 452 Total number of secondary neutrons per fission $\bar{\nu}_t$. It is equal to the sum of the delayed ($\bar{\nu}_d$) and prompt ($\bar{\nu}_p$) neutrons. The number of delayed neutrons was taken as 0.0158 per fission at thermal energy, 0.0166 per fission in the region from thermal energy to 4.0 MeV and 0.0092 per fission in the 8-15 MeV region [2].

MT = 456 Number of prompt fission neutrons $\bar{\nu}_p$. Normalization to $\bar{\nu}_p(^{252}Cf) = 3.757$. The evaluation of the energy dependence of $\bar{\nu}_p$ was made on the basis of experimental data listed in Ref. [2] and experimental data of Ref. [3] with allowance for corrections [4, 5]. The energy dependence takes the form: $\bar{\nu}_p(E) = 2.398 + 0.05656E + 0.03954E^2 - 0.005733E^3$ in the 0-2.25 MeV region and $\bar{\nu}_p(E) = 2.334 + 0.1420E + 0.001577E^2 - 0.0001086E^3$ in the 2.25-15.0 MeV region.

MF = 2 Resonance parameters:

MT = 151 The resolved resonance region from 0.29 eV to 99.5 eV contains data for 205 s-resonances. In the resolved resonance region, for calculation of neutron cross-sections, it is recommended that the multilevel Breit-Wigner formula be used with allowance for the contribution of all levels to that given. In making allowance for the contribution of all levels, the use of the Adler-Adler parameters obtained by us does not improve the description of the cross-sections in comparison with the multilevel Breit-Wigner formalism (background - "smooth file" - remains practically the same). The resonance parameters were obtained from the description of the following experimental data:

Total cross-section [6,7], fission cross-section [8,9,10,11] and capture cross-section [12,13].

The spin identification of levels was performed from the data of Ref. [8]. As the reference energy scale we took Refs [6,7,9-11], and this required a small shift of the scale in Refs [12,13].

A background - "smooth file" - should be added to the cross-sections calculated from the resonance parameters given in the file. It is recommended that the neutron cross-section calculations from parameters should be made in the 5-100 eV region.

In the 1.0 x 10^{-5}-5 eV region the cross-sections are given numerically.

MF = 3 Smooth neutron cross-sections:

For 0.253 eV the following were taken:

Total cross-section = 694.9 b, elastic cross-section = 14.0 b, fission cross-section = 582.6 b, capture cross-section = 98.3 b, ν total = 2.425.

The cross-sections of all reactions are given in three intervals:

In the 0.1 x 10^{-5}-1 eV region - total cross-section (MT = 1) obtained from the data of Refs [14,15,16,17,18], fission cross-section (MT = 18) from the data of Refs [9,19,20,18,12], capture cross-section (MT = 102) from the data of Refs [21,12] and scattering cross-section (MT = 2) calculated from the resolved resonance parameters. In the 1.5 eV region these cross-sections were calculated from the resonance parameters with the addition of a background. In the unresolved resonance region (0.1-100 keV) the evaluated data were obtained on the basis of the following experimental results: total cross-section [7,22,23], fission cross-section [12,24,25,21,26,13,7,27,28,29] and capture cross-section [30,31,13,32]. The elastic scattering cross-section was calculated for the value of the potential scattering cross-section in the low-energy region equal to 11.7 b [22]. From the evaluated cross-section data we obtained the parameters which take into account the cross-section fluctuation in the region up to 25 keV. The average value of radiation width was 31 meV (identical for the s- and p-waves), strength functions for the s-wave 0.98 x 10^{-4} and for the p-wave 1.6 x 10^{-4} for the whole unresolved resonance region. The contribution of the (n,γf) process to the fission cross-section is 2.4% in the 0.1-100 keV region. The calculated widths of the (n,γf) process were: 3.62 meV for the 3^- channel and 1.44 meV for the 4^- channel. The cross-section of the (n,γf) process was added to the fission cross-section. The error of cross-section calculation from parameters in energy intervals with a width of 1.0 keV was 0.5-1.5%

for the fission and capture cross sections and 3-5% for the total cross section in the 0.1-30 keV region. In the 30-100 keV region the error of neutron cross-section calculation from parameters was 5.4% for the fission cross-section, 4% for the capture cross-section and 1.7% for the total cross-section. The difference between the results of calculations from the average parameters and the evaluated values is given in the form of smooth backgrounds to cross sections in the 0.1-100 keV region.

In the region from 0.1 to 20 MeV the following reaction cross sections are given (for a more detailed description see Ref. [1]):

MT = 1 Total cross section.

The evaluation is based on the experimental data of Refs [33,34,23] and on our calculations by the coupled channel method [35].

MT = 2 Elastic scattering cross-section:
Calculated by the coupled channel method.

MT = 4 Inelastic scattering cross section
(sum of MT = 51,52,...,91).

MT = 16 (n,2n) reaction cross section.

MT = 17 (n,3n) reaction cross section.

The cross-sections of reactions (n,2n) and (n,3n) were calculated by the multicascade statistical model, and the fission barriers and the level density parameters of the nucleus with allowance for the collective effects were obtained from an analysis of the fission cross-sections for uranium isotopes in the "first plateau" region. By calculating the neutron spectra on the basis of the pre-equilibrium decay model with allowance for the consistent analysis of the neutron data for ^{238}U and ^{235}U, we were able to describe the fission cross sections for uranium isotopes in the 1-20 MeV region and, consequently, to make an evaluation of the (n,xn) reaction cross-sections. A more detailed description of the method is given in Ref. [36].

MT = 18 Fission cross section.

The fission cross-section was evaluated with allowance for correlations between the errors of different experiments (see Ref. [1]) on the basis of an analysis of the available experimental data. The evaluated data agree with the ENDF/B-5 evaluation [37] to within 1-2% (in the 0.4-5.0 MeV region they were, on an average, 1% lower than the data of Ref. [37]). The errors of the evaluated fission cross-sections were 3% on an average, except for the narrow region around 14 MeV. Since the fission cross-section data from ENDF/B-5 were included in the international file of standard neutron cross-sections, we used them in the present evaluation. Consistent analysis of data on the (n,2n) and (n,3n) reaction cross-sections, on the inelastic scattering cross-section and on the fission cross-section showed that the fission cross-section in the 16-20 MeV region should be somewhat higher than the ENDF/B-5 data (by 4% on an average). In the present evaluation, the fission cross-sections were taken from ENDF/B-5 so that it was necessary to raise the calculated cross-section of the (n,2n) reaction by 0.2 b in the 16-20 MeV region.

MT = 51...69 Discrete level excitation cross-sections.

The inelastic scattering cross-section for target nuclei was calculated by the coupled channel method (the contribution of the direct excitation of the 46.21, 103.03 and 170.73 keV levels) and by the statistical model (contribution of the compound process).

MT = 91 The inelastic scattering cross-section with excitation of target nucleus continuum levels was calculated by the statistical model.

MT = 102 Radiative capture cross-section.

The evaluation was carried out with allowance for correlations between the different experiments. The main data in the evaluation of the alpha value are those of Refs [30, 31]. The remaining data were used with a lower "weight". The error in the alpha value in the region up to 30 keV is 4% and in the 0.03-1 MeV region 8-10% in the presence of correlations (4-8%, if the correlations are not taken into account).

MF = 4 Neutron angular distributions

MT = 2 The angular distributions of elastically scattered neutrons were evaluated on the basis of an analysis of available experimental data and calculations by the coupled channel method with the addition of the compound contribution by the statistical model (below 4 MeV). In the evaluation, we separated the contribution of elastically scattered neutrons to the $7/2^-$ level and that of inelastically scattered neutrons to higher levels.

The angular distributions are given by Legendre polynomial expansion coefficients.

MT = 16, 17, 18 The angular distributions of neutrons from the (n,2n), (n,3n) and fission reactions are given isotropically in the laboratory system of co-ordinates.

MT = 51, 52, 54, 55, 57, 58, 60-62, 64....69, 91 The angular distributions of inelastically scattered neutrons are given isotropically in the laboratory system of co-ordinates.

MT = 53, 56, 59, 63 Angular distributions of inelastically scattered neutrons to the 46.21, 103.03, 170.73 and 291.10 keV levels.

Given as anisotropic in accordance with calculations by the coupled channel method.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17 Energy distributions of neutrons from the (n,2n) and (n,3n) reactions.

The neutron spectra were calculated by the multicascade statistical model with allowance for pre-equilibrium decay of the nucleus. The description of the high-energy part of the spectrum of inelastically scattered neutrons for ^{238}U required the value of parameter K = 10 in the pre-equilibrium decay model ($M^2 = K/A^3$). It was assumed that the high-energy part of the spectrum for ^{235}U was the same as that for ^{238}U.

MT = 18 The fission neutron spectrum is given in the Maxwellian form with an energy-dependent temperature.

MT = 91 Neutron energy distributions for inelastic scattering with excitation of target nucleus continuum levels.

Calculated by the statistical model with allowance for pre-equilibrium decay of the nucleus.

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92 - U-238 | MAT = 9271 | Evaluation - 1978
92 - U-238 | | Revision - 1981
| | Checking - 1985

Authors of evaluation: M.N. Nikolaev, L.P. Abagyan, N.O. Bazazyants et al.

Content of the file

MF = 1 General information:

MT = 451 A brief description of the evaluation is given. For full description see Refs [1, 2].

MT = 452 The energy dependence of the total number of secondary neutrons emitted during fission is equal to the sum of MT = 455 and MT = 456.

MT = 455 The decay probabilities and energy dependences for six groups of delayed neutrons were obtained on the basis of Ref. [3].

MT = 456 The energy dependence of spontaneous fission prompt neutrons, normalization to NU 98-CF-252 equal to 3.7374.

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are presented as a mixture of two isotopes of identical mass and concentration (AWR = 2.36006 + 02, ABN = 1.0). The first isotope contains the data for the s- and d-waves and the second the data for the p-wave. It was thus possible to introduce different limits of the resolved and unresolved resonance regions and different potential scattering radii for the s- and p-waves.

The evaluation method and the basic results are given in Ref. [1]. The fission width was assumed to be zero. The threshold fission cross-section in the resonance region is given in the file of smooth cross-sections (MF = 3, MT = 18).

During compilation of data:

(1) The values of radiation widths for the first five s-resonances were reduced as in Ref. [4];

(2) The average resonance parameters were re-evaluated as in Ref. [5], considering the limitations imposed by the ENDF/B format on the choice of the radius of the nucleus.

First isotope:

The resolved resonance region from 1.0 eV to 4650 eV contains data for 249 s-resonances up to 5756 eV. In the resolved resonance region, the multilevel Breit-Wigner formula (LRF = 2) is recommended for calculation of the cross-sections. In the unresolved resonance region from 4.65 keV to 200 keV for the s- and d-resonances the average resonance parameters are given at 34 energy points.

Second isotope:

The resolved resonance region from 1.0 eV to 2150 eV contains data for 252 p-resonances up to 3800 eV. In the resolved resonance region, the single-level Breit-Wigner formula (LRF = 1) is recommended for calculation of the cross-sections. The average resonance parameters for J = 1/2 and J = 3/2 are given in the 2.25-200 keV region at 39 energy points.

MF = 3 Neutron cross-sections:

For 0.0253 eV the following were taken:

SIGMA EL = 8.90 b
SIGMA GAM = 2.71 b

The cross-sections of all reactions are given in three intervals:

- From 1.E-5 eV to 1.0 eV: total cross-section (MT = 1), elastic scattering cross-section (MT = 2) and radiative capture cross-section (MT = 102) calculated from the resolved resonance parameters (MF = 2, MT = 151).

- From 1.0 eV to 200 keV: smooth backgrounds to resonance cross-sections - sub-threshold fission cross-section (MT = 18) and the total cross-section equal to it (MT = 1), elastic scattering cross-sections with excitation of the first and second levels (MT = 51,52) calculated from resonance parameters (MF = 2, MT = 151) and the total inelastic scattering cross-section equal to their sum (MT = 4). In this energy interval the cross-section balance is upset since according to the procedures for the ENDF/B format the total cross-section in this energy region is calculated from the resonance parameters (MF = 2, MT = 151) with allowance for the contribution of the smooth inelastic scattering cross-section; therefore, the contribution of inelastic scattering to the background of the total cross-section (MF = 3, MT = 1) is not taken into account.

- From 200 keV to 20 MeV the following reaction cross-sections are given in accordance with Ref. [2]:

MT = 1 Total cross-section.

MT = 2 Inelastic scattering cross-section (from the balance).

MT = 4 Inelastic scattering cross-section (sum of MT = 51,52...,58,91).

MT = 16 (n,2n) reaction cross-section.

MT = 17 (n,3n) reaction cross-section.

MT = 18 Fission cross-section.

MT = 37 (n,4n) reaction cross-section.

MT = 51,...,58 Excitation cross-sections for inelastic scattering to discrete levels of the target nucleus.

MT = 91 Inelastic scattering cross-section with excitation of a continuum of levels of the target nucleus.

MT = 102 Radiative capture cross-section.

MF = 4 Angular distributions:

MT = 2 The anisotropy of elastic scattering is given in the laboratory system of co-ordinates (LCT = 1) at 55 points of incident energy by Legendre polynomial expansion coefficients.

Below 10 keV, the linear indicatrix is given; the average cosine is evaluated from the assumption about isotropic scattering by free nuclei in the centre-of-inertia system.

At 20 MeV the angular distribution is taken to be the same as at 14.3 MeV.

The above ensures positive angular distributions both at and between the energy nodal points (for the given linear interpolation of the expansion coefficients).

MT = 16, 17, 18, 37 The angular distributions of neutron reactions (n,2n), (n,3n), (n,4n) and fission neutrons are given isotropically in the laboratory system of co-ordinates (LCT = 1).

MT = 51,....,58,91 The angular distributions of inelastically scattered neutrons are given isotropically in the laboratory system of co-ordinates (LCT = 1).

MF = 5 Energy distributions:

MT = 16, 17 The energy distributions of neutrons from the (n,2n) and (n,3n) reactions are given by an evaporation spectrum with an energy-dependent temperature (LF = 11) on the basis of Ref. [6].

MT = 18 The fission neutron spectrum is given in the Watt form with energy-dependent parameters (LF = 11) on the basis of Ref. [2].

MT = 37, 91 The energy distributions of neutrons from the (n,4n) reaction and inelastic scattering with excitation of a continuum of levels of the target nucleus are given by an evaporation spectrum with an energy-dependent temperature (LF = 9) according to Ref. [6].

MT = 455 The spectra of six groups of delayed neutrons are taken to be independent of energy. The spectra have the shape of broken curves describing the group histograms of spectra from Ref. [7].

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93 - Np-237 MAT = 9311

93 - Np-237
CAD FR
Power Phys. Inst. (USSR State Committee on the Utilization of Atomic Energy)

Evaluation - 1981
Checking - 1982

Authors of evaluation: H. Derrien and E. Fort

Content of the file

MF = 1 General information:

MT = 451 General information, comments and dictionary. The full description of the file is given in Ref. [1].

MT = 452 Energy dependence of the total number of fission neutrons.

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are given in the 0.3-150 eV energy region. In the neutron resonance energy region the resolved resonance parameters are presented up to E = 235 eV. For calculation of cross sections in the 0.3-150 eV region, the single-level Breit-Wigner formalism is recommended.

Calculated cross-sections for 2200 m/sec:

Total = 195.78 b, elastic = 14.74 b, fission = 0.018 b, radiative capture = 181.02 b.

MF = 3 The neutron cross-sections are given in the 10^{-5}eV-14 MeV region.

In the 0.3-150 eV region the background in the cross-section is zero. In this region the cross-sections should be calculated with the help of the resolved resonance parameters from MF = 2.

MT = 1 The total cross-sections were obtained by summing the partial cross-sections.

MT = 2, 18, 102 Neutron elastic scattering, fission and fast neutron radiactive capture cross-sections, respectively. In the 10^{-5}-0.3 eV region these cross-sections were calculated with the help of the resolved resonance parameters from MF = 2 and normalized at the thermal point to the corresponding thermal cross-sections. In the 0.15-40 keV region the radiative capture and elastic scattering cross-sections were calculated by the statistical model with the following parameters:

$R' = 9.54$ fm, $S_o = 0.994 \times 10^{-4}$,

$S_1 = 1.82 \times 10^{-4}$, $\Gamma_{\gamma o} = 0.04$, $D_o = 0.56$.

The evaluation of the fission cross-section for E_n = 0.15-4 keV was based on an analysis of experimental data and, in the 4-40 keV region, was obtained by statistical model calculations. In the 40 keV-14 MeV region all cross-sections were calculated by the statistical theory, in which the penetrability factors were determined by the optical model taking into account coupled channels. The approach is described in Ref. [1]. The theoretical calculations of the fission cross-section for E_n > 6 MeV were performed with allowance for the contributions of the (n,n'), (n,2n) and (n,3n) reactions with the corresponding self-consistent description of experimental data.

MT = 4, 51-83, 91 Total neutron inelastic scattering cross-sections and also inelastic scattering cross-sections with excitation of resolved levels (MT = 51-83) and a continuum (MT = 91). The data were obtained on the basis of the statistical theory, and the penetrability factors were determined by the coupled channel model.

MT = 16, 17 (n, 2n) and (n, 3n) reaction cross-sections, respectively.

The data were obtained on the basis of the statistical approach under the condition of a self-consistent description of the corresponding experimental data on the (n,2n) reaction and the fission cross-section.

MF = 4, 5 Angular and energy distributions of secondary neutrons.

No data are presented.

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94 - Pu-239	MAT = 9439	Evaluation - 1980
94 - Pu-239	Nuclear Power Institute (Byelorussian Academy of Sciences)	Re-evaluation (second version) - 1984 Checking and correction - 1985

Authors of evaluation: V.A. Kon'shin, E. Sh. Sukhovitskij, G.V. Antsipov, A.B. Klepatskij, V.M. Maslov, G.B. Morogovskij and L.A. Bakhanovich

Content of the data file

MF = 1 General information:

MT = 451 Comments and dictionary.

MT = 452 Number of neutrons per fission (sum of $\nu_p + \nu_d$). The evaluated value of ν_t was normalized to $\bar{\nu}_t$ (^{252}cf) = 3.767. The evaluation of $\bar{\nu}_p$ was obtained from the polynomial description of data given in Ref. [1] and also new data [2-4].

MT = 454 Number of prompt fission neutrons ν_p.

MF = 2 Resonance parameters:

MT = 151 Resonance parameters.

In the 1.0 x 10^{-5} eV-520 eV region the resonance parameters were obtained from the analysis of the following experimental data: Refs [5-7] for total cross-section, Refs [7-10] for fission cross-section and Ref. [8] for capture cross-section. A satisfactory description of experimental data within experimental errors was achieved in the 10^{-5}-1 eV region provided two negative resonances were taken into account; however, in the 0.7-1.0 eV region the fission and absorption cross-sections and in the 0.02-0.2 eV region the capture and fission cross-sections are calculated from parameters with errors of 6-9% and 2-4%, respectively. Therefore, in these regions, the numerical data on cross-sections given in MF-3 should be used.

In the unresolved resonance region (0.5-100 keV) the average resonance parameters were obtained by a consistent analysis of data from the resolved resonance region and data on average cross-sections: total [11], fission [12] and alpha value [12]. The analysis took into account the neutron inelastic scattering process, the (n,γf) reaction, direct level excitation and the energy dependence of the radiation width. A generalized distribution of partial widths was used. The average parameters obtained enable us to reproduce the fluctuation of average cross-sections in the energy intervals chosen. In accordance with the ENDF/B format specifications, the file gives only the inelastic widths for excitation of the first level (8 keV, $3/2^+$), and the number of degrees of freedom for fission width distribution was taken to be an integer and equal to the number of channels which make the principal contribution to the cross-sections.

More detailed information on the method employed and results is given in Ref. [12].

The average parameters obtained with allowance for the multichannel fission process and inelastic width distribution are given in Ref. [12].

The 2200 m/sec cross-sections are:

Total = 1024.81 b, fission = 748.1 b, capture = 269.3 b, absorption = 1017.3 b, alpha = 0.360 b, ν total = 2.877.

MF = 3 Neutron cross-sections:

MT = 1 Total cross-section.

MT = 2 Elastic scattering cross-section.

MT = 4 Total neutron inelastic scattering cross-section.

MT = 16 (n, 2n) reaction cross-section.

MT = 17 (n, 3n) reaction cross-section.

MT = 18 Fission cross-section.

MT = 51-71, 91 Inelastic scattering cross-sections to discrete levels and to a continuum.

MT = 102 Capture cross-section.

The fission cross-section and the alpha value were evaluated in Ref. [12] in the energy region from 0.1 MeV to 15 MeV taking into account the correlation between the partial errors of the different experiments. The fission cross-section was normalized to the σ_f (^{235}U) data from ENDF/B-5 [15]. The evaluated data for σ_t were obtained on the basis of experimental data [13].

The neutron elastic scattering cross-section and the direct excitation cross-section for low-lying levels were obtained by calculation using the coupled channel method with optimization of the non-spherical potential parameters by the SPRT method. The neutron transmission coefficients obtained by the coupled channel method were used in the statistical model calculations of $\sigma_{n\lambda}$, σ_{nn}, and $\sigma_{nn'}$. The collective effects (rotational and vibrational) were taken into account in the level density model.

MF = 4 Neutron angular distributions:

MT = 2 Angular distributions of elastically scattered neutrons.

MT = 16, 17, 18 Angular distribution of neutrons from the (n,2n), (n,3n) and fission reactions.

MT = 51-71, 91 Angular distributions of neutrons elastically scattered to levels.

The angular distributions of elastically and inelastically scattered neutrons in the 100 keV-15 MeV region were obtained from the analysis of experimental data and by calculation by the coupled channel method with the addition of the isotropic part of the compound nucleus formation process.

MF = 5 Energy distributions of secondary neutrons:

MT = 16, 17, 18, 91 Energy distributions of neutrons from the (n,2n), (n,3n) and fission reactions, and the reaction of inelastic scattering to a continuum.

Below 5 MeV, an evaporation model was used. In the higher region, the contribution of pre-equilibrium neutrons was taken into account. The neutron spectra from the (n,2n) and (n,3n) reactions were calculated with allowance for pre-equilibrium primary neutron emission.

MF = 12 Photon production cross-sections in neutron reactions.

MF = 15 Photon energy distributions in neutron reactions.

MT = 4, 16, 17, 18, 102 Energy distributions of photons from the neutron inelastic scattering, (n,2n), (n,3n), fission and capture reactions.

The photon spectra from the inelastic processes of neutron interaction were calculated by the statistical model, and the photon spectrum from fission was taken from Ref. [14].

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<u>94 - Pu-240</u> | <u>MAT = 9440</u>

94 - Pu-240 | Nuclear Power Institute (Byelorussian Academy of Sciences) | Evaluation - 1980; Re-evaluation - 1984; Checking and correction - 1985

Authors of evaluation: G.V. Antsipov, V.A. Kon'shin, A.B. Klepatskij, Yu.V. Porodzinskij, V.A. Zenevich and E.Sh. Sukhovitskij

<u>Content of the data file</u>

MF = 1 General information:

MT = 451 Comments and dictionary.

MT = 452 Number of neutrons per fission (sum of $\nu_p + \nu_d$). The evaluated value of ν_t was normalized to ν_t = 3.767 of ^{252}Cf spontaneous fission. The energy dependence of ν_p was: 2.8408 + 0.14703 E (MeV)

MT = 456 Number of prompt fission neutrons ν_p.

MF = 2 Resonance parameters:

MT = 151 Resonance parameters.

In the 1.0 x 10^{-5} eV -1 keV region the resonance parameters were evaluated on the basis of the Breit-Wigner parameters obtained in Refs [1-9] with renormalization to more accurate values of neutron widths.

In the unresolved resonance region (1-142 keV) the average resonance parameters are given.

The 2200 m/sec cross-sections are:

Total = 289.397 b, elastic = 1.54 b, fission = 0.059 b, capture = 287.798 b, ν total = 2.8696.

MF = 3 Neutron cross-sections:

MT = 1 Total cross-section.

MT = 2 Elastic scattering cross-section.

MT = 4 Total neutron inelastic scattering cross-section.

MT = 16 (n,2n) reaction cross-section.

MT = 17 (n,3n) reaction cross-section.

MT = 18 Fission cross-section.

MT = 51-73, 91 Cross-sections for inelastic scattering to discrete level and to a continuum.

MT = 102 Capture cross-section.

In the calculation of cross-sections in the thermal region (up to the first-resonance energy), the interference of the potential and resonance scattering for the first resonance was taken into account.

The cross-sections in the unresolved resonance region were obtained on the basis of the average resonance parameters. We used the double-humped fission barrier concept, so that the law of fission width distribution differs from the Thomas-Porter distribution. The method used in the evaluation is given in Ref. [10]. The energy dependence of the parameter $X_{max} = 1/X_{min}$, which characterizes the law of fission width distribution, is given below.

E, keV	X_{max}	E, keV	X_{max}
I	29.5I3	2	29.20I
3	28.892	4	28.587
6	27.987	8	27.40I
I0	26.828	I2	26.267
I4	25.720	I6	25.I84
20	24.I49	24	23.I59
28	22.2I3	32	2I.309
36	20.445	40	I9.6I9
45	I8.638	50	I7.740
60	I6.007	70	I4.485
80	I3.I25	90	II.9I0
I00	I0.824	II0	9.854
I20	8.986	I30	8.2I0
I40	7.5I5		

The fission cross-sections were evaluated mainly on the basis of experimental data [11-14, 18-20]. The coupled channel method with carefully fitted optical potential parameters and the statistical theory of nuclear reactions were used to evaluate the other types of cross-section. The transmission coefficients for neutrons were calculated by the coupled channel method. The non-spherical optical potential parameters were taken from Ref. [15]. To calculate level density, we used the Fermi-gas model with allowance for the collective effects.

The total cross-section in the 0.6-6 MeV region was obtained on the basis of the data of Ref. [16]. The fission cross-section was normalized to σ_f (^{235}U) from the data of Ref. [17].

MF = 4 Neutron angular distributions:

MT = 2 Angular distributions of elastically scattered neutrons.

MT = 16, 17, 18 Angular distributions of neutrons from the (n,2n), (n,3n) and fission reactions.

MT = 51-73 Angular distributions of neutrons inelastically scattered to levels.

The angular distributions for elastic scattering for the level 0^+ and for inelastic scattering for levels 2^+ and 4^+ and also the level excitation functions were obtained by the coupled channel method and by the statistical model.

MF = 5 Energy distributions of secondary neutrons:

MT = 16, 17, 18, 19 Energy distributions of neutrons from the (n,2n), (n,3n) and fission reactions and the reaction of inelastic scattering to a continuum.

MF = 12 Photon production cross-sections in neutron reactions.

MF = 15 Photon energy distribution in neutron reactions:

MT = 4 Energy distribution of photons from the neutron inelastic scattering reaction.

MT = 16, 17, 18 Energy distribution of photons from the (n,γ) and fission reactions.

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94 - Pu-241	MAT - 9441	
94 - Pu-241	Nuclear Power Institute (Byelorussian Academy of Sciences)	Evaluation - 1979 Re-evaluation (second version) - 1984 Checking and correction - 1985

Authors of evaluation: G.V. Antsipov, V.A. Kon'shin, E. Sh. Sukhovitskij, Yu.V. Porodzinskij, G.B. Morogovskij, L.A. Bakhanovich and A.B. Klepatskij

Content of the data file

MF = 1 General information:

MT = 451 Comments and dictionary.

MT = 452 Number of neutrons per fission (sum of $\nu_p + \nu_d$).

MT = 456 Number of prompt fission neutrons ν_p.

The evaluated value $\bar{\nu}_p$ was normalized to $\nu_p(^{252}Cf) = 3.757$.

The evaluation of ν_p was made by applying the method of least squares to the data of Refs [25, 26, 27]. The obtained dependence $\nu_p(E)$ takes the form: $\nu_p(E) = 2.9086 + 0.13543E + 0.0011290E^2$.

MF = 2 Resonance parameters:

In the resolved resonance region (0.25-148.9 eV) the resonance parameters were obtained by parametrization, using the Adler-Adler formalism, of the total cross-section [1] and fission cross-section [2] data.

The average resonance parameters in the 0.1-100 keV region were obtained by analysis [9] of the average parameters from the resolved resonance region and of experimental data on the fission cross-section [5, 6, 7, 8] and on the alpha value [4].

The 2200 m/sec cross-sections are:

Total = 1378.21 b, elastic = 8.91 b, fission = 1011.1 b, capture = 358.2 b, absorption = 1369.4 b, alpha = 0.354 b, ν total = 2.937 b.

MF = 3 Neutron cross-sections.

MT = 1 Total cross-section.

The evaluation of the total cross-section was based on the experimental data of Refs [10-13] and [29, 30] and on optical model calculations.

MT = 2 Elastic scattering cross-section.

MT = 4 Total neutron inelastic scattering cross-section.

MT = 16 (n,2n) reaction cross-section.

MT = 17 (n,3n) reaction cross-section.

MT = 18 Fission cross-section.

The evaluation of the fission cross-section was based on the data of Refs [14-21] in the region up to 0.1 keV and on the data of Refs [5, 6, 8, 22] in the 0.1 keV-15 MeV region. The fission cross-section was normalized to $\sigma_f(^{235}U)$ data of Ref. [28].

MT = 51-73, 91 Cross-sections for elastic scattering to discrete levels and to a continuum.

MT = 102 Capture cross-section.

To obtain the neutron elastic and inelastic scattering cross-sections in the 0.1-100 keV region we used the average resonance parameters. The capture cross-section in this region was obtained from the data of Ref. [4]. The capture and inelastic and elastic scattering cross-sections were obtained by the optical and statistical models calculations with allowance for the (n,σ_f) process. The (n,2n) and (n,3n) reaction cross-sections were calculated by the multicascade statistical model with allowance for the competition of fission and pre-equilibrium primary neutron emission. The level density model used took into account the collective effects (rotational and vibrational). More detailed information is given in Ref. [31].

MF = 4 Neutron angular distributions:

The angular distributions of elastically scattered neutrons taken were the same as those for ^{235}U [24].

MT = 16, 17, 18 The angular distributions of neutrons from the (n,2n), (n,3n) and fission reactions.

MT = 51-73 Angular distributions of neutrons inelastically scattered to levels.

MF = 5 Secondary neutron energy distributions:

MF = 16, 17, 18, 91 Energy distributions of neutrons from the (n,2n), (n,3n) and fission reactions and the reaction of neutron inelastic scattering to a continuum.

In the region below 5 MeV, an evaporation model was used. Above 5 MeV, the contribution of pre-equilibrium neutrons was taken into account. It was assumed that the high-energy part of the secondary neutron spectra, which was evaluated for ^{238}U, was valid also for ^{241}Pu. The evaluation of the inelastically scattered neutron spectra for ^{238}U led to a parameter $K = 10$ ($M^2 = K/A^{30}$) of the pre-equilibrium decay model.

MF = 12 Photon production cross-sections in neutron reactions.

MF = 15 Photon energy distributions in neutron cross-sections

MT = 4 Energy distributions of photons from the neutron inelastic scattering reaction.

MT = 16, 17, 18, 102 Energy distributions of photons from the fission, capture, (n,2n) and (n,3n) reactions.

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<u>94 - Pu-242</u>	<u>MAT - 9442</u>	
94 - Pu-242	Nuclear Power Institute (Byelorussian Academy of Sciences)	Evaluation - 1980 Re-evaluation - 1984 Checking and correction - 1985

Authors of evaluation: V.A. Kon'shin, G.V. Antsipov, E. Sh. Sukhovitskij, L.A. Bakhanovich, B.M. Maslov, Yu.V. Porodzinskij, and A.B. Klepatskij

<u>Content of the data file</u>

MF = 1 General information:

MT = 451 Comments and dictionary.

MT = 452 Number of neutrons per fission (sum of $\bar{\nu}_p + \bar{\nu}_d$).

For lack of experimental data the evaluation of $\bar{\nu}$ was based on the systematics of Howerton [1] taking into account our evaluation data on the (n,n'f) and (n,2nf) reaction cross-sections and on the average energies of neutrons emitted before fission.

MF = 2 Resonance parameters:

MT = 151 In the 1 x 10^{-5} eV-1 keV region, the resonance parameters were obtained from the data of Ref. [2] (position of resonances, neutron and radiation widths). The fission widths were obtained from experimental data [3]. In the 1.0 x 10^{-5}-2 eV region the resonance parameters were evaluated for the first resonance with the use of the data of Refs [4, 5] on total cross-section and the data for 2200 m/sec with consideration of one level for a negative energy.The neutron cross-section calculations in the resolved resonance region should be made by the multilevel Breit-Wigner formalism from the resonance parameters given.

The 2200 m/sec cross-sections are:

Total = 26.884 b, elastic = 8.247 b, fission = 0.001 b, capture = 18.636 b

MF = 3 Neutron cross-sections:

MT = 1 Total cross-section.

MT = 2 Elastic scattering cross-section.

MT = 3 Inelastic scattering cross-section.

MT = 4 Total neutron inelastic scattering cross-section.

MT = 16, 17 (n,2n) and (n,3n) reaction cross-sections.

MT = 18 Fission cross-section.

MT = 51-63, 91 Inelastic scattering cross-sections to discrete levels and to a continuum.

MT = 102 Capture cross-section.

The average parameters in the unresolved resonance region (1-200 keV) were obtained with the use of the data from the resolved resonance region and experimental data on the radiative capture [6] and fission [3] cross-sections. The fission cross-section was calculated by the double-humped fission barrier model.

The evaluation of the fission cross-section in the 0.2-15 MeV region was based on experimental data [7, 8, 9].

The fission cross-section was normalized to that of ^{235}U from the ENDF/B-5 data [11].

The total cross-section and the elastic scattering cross-section in the 0.6-6 MeV region were obtained on the basis of the data of Ref. [12]. The evaluation of the total cross-section, elastic scattering cross-section and excitation functions for inelastic scattering to levels was made by the coupled channel method with carefully optimized non-spherical potential parameters [13, 14] and by the statistical model. The experimental data on the total cross-section [10] in the 0.3-15.0 MeV region were also taken into account in the evaluation.

The radiative capture, inelastic scattering, and (n,2n) and (n,3n) reaction cross-sections were calculated by the statistical model with allowance for the competition of the fission process and the level density model with collective modes [15].

MF = 4 Neutron angular distributions:

The angular distributions of neutrons are given for MT = 2, 16, 17, 18, 51-63, 91.

The angular distributions of neutron elastic and inelastic scattering in the 1 keV-15 MeV region were obtained by the coupled channel method. The isotropic part was calculated by the statistical theory.

MF = 5 Secondary neutron energy distributions:

MT = 16, 17, 18, 91 Energy distribution of neutrons from the (n,2n), (n,3n) and fission reactions and the reaction of neutron inelastic scattering to a continuum.

In the region below 5 MeV an evaporation model was used. Above 5 MeV, the contribution of pre-equilibrium neutrons was taken into account.

MF = 12 Photon cross-section in neutron reactions.

MF = 15 Photon energy distributions in neutron reactions.

MT = 4 Energy distributions of photons from the neutron inelastic scattering reaction.

MT = 16, 17, 18, 102 Energy distributions of photons from the fission, capture and (n,2n) and (n,3n) reactions.

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95 - Am-241 | MAT = 9511
95 - Am-241 | HAR UK
Power Physics Institute (USSR State Committee on the Utilization of Atomic Energy)

Evaluation - 1979
Checking - Power Phys. Inst., 1982

Authors of evaluation: J.E. Lynn, B.H. Patrick, M.G. Sowerby and E.M. Bowey

After a critical analysis of the different evaluated neutron data files given in Ref. [1], the data file from INDL/A [2] was recommended for ^{241}Am. The initial file is presented in the UKNDL (DFN = 1009B) format in the neutron region up to 15 MeV [3]. At the Nuclear Data Centre (Power Physics Institute) the americium file was translated into the ENDF/B-5 format, and its evaluated data were extended up to the region of E_n = 20 MeV. The JENDL-2 data [4] were used to represent the angular and energy distributions of secondary neutrons.

Content of the data file

MF = 1, MT = 451 General information and dictionary.

MT = 452, 455, 456 Energy dependence of the total number of fission neutrons, delayed and prompt, respectively.

MF = 2 In the neutron resonance region, resonance parameters are lacking.

Calculated cross-sections for 2200 m/sec:

Total = 615 b, elastic = 11.9 b, fission = 3.1 b, radiative capture = 600 b.

Resonance integrals: radiative capture = 1499 b, fission = 11.1 b.

MF = 3 Neutron cross-sections:

The neutron cross-sections are presented in the 10^{-5} eV-20 MeV region. In the resonance energy region, the cross-sections are given in the pointwise representation for T = 0°K. The evaluation procedure is described fully in Ref. [3].

MT = 1 The total cross-section is the sum of the partial cross-sections.

MT = 2 The elastic scattering cross-section was obtained by the optical model.

MT = 3 Sum of the total neutron inelastic scattering cross-section and all other cross-sections (except the elastic channel).

MT = 4 Total neutron inelastic scattering cross-section:

4 = 51 + ... + 66 + 91.

MT = 16, 17 The cross-sections of the (n,2n) and (n,3n) reactions, respectively, were obtained on the basis of the statistical model.

MT = 18, 102 Fission and fast-neutron radiative capture cross-sections, respectively. In the resolved resonance region (E_n < 50 eV) the evaluated data were obtained by calculation from the resolved resonance parameters with normalization to the experimental data set. In the region of E_n > 50 eV the fission cross-section was obtained by smoothing the consistent set of experimental data. In the region of E_n = 50 eV-350 keV the capture cross-section was obtained by subtracting the evaluated data for σ_{nf} from the corresponding experimental data for the absorption cross-section. In the E = 350 keV-3 MeV region the evaluation of $\sigma_{n\gamma}$ is based on the statistical model; above 3 MeV, $\sigma_{n\gamma}$ is constant and equals 10 mb.

MT = 37-66, 91 Neutron inelastic scattering cross-section with excitation of resolved levels (MT = 51-66) and a continuum (MT = 91).

MT = 51-59 Contain data for the first nine resolved levels up to 505 keV. MT = 60-66 contain data for seven energy intervals with a width of 100 keV over which the level excitation cross-sections are summed. MT = 60-66 are given in the E = 550 keV-1.3 MeV region. In the region E > 1.3 MeV the neutron inelastic scattering cross-section is given with the help of a continuum (MT = 91). For MT = 51-66 the Hauser-Feshbach model calculations were used and the continuum cross-sections were obtained on the basis of the statistical approach [3].

MT = 251 The average cosine of elastically scattered neutrons was calculated on the basis of the angular distributions taken.

MF = 4 The angular distributions of elastically scattered neutrons were taken from Ref. [4] and represented with the help of Legendre coefficients.

MT = 2, 51-66, 91 Calculated by the optical model and given in the centre-of-mass system.

MT = 16, 17, 18 Isotropic in the laboratory system of co-ordinates.

MF = 5 Energy distributions of secondary neutrons:

MT = 16, 17, 91 Given with the help of the evaporation model parameters [4].

MT = 18 The fission neutron spectrum is given in the form of a Maxwellian distribution.

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(For original English Refs, see below.)

2. INDL/A -83. IAEA Nuclear Data Library for Evaluated Neutron Reaction Data for Actinides. Edited by V.G.Pronyaev et al., IAEA-NDS-12, Vienna, 1983.
3. J.E.Lynn et al., AERE-R 8528 (1979).
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95 - Am-243	MAT = 9530	
95 - Am-243	HAR UK Power Physics Institute (USSR State Committee on the Utilization of Atomic Energy)	Evaluation - 1980 Checking - Power Phys. Inst., 1982

Authors of evaluation: J.E. Lynn, B.H. Patrick, M.G. Sowerby and E.M. Bowey

After a critical analysis of the different evaluated neutron data files given in Ref. [1] the ^{243}Am evaluated data presented in INDL/A [2] were recommended. The initial data file for ^{243}Am is presented in the UKNDL format. The americium-243 file was translated into the ENDF/B-5 format (MAT = 9530 in INDL/A) in the IAEA Nuclear Data Section and then the file was corrected in the region up to 40 keV in the Nuclear Data Centre (Power Physics Institute). A brief description of the file is given in Ref. [2].

Content of the data file

MF = 1, MT = 451 General information and dictionary.

MT = 452 Energy dependence of the total number of fission neutrons.

MF = 2 Resonance parameters:

MT = 151 The resonance parameters are given for two energy regions:

(a) For the resolved resonance region with $E = 10^{-5}$ eV-250 eV;

(b) For the unresolved resonance region with E = 250 eV- 40 keV.

To calculate the cross-sections in the 10^{-5} eV-40 keV region, the multilevel Breit-Wigner formalism is recommended.

Calculated cross-sections for 2200 m/sec:

Total = 84.25 b, elastic = 7.10 b, fission = 0.05 b, radiative capture = 77.10 b.

Resonance integrals: radiative capture = 1846 b, fission = 5.95 b.

MF = 3 Neutron cross-sections:

The neutron cross-sections are presented in the 10^{-5} eV-15 MeV region. In the resonance energy region from 10^{-5} eV to 40 keV the background in the cross-sections is zero.

MT = 1 The total cross-section is the sum of the partial cross-sections.

MT = 2 The neutron elastic scattering cross-section was obtained by the optical model.

MT = 3 Sum of the neutron inelastic scattering cross-sections and all other cross-sections (except the elastic channel).

MT = 4 Total neutron inelastic scattering cross-section: 4 = 51 + ... + 59 + 91.

MT = 16, 17 The cross-sections of the (n,2n) and (n,3n) reactions, respectively, were obtained on the basis of the statistical model.

MT = 18 Fission cross-section.

In the E_n = 40-300 keV region, the evaluation is based on the Hauser-Feshbach model calculations with allowance for the double-humped fission barrier. For E_n > 300 keV the evaluation is based on the analysis of experimental data with consideration of the data from integral measurements.

MT = 51-59, 91 Neutron inelastic scattering cross-section with excitation of resolved levels (MT = 51-59) and a continuum (MT = 91).

MT = 51-56 Contain data for the first six resolved levels up to 180 keV.

MT = 57-59 Contain data for three groups of level, the excitation cross-sections of which are summed over the 100 keV-450 keV interval. In the E > 450 keV region the neutron inelastic scattering cross-section is given with the help of a continuum (MT = 91). For MT = 51-59 the Hauser-Feshbach calculations were used, and the continuum cross-sections were obtained by the semi-empirical approach [3].

MT = 102 Fast neutron radiative capture cross-section.

In the E_n = 40 keV-3.5 MeV region, it is based on Hauser-Feshbach model calculations. For E_n > 3.5 MeV it is taken constant and equal to 10 mb.

MF = 4 Angular distributions of secondary neutrons:

MT = 2, 16, 17, 18, 57-59, 91 Taken to be same as in the evaluation for ^{238}U [4] from the UKNDL library (DFN = 160F).

MF = 5 Energy distributions of secondary neutrons.

MT = 16, 17, 18, 19 Based on the evaluation of similar data for ^{238}U; the evaluation method is described in Ref. [4].

REFERENCES

1. Usachev, L.N., Tolstikov, V.A., Blokhin, A.I., Kravenchko, I.V., "Comparison of evaluated neutron cross-sections determining the scatter of the calculation of external fuel cycle activity". Paper presented at the fifth meeting on intercomparison of nuclear data for transactinides, Antwerp, 1982 (in Russian).

2. INDL/A-83. IAEA Nuclear Data Library for Evaluated Neutron Reaction Data of Actinides. Edited by V.G. Pronyaev et al., IAEA-NDS-12, Vienna, 1983.

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