KDK 40
NEANDC(OR)-155/A
INDC(SWD)-15/G

# SWEDISH NUCLEAR DATA REQUEST LIST

SWEDISH NUCLEAR DATA COMMITTEE

DECEMBER 1980

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Compiled

by

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Swedish Nuclear Data Committee

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## 1 INTRODUCTION

This is the third edition of the Swedish Request List of Nuclear Data for research and development in the nuclear energy field issued by the Swedish Nuclear Data Committee. The two earlier editions (KDK 7, december 1975 and KDK 29, december 1978) were written in Swedish. In comparison with the list of 1978 (KDK 29) 10 requests have been fulfilled in part or completely by new measurements.

The stated errors in the report are one standard deviation if nothing else is pointed out.

The reference citations are the same as in the CINDA index.

The requests have been sent to OECD/NEA to be integrated in the World Request List for Nuclear Data (WRENDA) 80/81 except for the fusion requests which at present are formulated as guidelines for research.

The requests related to fast reactor physics have been assigned priority 3 being nuclear data only of general interest in Sweden. The other requests have been assigned priority 2 being required during the next few years in applied nuclear energy programmes.

2 REACTOR PHYSICS

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| 0 | NEUTRON | DIFFERENTIAL ELASTIC CROSS SECTION | 100 keV-15 MeV | SEE QUANTITY COMMENTS | REMAIN | 712004 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

QUANTITY COMMENTS: Requested accuracy: 5 % between 100 keV and 4 MeV, 10 % between 4 and 15 MeV.

APPLICATIONS: Calculation of reactor parameters with uranium- and plutonium-oxide fuel.

STATUS OF WORK: Measurements of the differential elastic cross section are in progress at the Triangle Universities Nuclear Laboratory by Purser et al (DOE/NDC-15, 210 (1979)) at 11 neutron energies between 9.25 and 15 MeV with an accuracy of 10 %.

The ENDF/B IV and V evaluation is based on mostly old experiments with errors $\geq$10 % (ENDF-201 (1979)).

SUMMARY: More measurements are needed, in particular below 9 MeV, to obtain the requested accuracies.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{23}$Na | NEUTRON | ENERGY-ANGLE DIFFERENTIAL INELASTIC CROSS SECTION | UP TO 15 MeV | 10 % | REMAIN | 712005 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: Calculation of void coefficients, neutron economy, etc. in fast sodium cooled reactors.

STATUS OF WORK: A number of measurements have been made both of the $^{23}$Na(n,n') reaction, see e.g. Towle and Gilboy (NP 32, 610 (1962)), Fasoli et al (NP/A 125, 227 (1969)) and Perey and Kinney (ORNL-4518 (1970)) and of the $^{23}$Na(n,n'$\gamma$) reaction from which the (n,n') cross section can be deduced, see e.g. Dickens (NSE 50, 98 (1973)), Lachkar et al (73 Kiev 3, 187), Donati et al (PR/C 16, 939 (1977)), and Larson and Morgan (NSE 75, 151 (1980)). Most measurements claim total experimental error in single data of 10-20 %.

The recent measurement of the $^{23}$Na(n,x$\gamma$) reaction cross section by Larson and Morgan covers the neutron energy range $0.2 \leq E_n \leq 20$ MeV. Results are $\sim$18 % lower than the data of Donati et al and $\sim$20 % higher than the data of Lachkar et al. Average agreement between the experimental results and Hauser-Feshbach model calculations is within 15 %.

ENDF/B evaluation assumes that all angular distributions are isotropic. Version V evaluation (ENDF-201 (1979)) claims problems with energy shifts ($\sim$100 keV) and normalizations ($\sim$10 %) between different measurements.

SUMMARY: Requested accuracy is not achieved.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{235}U$ | NEUTRON | INELASTIC CROSS SECTION | UP TO 15 MeV | 10 % | REMAIN | 692363 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: Evaluation of $^{235}U$ integral measurements.

STATUS OF WORK: Only a few measurements at single energies up to 8 MeV are made with errors of the order of 10-20 % (see e.g. Armitage et al, 66 Paris 1, 383, Drake, NP/A 133, 108 (1969) and Knitter et al, ZP 257, 108 (1972)). Results from these measurements differ with more than the claimed accuracies.

A recent measurement is made of the angle-energy differential cross section at 3.4 MeV by Haouat et al (NEANDC(E) 196 L (1978)) to check evaluated data files and to specify optical model parameters. A large disagreement (about a factor of 10) was observed between measured and evaluated angle integrated inelastic cross sections using data from the ENDF/B IV file (version IV ≡ version V). In the ENDF/B evaluations one has assumed isotropic angular distributions.

SUMMARY: Requested accuracy is not achieved.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{235}U$ | NEUTRON | FISSION CROSS SECTION | 200 eV-500 keV | 2 % | REMAIN | 692496 R |
| $^{239}Pu$ | NEUTRON | FISSION CROSS SECTION | 1 keV-1 MeV | 2 % | REMAIN | 742006 R |
| | | | 1-5 MeV | 5 % | FULFILLED | |
| $^{240}Pu$ | NEUTRON | FISSION CROSS SECTION | UP TO 5 MeV | 10 % | FULFILLED | 742008 R |
| $^{241}Pu$ | NEUTRON | FISSION CROSS SECTION | 1 keV-5 MeV | 10 % | FULFILLED | 692463 R |
| $^{242}Pu$ | NEUTRON | FISSION CROSS SECTION | 1 keV-5 MeV | 10 % | FULFILLED | 742009 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: Fisson reactors, core physics. The fission cross section of $^{235}U$ (above 100 keV) is also requested being a standard neutron cross section.

STATUS OF WORK:

$^{235}U$: The last review by the NEANDC Discrepancy Subcommittee (Sowerby, NEANDC 124 A (1980)) concludes that there is general agreement that the cross section is known to an accuracy of ±3 % (one standard deviation) below 15 MeV. It also points out some energy regions where the resolution of certain discrepancies could make significant improvements. Below 500 keV those are:

1 Inconsistencies in the shapes of measured cross sections in the keV energy range.

2 Data by Wasson (ANL-76-90, 183), Wasson and Meier (79 Knoxville, paper GA1) and Poenitz (NSE 53, 370 (1974) are low compared to other data.

The final evaluation for ENDF/B V by Poentiz et al (79 Knoxville, paper EB5) above 100 keV takes into account a $^{235}U$-sample mass comparison made between different laboratories in the U.S. From the result of this work and by comparisons with various data bases the authors suggest an overall evaluation accuracy for ENDF/B V of 1.6 %.

There is a U.S. proposal to produce a $^{235}U$ fissile foil assayed to 0.3 % to obtain fission cross sections accurate to about 1 % or better.

$^{239}Pu$: Several recent measurements relative to the $^{235}U$ fission cross section are made in the energy region 1 keV to 5 MeV with claimed relative errors of 1-4 % (KDK-35 (1979)). Results from different measurements differ with up to ±5 %.

The evaluation for the BOYaD-3 Library (INDC(CCP)-132/LV (1979)) made by Konshin et al gives errors of 2.2-2.8 % in the 0.1-30 keV region and above that up to 10 MeV 3.5-4 % taking into account correlations between the partial errors of different experiments.

$^{240}Pu$: There is a reasonable agreement between recent measurements which use the $^{235}U$ fission cross section as standard. The relative errors are 2-10 % in the energy region up to 5 MeV (KDK-35 (1979)).

Taking all measurements into account the cross section can probably be evaluated to an accuracy of better than 5 % above 500 keV (Patrick, 78 BNL-2, 133).

$^{241}$Pu: Several measurements made but many of them quite old (KDK-35 (1979)). A recent accurate measurement was made at Livermore by Carlsson and Behrens (NSE 68, 128 (1978)) from 1 keV to 30 MeV claiming an error of 2 % relative to the $^{235}$U fission cross section.

The results from different measurements scatter more than 10 % below 1 MeV. There is considerable structure in the cross section below 100 keV which may account for some of the differences between single energy measurements and average cross sections in this energy region. Between 100 keV and 1 MeV the spread in data might partly be due to differences in adopted standards. Taking these facts into account the cross section can probably be evaluated with an accuracy of 5 % between 5 keV and 10 MeV (Patrick, 78 BNL-2, 133).

$^{242}$Pu: Only a few measurements are made of the fission cross section (KDK-35 (1979)). Good agreement was obtained between the recent measurements by Meadows (NSE 68, 361 (1978)) and by Behrens et al (NSE 66, 433 (1978)). In the review by Patrick (78 BNL-2, 133) an error of 5 % was assigned to the cross section between 1 keV and 10 MeV. In an evaluation by Antsipov et al (INDC (CCP) 150/LJH (1980)) of the neutron cross sections for $^{242}$Pu the recommended uncertainties in the fission cross section ranges from 4.3 to 6.7 % in the energy region 0.1-15 MeV.

SUMMARY: Requested accuracy is obtained for the fission cross sections of $^{240,241,242}$Pu and for $^{239}$Pu between 1 MeV and 5 MeV. The requested accuracy is not achieved for the fission cross section of $^{235}$U and for $^{239}$Pu between 1 keV and 1 MeV.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{235}U$ | NEUTRON | CAPTURE CROSS SECTION | 200 eV-500 keV | 3 % | REMAIN | 742005 R |
| $^{238}U$ | NEUTRON | CAPTURE CROSS SECTION | 2 keV-1 MeV | 3 % | REMAIN | 692406 R |
| $^{239}Pu$ | NEUTRON | CAPTURE CROSS SECTION | 1-500 keV | 3 % | REMAIN | 692437 R |
| $^{240}Pu$ | NEUTRON | CAPTURE CROSS SECTION | 100-500 keV | 10 % | LOW ENERGY LIMIT CHANGED FROM 1 keV TO 100 keV | 692452 R |
| $^{241}Pu$ | NEUTRON | CAPTURE CROSS SECTION | 1 keV-5 MeV | 10 % | REMAIN | 692470 R |
| $^{242}Pu$ | NEUTRON | CAPTURE CROSS SECTION | 200 keV-5 MeV | 10 % | LOW ENERGY LIMIT CHANGED FROM 1 keV TO 200 keV | 742010 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: Fission reactors, core physics. The requested accuracies of the cross section data correspond to an error in $k_{eff}$ of about 1 %.

STATUS OF WORK:

$^{235}U$: The errors of existing measurements range from 5 to 25 % (KDK-35 (1979)). The evaluated capture cross section for ENDF/B V (Bhat, BNL-NCS-51184 (1980)) is based on the measurements by de Saussure et al (ORNL-TM-1804 (1967)), Gwin et al (NSE 59, 79 (1976)) and Perez et al (NSE 52, 46 (1973)). The results of the three measurements differ by more than 10 % in the energy region 200 eV-500 keV.

$^{238}$U: The capture cross section measurements between 5 keV and 1 MeV have generally large uncertainties (of the order of 10 %) (KDK-35 (1979)) and show significant discrepancies even among the most recent data. The evaluation in ENDF/B V by Poenitz et al (ANL/NDM-32 (1977)) disagrees with ENDF/B IV with up to 10 % in the energy region below 1 MeV.

$^{239}$Pu: In the current review of the status of standard reference and other important nuclear data undertaken by the U.S. Cross Section Evaluation Working Group (ENDF-300 (1979)) it is concluded that alpha ($\alpha=\sigma_c/\sigma_f$) for $^{239}$Pu in the neutron energy range from 0.5 eV to 500 keV has been measured with an average uncertainty of about 8 %. Measurements of alpha have been reviewed by Kononov and Poletaev (INDC (CCP)-108 U (1977)). The evaluation by Sowerby and Konshin (At. En. Rev. 10, 453 (1972)) gives a 10 % uncertainty in $\alpha$ at 1 keV increasing to 30 % at 1 MeV.

$^{240}$Pu: Measurements have been made of the capture cross section in the keV energy range (below 350 keV) (KDK-35 (1979)) by three different groups. The experimental errors range from 5 to 15 %. Below 150 keV there is a reasonable agreement between the existing measurements within an error of 10 % while above that energy the data by Wisshak and Kaeppeler (NSE 69, 39 (1979)) are about 20 % higher than the data by Weston and Todd (NSE 63, 143 (1977)). The ENDF/B V evaluation is based on the measurement by Weston and Todd and is about 30 % higher than the ENDF/B IV evaluation in the energy range below 400 keV.

$^{241}$Pu: There is only one extensive measurement of alpha ($\sigma_c/\sigma_f$) for $^{241}$Pu from 0.01 to 300 keV which is made by Weston and Todd (NSE 65, 454 (1978)). The uncertainty in this measurement is about 9 %. The achieved accuracy of the capture cross section between 5-250 keV was estimated to 20 % in a recent review of actinide cross sections by Patrick (78 BNL-2, 133).

$^{242}$Pu: Two measurements are made, one by Hockenbury et al (75 Wash., 2, 584) between 8-70 keV and one by Wisshak and Kaeppeler (NSE 69, 39 (1979)) between 20-250 keV. The results of the measurement by Wisshak and Kaeppeler are about 15 % higher than those of Hockenbury et al in the energy region of overlap. Since the uncertainty in the former data is 10-15 %, there is no real discrepancy. The uncertainty of the capture cross section estimated by Patrick (78 BNL-2, 133) is 10 % between 5 and 200 keV. The ENDF/B V evaluation is based on compound nuclear statistical calculation with gamma strength function adjusted to agree with Hockenbury et al. Above 4 MeV semi-direct contribution is added. The ENDF/B V evaluation is 30-50 % higher than the ENDF/B IV in the keV energy range.

SUMMARY: The requested accuracies are not achieved for $^{235}$U, $^{238}$U, $^{239}$Pu and $^{241}$Pu. For $^{240}$Pu and $^{242}$Pu the requests have been fulfilled up to 100 and 200 keV, respectively by recent measurements.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{238}U$ | NEUTRON | RESONANCE PARAMETERS | 2-5 keV | 3 % | REMAIN | 692385 R |
| $^{239}Pu$ | NEUTRON | RESONANCE PARAMETERS | 250 eV-1 keV | 3 % | REMAIN | 692415 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: To calculate shielded cross sections and Doppler effects.

STATUS OF WORK:

$^{238}U$: A large number of new measurements of the low energy $^{238}U$ cross sections have recently been reviewed by Keyworth and Moore (78 Harwell, 241). Much of this work was stimulated by the inability of ENDF/B IV to predict the $^{238}U$ capture rate in thermal critical lattices. The most significant changes suggested by recent work is a reduction by about 15 % of the capture widths of the first three s-wave levels and an increase of about 10 to 20 % of the strength function above 1.5 keV. These changes have reduced but not completely eliminated the discrepancy between computed and measured $^{238}U$ capture values in thermal critical lattices (de Saussure et al, ORNL-TM-6152, (1978)). Typical accuracies for $g\Gamma_n^{(0)}$ and ($\Gamma_\gamma$ and $\Gamma$) below 1 keV are 2-3 % and 5-10 %, respectively.

$^{239}Pu$: The status of the measurements and evaluations of the $^{239}Pu$ resonance parameters has been reviewed by Keyworth and Moore (78 Harwell, 262). They claimed that the inconsistencies between the ENDF/B IV and the Ribon and Le Coq (CEA-N 1484, EANDC(E) 138 AL (1971)) evaluations were depending on the reluctance to assign resonance spins of $1^+$ to the sharp resonances in the former evaluation. In the analysis by Smith, Kinsey and Garber of $^{239}Pu$ resonance data for ENDF/B V based on data by Gwin et al (NSE 45, 25 (1971)) for fission and capture and by

Derrien (66 Paris, 2, 195) for the total cross section, the problems of internal consistency in the measured data could not be completely removed by making spin assignments.

The errors in the resonance parameters above 250 eV is estimated to 10-20 %.

SUMMARY: The requested accuracies are not achieved.

3 NUCLEAR FUEL CYCLE

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| B | ALPHA | ALPHA, N | UP TO 10 MeV | 20 % | REMAIN | 762160 R |
| F | ALPHA | ALPHA, N | UP TO 10 MeV | 20 % | REMAIN | 762161 R |
| O | ALPHA | ALPHA, N | UP TO 10 MeV | 20 % | REMAIN | 762162 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: Calculation of neutron output of solidified nuclear waste.

STATUS OF WORK: Lieskien and Paulsen (AKE, 30, 1 (1977)) reviewed existing data and calculated thick target ($\alpha$,n) yields from various targets. In general they stated uncertainties of 20-30 %. In a recent measurement by Bair and del Campo (NSE 71, 18 (1979)) results of thick target ($\alpha$,n) neutron yields are reported for B, F and O. They compared their results with calculations using thin target cross section data and obtained agreement within 5-10 % not only for thick target elements but also for compounds. However, Bair and del Campo obtain a 20 % lower thick target yield for O between 3 and 4 MeV than that obtained by Lieskien and Paulsen, and a 65-50 % lower yield for B between 3.5-5 MeV. Moreover the only known value for F is that measured by Bair and del Campo.

SUMMARY: More measurements are needed to verify the data by Bair and del Campo.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{235}U$ | NEUTRON | FISSION PRODUCT MASS YIELD SPECTRUM | 25.3 mV | SEE QUANTITY COMMENTS | FULFILLED | - |
| $^{239}Pu$ | NEUTRON | FISSION PRODUCT MASS YIELD SPECTRUM | 25.3 mV | SEE QUANTITY COMMENTS | REMAIN | NEW REQUEST |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

QUANTITY COMMENTS: The cumulative fission yields are requested for nuclei of A = 129, 135, 137, 145, 147, 148 and 149 with a 2.5 % error and for A = 150-153, 155 and 157 with a 10 % error.

APPLICATION: For burn up calculations related to e.g. decay heat, shielding, waste management.

STATUS OF WORK: Average errors of the cumulative fission yields for the thermal fission of $^{235}U$ and $^{239}Pu$ were estimated by Cunningham (77 Petten, 1, 351) taking into account the evaluations made by Meek and Ryder for ENDF/B V (NEDO 12154-2 (E) (1978)) and by Crouch (ND/A 19, 419 (1977)). The suggested errors ($1\sigma$) were the following

| $^{235}U$ | | $^{239}Pu$ | |
|---|---|---|---|
| A | Yield error | A | Yield error |
| 105-129 | 13.2 % | 110-129 | 16.2 % |
| 130-150 | 2.0 % | 130-150 | 3.7 % |
| 151-161 | 8.1 % | 151-161 | 11.1 % |

In a recent measurement by Dickens and McConnell (NSE 73, 42 (1980)) cumulative fission yields are reported for 49 fission products representing 36 mass chains during thermal fission of $^{239}Pu$. The results agree with the data of Meek and Ryder within the claimed accuracies between 2.5 to 25 % except for A = 151 which disagrees with about twice the stated error of 10 %.

SUMMARY: The requested accuracy is obtained for $^{235}U$ but more measurements are needed for $^{239}Pu$.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{237}$Np | NEUTRON | CAPTURE CROSS SECTION | 1 mV-1 keV | 10 % | FULFILLED | - |
| $^{238}$Np | NEUTRON | CAPTURE CROSS SECTION | 25.3 mV | 20 % | REMAIN | 762169 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

APPLICATION: For calculation of the production of $^{238}$Pu in thermal reactors.

STATUS OF WORK: In an evaluation by Caner et al (IA-1346 (1977)) the estimated accuracy of the $^{237}$Np capture cross section is 2-5 % in the energy region from 1 mV to 10 eV and 5-10 % from 10 eV to 100 keV. The recent measurement by Mevissen et al (NSE 70, 155 (1979)) gives resonance parameters between 8 and 24 eV with an error of about 7 %.

No experimental data are known of the capture cross section for $^{238}$Np.

SUMMARY: The requested accuracy is obtained for the $^{237}$Np capture cross section in the thermal energy range while the cross section for $^{238}$Np would be very difficult to obtain experimentally because of a brief half-life, 2.1 days. The estimated accuracy that can be obtained from systematic and theoretical calculations is 30-50 %.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{241}$Am | NEUTRON | CAPTURE CROSS SECTION | 1 mV-1 keV | 10 % | REMAIN | 762170 R |
| $^{242}$Am | NEUTRON | CAPTURE CROSS SECTION | 1 mV-1 keV | 20 % | REMAIN | 762171 R |
| $^{242}$Am | NEUTRON | FISSION CROSS SECTION | 1 mV-1 keV | 20 % | FULFILLED | 762172 R |
| $^{242}$Cm | NEUTRON | CAPTURE CROSS SECTION | 1 mV-1 keV | 15 % | REMAIN | 762173 R |
| $^{243}$Cm | NEUTRON | CAPTURE CROSS SECTION | 1 mV-1 keV | 15 % | REMAIN | 762174 R |

REQUESTOR: H. Haeggblom, Studsvik Energiteknik AB

QUANTITY COMMENTS:

$^{241}$Am: Capture cross section to the ground and isomeric states wanted.

$^{242}$Am (762171): Thermal capture cross section (accuracy 20 %) and RI (accuracy 10 %) wanted for the ground and isomeric states.

$^{242}$Am (762172): Thermal fission cross section wanted for the ground and isomeric states.

$^{242}$Cm: Thermal cross section and RI wanted.

$^{243}$Cm: Thermal cross section and RI wanted.

APPLICATION: Actinide production calculation.

STATUS OF WORK:

$^{241}$Am: There are a number of measurements for the thermal capture cross section of $^{241}$Am (KDK-35 (1979)). However, none of these measurements is an absolute differential measurement. The thermal capture cross section has throughout been determined with the Cd-difference method. This method is not suitable to obtain exact thermal capture cross sections because of the existence of strong capture resonances at 0.31 and 0.58 eV. The value of an effective cross section determined out of these measurements depends strongly on the neutron spectrum and Cd-cutoff energy. The thermal capture cross section obtained by subtracting the relatively small fission and elastic scattering cross sections from the total cross section is 627±20 b (Goel, 78 BNL-2, 177).

The ENDF/B V evaluation (Mann and Schenter, NSE 63, 242 (1977)) is significantly different from the ENDF/B IV evaluation in the resolved and unresolved energy regions. It is based on statistical model calculations and the data by Weston and Todd (NSE 61, 356 (1976)) and by Derrien and Lucas (75 Wash., 2, 637 (1975)).

In the evaluation for UKNDL by Lynn et al (AERE-R 8528 (1980)) the accepted thermal capture cross sections are (540±20)b and (60±7)b to the ground and isomeric states, respectively. The estimated error in the capture cross section below 1 keV is 10 %.

Recommended values by Benjamin (EPRI NP-1098, 12-1 (1979)) are for the thermal capture cross section and the resonance integral to the ground state 748 b (±3 %) and 1 330 b (±9 %), respectively and to the isomeric state 83.8 b (±8 %) and 208 b (±9 %) respectively.

$^{242}$Am: No capture measurements have been performed for the ground or isomeric states of $^{242}$Am.

In a recent experiment by Brown et al (78 Harwell, 887) a value of (7 065±280) b for the thermal fission cross section of $^{242m}$Am was obtained.

Measurements of the fission cross section of $^{242m}$Am are in progress by Dabbs et al (NEANDC (US)-207/U (1980)).

Recommended values by Benjamin (EPRI NP-1098, 12-1 (1979)) are for the thermal fission cross section and fission resonance integral of the ground state 2 100 b (±10 %) and <300 b, respectively and of the isomeric state 6 900 b (±5 %) and 1 570 b (±7 %) respectively.

ENDF/B V contains an evaluation of $^{242m}$Am (Mann and Schenter, 78 BNL-2, 275).

Evaluations of $^{242m}$Am and $^{242g}$Am are in progress for JENDL (Nakagawa and Igarasi, NEANDC (J)-67/U (1980)) and of $^{242m}$Am for KEDAK (Fröhner and Goel, NEANDC (E)-212U, Vol. V (1980)).

$^{242}$Cm: The thermal capture cross section and resonance integral have been measured with an accuracy of 50 and 30 % according to Benjamin (EPRI NP-1098, 12-1 (1979)).

The resonance capture integral has been measured by Schuman (WASH-1136, 53 (1969)) and deduced from resonance parameters obtained in a measurement of the total cross section by Artamonov et al (77 Kiev 2, 257). The results agree within about 30 %.

The evaluation for JENDL-2 by Igarasi and Nakagawa (NEANDC(J) 61/U (1979)) gives a thermal capture cross section of 16.0 b and a resonance integral of 116.2 b.

$^{243}$Cm: Recommended values by Benjamin (EPRI NP-1098, 21-1 (1979)) are for the thermal capture cross section 130.7 b (±7 %) and for the resonance integral 214.4 b (±10 %).

The first evaluation of $^{243}$Cm (Mann and Schenter, HEDL TME 77-54 (1977)) of the ENDF/B library is contained in version V.

SUMMARY: The capture cross sections in the thermal energy region for $^{241}$Am and $^{243}$Cm are probably known with errors less than 10 and 15 % respectively. However, in view of the very sparse experimental material yet available for these isotopes the requests remain until the existing data have been verified by ongoing experiments and evaluations. The requested accuracies have not been obtained for the thermal capture cross sections of $^{242}$Am and $^{242}$Cm. The fission cross section of the $^{242}$Am in thermal energy region is probably known with an error less than 20 %.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{238}U$ | NEUTRON | DECAY POWER | BWR, PWR | 10 % | REMAIN | - |
| $^{239}Pu$ | NEUTRON | DECAY POWER | BWR, PWR | 10 % | REMAIN | - |

REQUESTOR: J. Elkert, Asea-Atom, Västerås

QUANTITY COMMENTS: The decay power for fast fission of $^{238}U$ and thermal fission of $^{239}Pu$ is requested. For short cooling times the following accuracies are requested: 1 sec - 25 % and 10 sec - 20 %.

APPLICATIONS: For dimension cooling systems at thermal reactors.

STATUS OF WORK: The status of fission product decay heat for thermal reactors has recently been reviewed by Dickens (79 Knoxville, paper AA4). The need for experimental measurements of decay power for fast-neutron fission of $^{238}U$ was pointed out.

Two precise measurements of the decay power of $^{239}Pu$ have been carried out, one at LASL by Yarnell and Bendt (LA-7452-MS (1978)) and one at ORNL by Dickens et al (ORNL/NUREG-34 (1978)). The results disagree with about 5-10 % in the decay time interval 1 to $10^4$ sec. Summation calculations using the ENDF/B IV data base are in better agreement with the ORNL-results than with the LASL-results (England and Young, NEANDC 124A (1980)).

A measurement of the decay heat for $^{239}Pu$ is in progress at Studsvik (P.I. Johansson, private communication).

SUMMARY: Further measurements are needed to obtain the requested accuracy of the decay power for the fast fission of $^{238}U$ and to solve discrepant results for the thermal fission of $^{239}Pu$.

4 SHIELDING

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| $^{18}O$ | NEUTRON | N, ALPHA | FISSION | 30 % | REMAIN | 792093 R |

REQUESTOR: J. Elkert, Asea-Atom, Västerås

QUANTITY COMMENTS: Incident energy: fission spectrum.

APPLICATION: For calculation of the $^{15}C$ ($T_{1/2}$=2.3 sec) production in the cooling media of BWR.

STATUS OF WORK: Estimated values are given in the Handbook on Nuclear Activation Cross Section (A. Calamand, IAEA 156 (1974)) 0.42 mb (+80 %, -45 %) and in the Table of Estimated Cross Sections for (n,p), (n,$\alpha$) and (n,2n) Reactions in a Fission Neutron Spectrum (J.C. Roy and J.J. Hawton, AECL-1181 (1960)) 1.5 mb.

SUMMARY: No measurement are made and there is a large uncertainty in the estimated cross section.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| Al | NEUTRON | ENERGY-ANGLE DIFFERENTIAL NEUTRON EMISSION CROSS SECTION | 500 keV-15.0 MeV | 15 % | REMAIN | 762163 |
| Si | NEUTRON | ENERGY-ANGLE DIFFERENTIAL NEUTRON EMISSION CROSS SECTION | 500 keV-15.0 MeV | 15 % | REMAIN | 762164 |
| Ca | NEUTRON | ENERGY-ANGLE DIFFERENTIAL NEUTRON EMISSION CROSS SECTION | 500 keV-15.0 MeV | 15 % | REMAIN | 762165 |
| Fe | NEUTRON | ENERGY-ANGLE DIFFERENTIAL NEUTRON EMISSION CROSS SECTION | 500 keV-15.0 MeV | 15 % | FULFILLED | - |

REQUESTOR: G. Engström, National Defence Research Institute, Stockholm

APPLICATION: Shielding. Neutron transport calculations.

STATUS OF WORK: Systematic studies of neutron elastic (1.5-8.5 MeV) (Holmqvist and Wiedling, AE-430 (1971)) and inelastic scattering (2.0-4.5 MeV) (Almén-Ramström, AE-503 (1975)) have shown that the experiments and the theoretical model calculations in general agree within 10 % and 20 %. However, structure has been observed in the elastic cross section for some elements e.g. Si in the energy region below 5 MeV which is not reproduced by the optical model calculations. Furthermore, at certain energies and angles deviations were obtained by as much as 30-50 %.

Recent scattering measurements have been made by Smith et al (ANL/NDM 41 (1978)) on Fe up to 4 MeV with an error in the angle integrated elastic and inelastic cross sections of 5 and 5-10 %, respectively. The errors in the elastic and inelastic cross section above 4 MeV were estimated in the same report to about 10 % and 10-15 %, respectively. They also point out that different model calculations used to describe the scattering cross sections in the mass region about A=50 differ with as much as 25-50 %.

The ENDF/B evaluations for the requested nuclei are to a large extent based on model calculations.

SUMMARY: The requested accuracy is obtained for Fe but not achieved for Al, Si and Ca.

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR | COMMENTS | WRENDA IDENTIFICATION NO. |
|---|---|---|---|---|---|---|
| Al | NEUTRON | ENERGY-ANGLE DIFFERENTIAL PHOTON-PRODUCTION CROSS SECTION | 0.1-15 MeV | 15 % | REMAIN | NEW REQUEST |
| Si | NEUTRON | ENERGY-ANGLE DIFFERENTIAL PHOTON-PRODUCTION CROSS SECTION | 0.1-15 MeV | 15 % | REMAIN | NEW REQUEST |
| Ca | NEUTRON | ENERGY-ANGLE DIFFERENTIAL PHOTON-PRODUCTION CROSS SECTION | 0.1-15 MeV | 15 % | REMAIN | NEW REQUEST |
| Fe | NEUTRON | ENERGY-ANGLE DIFFERENTIAL PHOTON-PRODUCTION CROSS SECTION | 2-15 MeV | 15 % | REMAIN | 762166 |

REQUESTOR: G. Engström, National Defence Research Institute, Stockholm

QUANTITY COMMENTS: Requested gamma-ray energy resolution is 0.5 MeV.

APPLICATION: Shielding calculations.

STATUS OF WORK: Measurements have been made on the requested targets by Dickens et al (NSE 62, 515 (1977)) for $E_n$=1-20 MeV at $125^o$ and for Al and Si also at $90^o$ with an error of 10-15 %. The angular distributions for the 0.847 and 1.408 gamma-rays of Fe were measured for 11 neutron energies below 2 MeV by D. Smith (ANL/NDM-20 (1976)) with absolute errors of 12 and 15 %, respectively. ENDF/B V evaluations are based in many cases on model calculations.

SUMMARY: More measurements are needed to check model calculations. Requested accuracies are not obtained.

5 FUSION

| TARGET | INCIDENT PARTICLE | QUANTITY | ENERGY RANGE | ERROR |
|---|---|---|---|---|
| Mg, Al | NEUTRON | (n,xp), (n,xd) | Thresh-14 MeV | ≤50 % |
| Ti, V, Cr | | (n,xt) | | |
| Fe, Co, Ni | | (n,x$^{3}$He) | | |
| Cu, Nb, Mo | | (n,x$^{4}$He) | | |
| | | (n,xn') | | |
| | | (n,xn' light part.) | | |
| Mg, Al | NEUTRON | (n,xn') | Thresh-14 MeV | ≤50 % |
| Ti, V, Cr | | Energy spectrum | | |
| Fe, Co, Ni | | of the neutrons | | |
| Cu, Nb, Mo | | requested | | |
| and Be | | | | |

REQUESTOR: R. Pauli, Studsvik Energiteknik AB

APPLICATION: Calculation of gas production in structural materials for fusion reactors. There is a special interest to investigate the gas production of isotopes with high (n,α) or (n,p) cross sections formed by transmutation - analogues to the gas production in fission reactor structural materials by $^{59}$Ni which has a high (n,α) cross section and is formed by neutron capture in $^{58}$Ni.

The transmutation production of isotopes with long half lives and/or penetrating gamma radiation is of importance for reactor shielding and activation calculations.

The energy spectrum of secondary neutrons - in particular Be (n,2n) - is of importance to calculated tritium breeding in $^{7}Li$.

STATUS OF WORK: The status of nuclear data for transmutation and activation of reactor wall and structural materials was reviewed by O.N. Jarvis at the IAEA Advisory Group Meeting on Nuclear Data for Fusion Reactor Technology, Vienna dec. 1978 (IAEA-TECDOC-223, p. 47 (1979)).

# 6 LIST OF NEW AND WITHDRAWN WRENDA REQUESTS

## 6.1 New requests

| Target | Quantity | Page |
|---|---|---|
| $^{239}Pu$ | Fission product mass yield spectrum | 15 |
| Al | Energy-angle differential photon-production cross section | 26 |
| Si | Energy-angle differential photon-production cross section | 26 |
| Ca | Energy-angle differential photon-production cross section | 26 |

## 6.2 Changed requests

| Target | Quantity | Comments | WRENDA indentification No. | Page |
|---|---|---|---|---|
| $^{239}Pu$ | Fission cross section | Partly fulfilled | 742006 | 6 |
| $^{240}Pu$ | Capture cross section | Partly fulfilled | 692452 | 9 |
| $^{242}Pu$ | Capture cross section | Partly fulfilled | 742010 | 9 |

## 6.3 Withdrawn requests

| Target | Quantity | Comments | WRENDA identification No. | Page |
|---|---|---|---|---|
| $^{240}Pu$ | Fission cross section | Fulfilled | 742008 | 6 |
| $^{241}Pu$ | Fission cross section | Fulfilled | 692463 | 6 |
| $^{242}Pu$ | Fission cross section | Fulfilled | 742009 | 6 |
| $^{242}Am$ | Fission cross section | Fulfilled | 762172 | 18 |