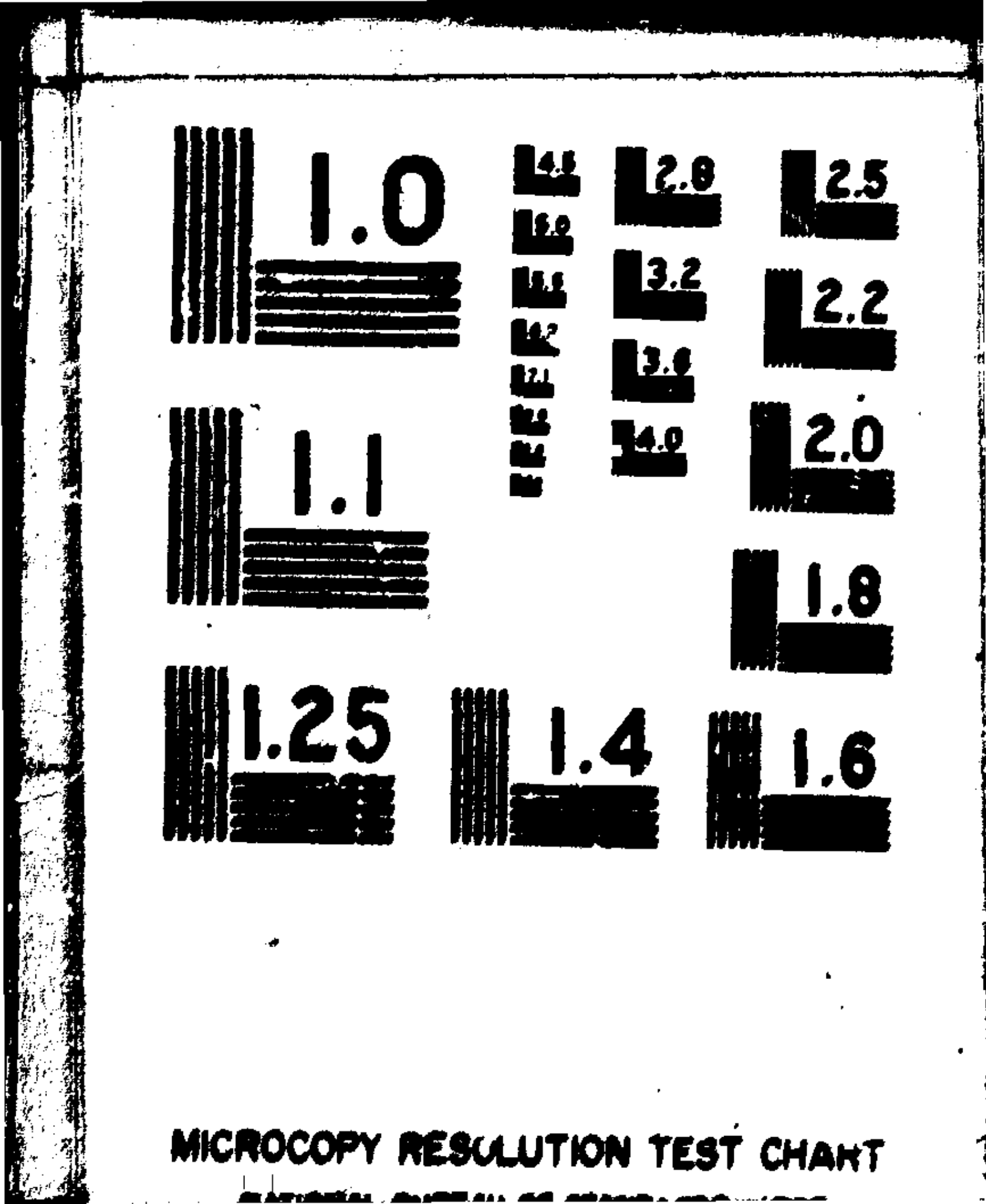
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1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART

Comitato Nazionale Energia Nucleare

Cross Section Libraries Set-up for Burn-up Calculations in the Presence of Gd as a Burnable Poison in LWR'S

G. Iorio, F. Pistella, F. Sisto

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RT/FI(71)9

CNEN - RT/FI(71) 9

G. Iorio, F. Pistella, F. Sisto (CNEN, Laboratorio Fisica e Calcolo Reattori)

CROSS SECTION LIBRARIES SET-UP FOR BURN-UP CALCULATIONS IN THE PRESENCE OF Gd AS A BURNABLE POISON IN LWR'S

RIASSUNTO - E' stata messa a punto una libreria di sezioni d'urto da usare per calcoli di burn-up in presenza di Gd. Dopo aver discusso i dati disponibili si suggerisce un nuovo schema energetico ridotto e se ne verifica la validità; sono inoltre riportati i valori ottenuti per i materiali di interesse. Sono discusse alcune ipotesi che consentono di semplificare il modello da usare in calcoli di burn-up.

CNEN - RT/FI(71)9

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G. Iorio, F. Pistella, F. Sisto (CNEN. Laboratorio Fisica e Calcolo Reattori)

CROSS SECTION LIBRARIES SET-UP FOR BURN-UP CALCULATIONS IN THE PRESENCE OF Gd AS A BURNABLE POISON IN LWR'S

SUMMARY - A cross section library has been set-up to be used for burn-up calculations in the presence of Gd. The available cross section data are briefly discussed, a new reduced energy scheme is suggested and its validity is tested; the values resulted for the materials of interest are also given. A few assumptions are discussed which allow to simplify the model to be used in burn-up calculations.

Comitato Nazionale Energia Nucleare

Cross Section Libraries Set-up for Burn-up Calculations in the Presence of Gd as a Burnable Poison in LWR'S

G. Iorio, F. Pistella, F. Sisto

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INDEX

I. INTRODUCTION

The use of Gd as a burnable poison for light water reactors is being investigated at our laboratory from the experimental as well as calculational stand points [1], [2] and [3].

The stress is at present put on burn-up calculations in the presence of Gd: while for zero life calculations only the cross section of natural Gd has to be adequately known, for burn-up calculations - to describe the contribution to the absorption rate due to the different Gd isotopes and their consequent depletions - the cross sections of the single isotopes must be adequately known.

From Table I - which is taken from BNL-325, Second Edition (1958) - it appears that to this purpose the most significant isotopes to be considered are Gd-155 and Gd-157 (having very large cross sections) and possibly Gd-156 (acting to some extent as a link in the isotopical chain).

In the present work a proper cross section library has been set-up to be used for burn-up calculations in the presence of Gd. First the cross section data available for the Gd isotopes are briefly discussed here; then the reasons for preferring the new energy scheme adopted are presented

and a test is given of the reliability of this scheme; the values resulted for structural and fuel materials (in addition to those for Gd isotopes) are also given.

In particular three questions are discussed and answered to in the present report:

- Do the cross sections of Gd-155 and Gd-157 depend on energy in almost the same way so that an equivalent concentration of natural Gd can be defined at each irradiation step instead of the actual concentrations of Gd-155 and Gd-157?
- Can the situation be realistically described as: Gd-155 → Gd-156 and separately Gd-157 → Gd-158 without considering the coupling between Gd-155 and Gd-157 due to Gd-156?
- Can the isotopical depletion of Gd be described by modifying the poison constants vs. burn-up only in the thermal group?

Affirmative answers to these questions significantly simplify the model to be used in burn-up calculations.

II. CROSS SECTIONS FOR Gd-nat, Gd-155, Gd-156 and Gd-157 IN THE THERMAL RANGE ($E \leq 0.64$ eV)

II.1. Cross Section Data Available

For what concerns the values at $E_o = 0.0253$ eV, the values given in BNL-325, Second Edition (1958), and in its Supplements n.1 (1960) and n.2 (1966) have been considered; the values for Gd-156 have been taken from the papers reported in [7]

For the Gd-155 and Gd-157 isotopes the cross section curves have been obtained by means of the single level Breit-Wigner formula by the resonance parameters reported in the BNL Supplement n.2 (1966); for Gd-nat a 110 groups pointwise library is available in the production library of the TEMPEST code [5], in addition to the curves reported in the BNL Supplement n.2 according to the measurements of different authors.

As about $\sigma(E_o)$, the newest experimental values and the calculated ones are compared in Table II.

As about the curves for Gd-nat the results from the resonance parameters agree well with the values from TEMPEST and with the experimental values taken from BNL

Supplement n.2, as it is shown in Fig.1 for some points of interest. The largest differences appear where either the neutron density or the cross section are negligibly small.

II.2. The Energy Dependence of Gd-155 and Gd-157 Cross Sections

If we compare the two energy functions (°)

$$f^5(E) = \sigma^5(E)/\sigma^5(E_o) \quad \text{and} \quad f^7(E) = \sigma^7(E)/\sigma^7(E_o)$$

it results that the largest deviations appear of the order of 5% at very low energy - where the neutron population is strongly reduced - and of the order of 10% - at the upper limit of the thermal range where both the neutron population and the cross sections are small.

In a number of cases of interest - typical PWR cell (°°) - a check has been performed to verify that such

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(°) Here and in the following the idexes 5 and 7 refer to Gd-155 and Gd-157 respectively.

(°°) Approximate cell characteristics:

internal diameter of fuel rods	~ 0.9 cm
lattice pitch	~ 1.3 cm
fuel	UO_2 pelletized
enrichment	~ 5. % U-235
moderator	H_2O

deviations are not actually significant. The values of the difference $\hat{f}^7 - \hat{f}^5$ relative to $\hat{f}^7$ - averaged over the thermal spectrum, calculated by the THERMOS code [5] - are presented in the following vs. the concentration of Gd_2O_3 in the pellet; values of the order of 4% are always found.

Gd content (mg/cm3)	10	20	30	50	100	200	400
$\frac{\hat{f}^7 - \hat{f}^5}{\hat{f}^7}$ (%)	3.2	3.7	3.9	4.1	4.1	4.0	3.8

The assumption $\hat{f}^5 = \hat{f}^7$ may be adopted for our purposes.

An application of this result - to simplify the description of the isotopical content vs. burn-up - is given in [3].

II.3. Relevance of the Presence of Gd-156

From the burn-up equations for the chain

Gd-155 → Gd-156 → Gd-157 → Gd-158

$$N^5(T) = N^5(0) \exp(-\sigma^5 T)$$

$$N^6(T) = \left[N^6(0) - N^5(0)\frac{\sigma^6}{\sigma^6-\sigma^5}\right]\exp(-\sigma^6 T) + N^5(0)\frac{\sigma^5}{\sigma^6-\sigma^5}\exp(-\sigma^5 T)$$

$$N^7(T) = \left[N^7(0) - N^6(0)\frac{\sigma^6}{\sigma^7-\sigma^6} + N^5(0)\frac{\sigma^5\sigma^6}{(\sigma^7-\sigma^6)(\sigma^7-\sigma^5)}\right]\exp(-\sigma^7 T) +$$

$$+ \left[N^6(0) - N^5(0)\frac{\sigma^5}{\sigma^6-\sigma^5}\right]\frac{\sigma^6}{\sigma^6-\sigma^5}\exp(-\sigma^6 T) +$$

$$+ N^5(0)\frac{\sigma^5\sigma^6}{(\sigma^7-\sigma^5)(\sigma^6-\sigma^5)}\exp(-\sigma^5 T)$$

the overall macroscopic absorption cross section Σ (the actual quantity of interest) has been calculated as

$$\sigma^5 N^5 + \sigma^6 N^6 + \sigma^7 N^7 = \Sigma$$

vs. the time integrated flux $T = \int_0^t \phi(t)dt$. The cell previous described has been investigated, considering for T the range from 0 up to 10^{21} n/cm^2; the microscopic energy and space averaged cross sections in the pellet at zero burn-up have been used (o) (oo).

$$\hat{\sigma} \equiv \frac{\int_{pellet} d\vec{r} \int_0^{0.64\,eV} \sigma(E)\ \phi(E,r)\,dE}{\int_{pellet} d\vec{r} \int_0^{0.64\,eV} \phi(E,r)\,dE}$$

(o) The use - throughout the calculations - of $\hat{\sigma}^5$, $\hat{\sigma}^6$ and $\hat{\sigma}^7$ evaluated at zero life is conservative for our purpose; in fact since the variazions vs. burn-up would have enlarged $\hat{\sigma}^6$ less than $\hat{\sigma}^5$ and $\hat{\sigma}^7$ (with respect to zero life values) the importance of Gd-156 would have been furtherly reduced.

(oo) Moreover it must be pointed out that the largest value (14 barns) was used, reported for $\sigma^6(E_o)$ as an upper limit.

The calculations have been repeated when σ^6 was assumed to be zero, the isotopical concentrations thus become:

$$N_*^5(T) = N^5(0)\exp(-\sigma^5 T)$$

$$N_*^7(T) = N^7(0)\exp(-\sigma^7 T)$$

and $\Sigma_*(T) = \sigma^5 N_*^5 + \sigma^7 N_*^7$

In Fig. 2 Σ and Σ_* are compared vs. burn-up. It appears that, at the end of the irradiation (when Σ becomes a very small fraction - 1% - of the zero life value) the difference reaches the largest value (less than 4%).

The assumption that $\sigma^6 = 0$ is thus justified, for our purposes.

III. THE 22-GROUP LIBRARY FOR BURN-UP CALCULATIONS BY THE THERMOS CODE

III.1.Choice of the Scheme

The THERMOS code [6] was planned to be used for cell burn-up calculations in the presence of burnable poisons; this choice (due to the presence of large radial variations in the flux and in the spectrum of neutrons within the pellet because of the very large absorption cross section of the poison)is discussed in [1]. The standard version of the code (°)could not be used since only 5 different material compositions(mixtures) are allowed in the description of the cell; this limitation (unrelevant at zero life when one mixture is enough to describe the pellet) forbids an adequate description of the pellet after an irradiation of some extent (when-due to selfshielding effects - a strong radial dependence of the poison concentration is estabilished within the pellet: i.e. the outermost poison is almost completely burnt, while

---

(°) In the standard version 30 energy groups, 20 space points and 5 mixtures are considered.

the innermost is practically in the same concentration as at the start-up).

To increase the number of mixtures without enlarging the machine storage required, it is necessary to reduce properly the number of space points, as well as of energy groups.

It has been found that 15 space points are enough for our purposes (8 points in the pellet, 1 in the cladding, 4 in the moderator and 2 in a possible coupling ring surrounding the cell [1]); accordingly, 11 mixtures are considered (8 rings constituting the pellet, plus the cladding, the moderator and the coupling ring).

To reduce the number of energy groups the reaction rate R(v) - defined as

$$R(v) = n(v)\, v\, \sigma(v)$$

- was evaluated as a function of v in the innermost and in the outermost space points of a typical Gd poisoned cell of interest. The previous structure (14 groups) has been kept in the range 0.025 - 0.20 eV where the R(v) has a flat maximum; below this range 5 equally spaced groups have been adopted instead of 9; 3 groups with increasing width as v increases have been adopted-instead of 7 - above 0.20 eV (°).

(°) It might be useful to remind that the choice here adopted while appearing as the most convenient in the presence of Gd, may be not the best for problems involving different materials (for instance in the presence of relevant amounts of Pu-239).

The group scheme is presented in Table III.

III.2 The New Library Set-up

The new library has been set-up by means of the LIBP code [6]. For light water the Honeck version of the Nelkin kernel has been used as computed by the GAKER code [6]. For the remaining isotopes the 22 values have been computed by averaging the pointwise cross section sets (110 points) previously available [7] as described in [8](°); for the isotopes considered 1/v only the $\sigma(E_0)$ values are given in input. For the Gd isotopes, in particular, three sets have been prepared for Gd-155, Gd-157 (both from the BNL-325 (1966) resonance parameters) and Gd-nat (from TEMPEST library) respectively.

A list of the isotopes considered in the new library and a list of the cross section values is given in Appendix I . This library is now available at the Bologna Calculation Center (CNEN) on tape no. 169000.

III.3 Evaluation of the Reliability of the 22-group Scheme

To check the reliability of the new scheme THERMOS calculations performed with the 22-group scheme have been compared to calculations performed with the standard 30-group scheme, for the same cell considered in sec. II. The calculations have been repeated for different poison concentrations:

(°) Since the energy structure of the library is now somewhat enlarged, it is significant to use values averaged in the group instead of midpoint values.

0, 10, 35.6, 50 mg/cm^3 of Gd; the results are presented in Table IV.

The differences between the results of the two schemes are limited in the range (1% - 2%) for Σ_a and $\nu\Sigma_f$; the differences reduce as the Gd concentration increases as a consequence of the criterion adopted when choosing the new scheme; for the ratio $\nu\Sigma_f / \Sigma_a$ the differences are of the order of 0.5% in the presence of Gd and smaller than 0.1% for unpoisoned fuel.

The 22-group scheme can be considered adequate for our purposes.

IV. THE ABSORPTION DUE TO Gd IN THE EPITHERMAL AND FAST RANGE

IV.1 Available Data and the New Library

The resonance parameters reported in BNL-325(1966) for Gd-155 and Gd-157 can be used to describe the absorption cross section of natural Gd also in the epithermal range (the largest resonance energy identified is at 158 eV). A 26 group library for Gd is given by Schmidt and Siep (KFK) [9] in the ABBN scheme. In the production library of the FORM code [10][11] available at the Bologna Calculation Center (CNEN) a cross section set is listed for Gd-nat (identification number 44); since this set presents for the absorption cross section much lower values than elsewhere reported and does not reproduce the resonance structure of Gd - it cannot be used (°).

For our purposes the most convenient scheme to

(°) Either a mistake took place in the identification or the resonance parameters were missed.

calculate the fast constants seems to be the FORM code and a new library has been set-up according to this scheme as outlined in the following;

- for the absorption cross section: above ~ 20 eV (FORM groups 40 → 1) the KFK values have been properly interpolated and averaged while in the range from 0.64 to 20 eV (FORM groups 54 → 41) - where the FORM scheme is more detailed than the ABBN one - use has been made of the Breit and Wigner formula averaged over a 1/E spectrum using the BEWMEV program [8]
- for the scattering cross sections (since in the KFK library small differences appear between Eu and Gd) the values previously set-up [12] for Eu (Z= 63 M= 152) in the FORM scheme have been used for Gd also (Z= 64 M= 157); only minor effects due to scattering cross sections may be found for the Gd concentration in natural UO_2 of interest for our purpose.

The FORM library thus obtained for Gd is listed in Appendix II and is now included (identification number 45) in the FORM library tape n. 165005 available at the Bologna Calculation Center (CNEN).

IV.2 FORM Calculations

The contribution to the epithermal and fast absorption cross section due to Gd has been evaluated by using the FORM code with the new cross section library set-up; the same cell previously considered has been calculated for a fewpoison contents. In the most pessimistic conditions (no

selfshielding in the Gd is considered) the contribution due to Gd does not exceed 15% for a Gd content of the order of 150 mgr/cm^3 and is smaller than 5% for Gd content below 50 mgr/cm^3.

REFERENCES

[1] U.CALDOGNETTO, F.PISTELLA : "Cell Calculations for Reactor Fuel Containing Gd as a Burnable Poison" RT/FI(70)21,CNEN Roma 1970

[2] B.ARCIPIANI, U.CALDOGNETTO, A.GIBELLO, F.PISTELLA : "Calculations and Experiments for a Pu Fueled Micro-lattice with Gd as a Burnable Poison" Energia Nucleare vol.17, n.5, 312, 1970

[3] F.PISTELLA : "Burn-up Calculations for Reactor Cells Containing Gd as a Burnable Poison" RT/FI(71)1, CNEN, Roma 1971

[4] R.DOBROZEMSKY et al. : "Pile Neutron Capture Cross Sections of Rare Earth Isotopes" Nuclear Data for Reactors CN-23/87, IAEA, Vienna, 1967

[5] R.H. SHUDDE and J.DYER, "TEMPEST - a Neutron Thermalization code" NAA (Dec No. 3W-354) Atomics International .1960

[6] H.C.HONECK : "THERMOS, a Thermalization Transport Theory code for Reactor Lattice Calculation" BNL-5826 1961

[7] A.GIBELLO, F.ORESTANO, F.PISTELLA, E.SANTANDREA : "Evaluation of Neutron Spectral Effects in Systems with Thermal Resonance Absorbers" Nucl.Sci.Eng, 40, 1970

[8] F.V.ORESTANO, F.PISTELLA : "Programmi vari per l'elaborazione di sezioni d'urto per librerie di codici neutronici" RTI/FCR(68)7,CNEN,Roma 1968

[9] J.J.SCHMIDT and I.SIEP, "26-Gruppen-Wirkungsquerschnitte für Eu, Sm, Gd und Hf", KFK-352, Kernforschungszentrum, Karlsruhe , 1965

[10] D.J.MCGOFF :"FOR- a Fourier Transform Fast Spectrum Code" NAA(SR-MEMO-5766)1960

[11] A.F. HENRY : "54 Group Library for P-1 Programmes", WAPD-TM-224, Bettis Atomic Power Laboratory , 1960

[12] F.V.ORESTANO, F.PISTELLA :"L'europio come assorbitore risonante per la simulazione del plutonio e come rivelatore spettrale" RT/FI(68)52,CNEN, Roma, 1968.

Table I

Abundances of Gd Isotopes

Element	Isotope (%)	σ_{abs} (barn)	σ_{act} (barn)	$T_{1/2}$
$_{64}Gd$	Gd^{152} (0.20)		<125	230 d
	Gd^{154} (2.15)			
	Gd^{155} (14.73)	60,000		
	Gd^{156} (20.47)			
	Gd^{157} (15.68)	250,000		
	Gd^{158} (24.87)		4	18.0 h
	Gd^{160} (21.90)		0.8	3.6 m

Table II

Calculated and Experimental $\sigma(E_o)$ values (barns) for Gd^{155}, Gd^{156}, Gd^{157} and Gd^{nat}.

	Breit & Wigner (BNL-325)		Experimental values (BNL-325)
Gd^{155}	60,380		61,000 ± 1,000
Gd^{157}	251,460		254,000 ± 2,000
Gd^{nat}	48,320		49,000 ± 2,000 (°)
	Reference [4]		BNL- 325
Gd^{156}	< 14	6.3 ± 1	11.5 ± 7.

(°) The value given in TEMPEST library is 47,218 barns.

Table III

Group Scheme Adopted for Burn-up Calculations in the Presence of Gd

Velocity Is Expressed in Adimensional Units v(m/sec) / 2200(m/sec)

Group Number	Lower Bound (Velocity)	Mid Point (Velocity)	Upper Bound (Velocity)	Mid-point Energy (eV)
1	0.0	0.095	0.19	0.00023
2	0.19	0.285	0.38	0.00206
3	0.38	0.475	0.57	0.00571
4	0.57	0.665	0.76	0.01119
5	0.76	0.855	0.95	0.01850
6	0.95	1.0	1.05	0.02529
7	1.05	1.1	1.15	0.03060
8	1.15	1.2	1.25	0.03642
9	1.25	1.3	1.35	0.04274
10	1.35	1.4	1.45	0.04957
11	1.45	1.5	1.55	0.05690
12	1.55	1.605	1.66	0.06515
13	1.66	1.72	1.78	0.07482
14	1.78	1.845	1.91	0.08609
15	1.91	1.98	2.05	0.09915
16	2.05	2.1225	2.195	0.11393
17	2.195	2.2775	2.36	0.13118
18	2.36	2.455	2.55	0.15248
19	2.55	2.725	2.90	.18787
20	2.90	3.175	3.45	0.25504
21	3.45	3.80	4.15	0.36533
22	4.15	4.575	5.0	0.52955

Table IV

Cell Constants Calculated by the 22 Group and the 30 Group Scheme

Gd Content (mg/cm^3)	Σ_a (cm^{-1})		$\nu\Sigma_f$ (cm^{-1})		$\nu\Sigma_f/\Sigma_a$	
	22 grs.	30 grs.	22 grs.	30 grs.	22 grs.	30 grs.
0.	0.1605	0.1641	0.2598	0.2657	1.6183	1.6185
10.	0.2345	0.2391	0.1804	0.1826	0.7693	0.7638
35.6	0.2959	0.3007	0.1273	0.1286	0.4301	0.4276
50.	0.3117	0.3163	0.1152	0.1164	0.3695	0.3681

APPENDIX I Cross Section Values of the 22 Group Library

The materials considered in the library are listed in the following.

Material	1st Ident. Number	2nd Ident. Number	Material	1st Ident. Number	2nd Ident. Number
Unit	3000	20	Dy^{164}	16466	11
O	168	1	Lu^{176}	17671	31
SS AISI 348	348	1	U^{235}_{abs}	23592	1
B	1105	1	U^{235}_{fis}	23592	2
Al	2713	1	U^{236}	23692	1
Cr	5224	1	Pu^{239}_{abs}	23994	24
Fe	5626	1	Pu^{239}_{fis}	23994	124
Ni	5928	1	Pu^{240}	24094	1
Zr	9140	1	Pu^{241}_{abs}	24194	1
Xe^{135}	13554	27	Pu^{241}_{fis}	24194	2
Sm^{149}	14962	26	Pu^{242}	24294	1
Eu^{151}	15163	3	Heavy Scat.	2000	20
Gd^{155}	15564	9	H_2O (Nelkin)	18	50
Gd^{157}	15764	9			
Gd	15764	1	U^{238}	23892	1

```
   NASTRO  LIBRERIA THERMOS 22 GRUPPI PER BURNUP CELLA
GROUPS= 22
ADDED ISOTOPES= 29
DELETED ISOTOPES= -0

NEW ISOTOPES

    IDENT      P-DECKS
 -----------  -------
  3000-    20     -1
 XA
1.05263E 01 3.50877E 00 2.10526E 00 1.50376E 00 1.16959E 00
1.00000E 00 9.09091E-01 8.33333E-01 7.69231E-01 7.14286E-01
6.66667E-01 6.23053E-01 5.81395E-01 5.42005E-01 5.05050E-01
4.71143E-01 4.39078E-01 4.07332E-01 3.66972E-01 3.14961E-01
2.63158E-01 2.18579E-01
 TERMS= 1    T= 1.00000E 00
 SIG=-0.              M= 1.08000E 01    KAP=-0.
 XS
0.          0.          0.          0.          0.
0.          0.          0.          0.          0.
0.          0.          0.          0.          0.
0.          0.          0.          0.          0.
0.          0.

    IDENT      P-DECKS
 -----------  -------
   168-     1     -1
 XA
1.05263E-03 3.50877E-04 2.10526E-04 1.50376E-04 1.16959E-04
```



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40.00000E-05 9.09091E-05 8.33333E-05 7.69231E-05 7.14286E-05
 6.66667E-05 6.23053E-05 5.81395E-05 5.42005E-05 5.05050E-05
 4.71143E-05 4.39078E-05 4.07332E-05 3.66972E-05 3.14961E-05
 2.63158E-05 2.18579E-05
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  SIG= 4.20000E 00    M= 1.60000E 01    KAP=-0.
  XS
 1.30632E 01 5.76068E 00 4.78106E 00 4.49674E 00 4.37954E 00
 4.33125E 00 4.30847E 00 4.29115E 00 4.27766E 00 4.26696E 00
 4.25833E 00 4.25095E 00 4.24437E 00 4.23856E 00 4.23348E 00
 4.22913E 00 4.22530E 00 4.22178E 00 4.21768E 00 4.21302E 00
 4.20909E 00 4.20627E 00

    IDENT      P-DECKS
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2.81420E 00 2.55836E 00 2.34517E 00 2.16477E 00 2.01014E 00
1.87613E 00 1.75340E 00 1.63616E 00 1.52531E 00 1.42131E 00
1.32589E 00 1.23565E 00 1.14631E 00 1.03273E 00 8.86362E-01
7.40579E-01 6.15126E-01
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1.01204E 01 1.01153E 01 1.01108E 01 1.01067E 01 1.01032E 01
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1.98684E 02 1.65027E 02
 TERMS= 1    T= 1.00000E 00
 SIG= 4.32000E 00    M= 1.08200E 01    KAP=-0.
 XS
1.61016E 01 6.60401E 00 5.19946E 00 4.77123E 00 4.59304E 00
4.51962E 00 4.48498E 00 4.45863E 00 4.43812E 00 4.42185E 00
4.40872E 00 4.39750E 00 4.38748E 00 4.37865E 00 4.37092E 00
4.36431E 00 4.35849E 00 4.35312E 00 4.34688E 00 4.33980E 00
4.33382E 00 4.32954E 00

    IDENT      P-DECKS
 -----------  -------
  2713-     1     -1
 XA
2.42105E 00 8.07018E-01 4.84211E-01 3.45865E-01 2.69006E-01
2.30000E-01 2.09091E-01 1.91667E-01 1.76923E-01 1.64286E-01
1.53333E-01 1.43302E-01 1.33721E-01 1.24661E-01 1.16162E-01
1.08363E-01 1.00988E-01 9.36864E-02 8.44037E-02 7.24409E-02
6.05263E-02 5.02732E-02
 TERMS= 1    T= 1.00000E 00
 SIG= 1.40000E 00    M= 2.70000E 01    KAP=-0.
 XS
```

3.45405E 00 1.71643E 00 1.51488E 00 1.45862E 00 1.43547E 00
1.42593E 00 1.42143E 00 1.41800E 00 1.41534E 00 1.41323E 00
1.41152E 00 1.41006E 00 1.40876E 00 1.40762E 00 1.40661E 00
1.40575E 00 1.40500E 00 1.40436E 00 1.40349E 00 1.40257E 00
1.40180E 00 1.40124E 00

IDENT	P-DECKS
5224-	1 -1

XA
3.26316E 01 1.08772E 01 6.52632E 00 4.66165E 00 3.62573E 00
3.10000E 00 2.81818E 00 2.58333E 00 2.38462E 00 2.21429E 00
2.06667E 00 1.93146E 00 1.80233E 00 1.68022E 00 1.56566E 00
1.46054E 00 1.36114E 00 1.26273E 00 1.13761E 00 9.76378E-01
8.15789E-01 6.77596E-01
TERMS= 1 T= 1.000CCE CC
SIG= 3.00000E 00 M= 5.20100E 01 KAP=-0.
XS
5.68010E 00 3.35484E 00 3.12782E 00 3.06522E 00 3.03945E 00
3.02884E 00 3.02384E 00 3.02003E 00 3.01707E 00 3.01471E 00
3.01282E 00 3.01120E 00 3.00975E 00 3.00847E 00 3.00736E 00
3.00640E 00 3.00556E 00 3.00479E 00 3.00388E 00 3.00286E 00
3.00200E 00 3.00138E 00

IDENT	P-DECKS
5626-	1 -1

XA
2.66316E 01 8.87719E 00 5.32632E 00 3.80451E 00 2.95906E 00
2.53000E 00 2.30000E 00 2.10833E 00 1.94615E 00 1.80714E 00
1.68667E 00 1.57632E 00 1.47093E 00 1.37127E 00 1.27778E 00
1.19199E 00 1.11087E 00 1.03055E 00 9.28440E-01 7.96850E-01
6.65789E-01 5.53005E-01
TERMS= 1 T= 1.00000E 00
SIG= 1.10000E 01 M= 5.58500E 01 KAP=-0.
XS
2.02825E 01 1.22118E 01 1.14365E 01 1.12227E 01 1.11347E 01
1.10985E 01 1.10814E 01 1.10684E 01 1.10583E 01 1.10502E 01
1.10438E 01 1.10382E 01 1.10333E 01 1.10285E 01 1.10251E 01
1.10219E 01 1.10190E 01 1.10163E 01 1.10133E 01 1.10098E 01
1.10068E 01 1.10047E 01

IDENT	P-DECKS
5928-	1 -1

XA
5.05263E 01 1.68421E 01 1.01053E 01 7.21804E 00 5.61404E 00
4.80000E 00 4.36364E 00 4.00000E 00 3.69231E 00 3.42857E 00
3.20000E 00 2.99065E 00 2.7907CE 00 2.60163E 00 2.42424E 00
2.26148E 00 2.10757E 00 1.95519E 00 1.76147E 00 1.51181E 00
1.26316E 00 1.04918E 00
TERMS= 1 T= 1.CCCCOE CC
SIG= 1.75000E 01 M= 5.87100E 01 KAP=-0.
XS
3.16834E 01 1.93341E 01 1.81605E 01 1.78370E 01 1.77039E 01
1.76490E 01 1.76232E 01 1.76035E 01 1.75882E 01 1.75760E 01
1.75662E 01 1.75579E 01 1.75504E 01 1.75438E 01 1.75380E 01
1.75331E 01 1.75287E 01 1.75247E 01 1.75201E 01 1.75148E 01
1.75103E 01 1.75071E 01

IDENT	P-DECKS

IDENT	P-DECKS
9140-	1 -1

XA
1.89474E 00 6.31579E-01 3.78947E-01 2.7C677E-01 2.10526E-01
1.80000E-01 1.63636E-01 1.50000E-01 1.38462E-01 1.28571E-01
1.20000E-01 1.12150E-01 1.04651E-01 9.75610E-02 9.09091E-02
8.48057E-02 7.90340E-02 7.33198E-02 6.8C550E-02 5.66929E-02
4.73684E-02 3.93443E-02
TERMS= 1 T= 1.0C0C0E 00
SIG= 8.00000E 00 M= 9.12200E 01 KAP=-0.
XS
1.24780E 01 8.53976E 00 8.19435E 00 8.09516E 00 8.05998E 00
8.04385E 00 8.03624E 00 8.03045E 00 8.02595E 00 8.02237E 00
8.01949E 00 8.01702E 00 8.01482E 00 8.01288E 00 8.01118E 00
8.00973E 00 8.00845E 00 8.00728E 00 8.00591E 00 8.00435E 00
8.00304E 00 8.00209E 00

IDENT	P-DECKS
13554-	27 -1

XA
1.66022E 07 5.85648E 06 4.39398E 06 3.43259E 06 3.16034E 06
3.09889E 06 3.10189E 06 3.15571E 06 3.27367E 06 3.40889E 06
3.48914E 06 3.52493E 06 3.48055E 06 3.31574E 06 2.96496E 06
2.43680E 06 1.80431E 06 1.21254E 06 6.5444CE 05 2.72283E 05
8.39527E 04 3.26463E 04
TERMS= 1 T= 1.0CCCCE CC
SIG= 4.30000E 00 M= 1.35000E 02 KAP=-0.
XS
5.99569E 00 4.49607E 00 4.37059E 00 4.33601E 00 4.32179E 00
4.31593E 00 4.31316E 00 4.31106E 00 4.30942E 00 4.30813E 00
4.30708E 00 4.30618E 00 4.30538E 00 4.30466E 00 4.30406E 00
4.30354E 00 4.30307E 00 4.30264E 00 4.30214E 00 4.30158E 00
4.30110E 00 4.30076E 00

IDENT	P-DECKS
14962-	26 -1

XA
3.06285E 04 1.09024E 04 8.03443E 03 6.15767E 03 5.67464E 03
5.54498E 03 5.59770E 03 5.73602E 03 6.08478E 03 6.89337E 03
8.09512E 03 9.96861E 03 1.23329E 04 1.46313E 04 1.48623E 04
1.12350E 04 6.67566E 03 3.47286E 03 1.43094E 03 4.71400E 02
1.74860E 02 1.07210E 02
TERMS= 1 T= 1.00000E 0C
SIG= 5.00000E 00 M= 1.49000E 02 KAP=-0.
XS
6.80012E 00 5.20656E 00 5.07436E 00 5.03794E 00 5.02295E 00
5.01678E 00 5.01387E 00 5.01165E 00 5.00993E 00 5.00856E 00
5.00746E 00 5.00651E 00 5.00567E 00 5.00493E 00 5.00428E 00
5.00372E 00 5.00323E 00 5.00278E 00 5.00226E 00 5.00166E 00
5.00116E 00 5.00080E 00

IDENT	P-DECKS
19163-	3 -1

XA
2.52202E 04 8.09252E 03 5.07865E 03 2.90991E 03 1.95762E 03
1.46672E 03 1.21349E 03 1.00828E 03 8.41286E 02 7.06610E 02
5.98020E 02 5.03110E 02 4.20110E 02 3.5C06CE 02 2.92760E 02

```
2.47940E 02 2.13960E 02 1.8975CE 02 1.8072CE 02 2.99560E 02
6.81340E 02 6.95640E 02
 TERMS= 1    T= 1.COOCCE 00
 SIG= 0.              M= 1.51000E 02    KAP=-0.
 XS
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.
```

IDENT	P-DECKS
15564- 9	-1

```
 XA
5.09579E 05 1.74372E 05 1.21161E 05 8.38784E 04 6.87979E 04
6.00459E 04 5.43463E 04 4.8525CE 04 4.25193E 04 3.64792E 04
3.06635E 04 2.50385E 04 1.96622E 04 1.49124E 04 1.09930E 04
7.95688E 03 5.65767E 03 3.88934E 03 2.31416E C3 1.07498E 03
4.36990E 02 1.81570E 02
 TERMS= 1    T= 1.COCCCE CC
 SIG= 0.              M= 1.55000E 02    KAP=-0.
 XS
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.
```

IDENT	P-DECKS
15764- 1	-1

```
 XA
3.86787E 05 1.32716E C5 9.27187E 04 6.49105E 04 5.41503E 04
4.80918E 04 4.41365E 04 3.99755E 04 3.55079E 04 3.08091E 04
2.60962E 04 2.14243E 04 1.68559E 04 1.27563E 04 9.35365E 03
6.72229E 03 4.73852E 03 3.22589E 03 1.89367E 03 8.60560E 02
3.37090E 02 1.30210E 02
 TERMS= 1    T= 1.00000E 00
 SIG=10.00000E-08    M= 1.57000E 02    KAP=-0.
 XS
1.34291E-07 1.03921E-07 1.C1 12E-C7 1.CC720E-07 1.00436E-07
1.00318E-07 1.00263E-07 1.00221E-07 1.00188E-07 1.00162E-07
1.00142E-07 1.00124E-07 1.00108E-07 1.00094E-07 1.00081E-07
1.00071E-07 1.00061E-07 1.00053E-07 1.00043E-07 1.00032E-07
1.00022E-07 1.00015E-07
```

IDENT	P-DECKS
15764- 9	-1

```
 XA
1.98800E 06 6.82811E 05 4.77431E 05 3.35198E 05 2.80714E 05
2.50307E 05 2.30434E 05 2.09367E 05 1.86516E 05 1.62227E 05
1.37643E 05 1.13127E C5 8.90311E C4 6.73523E 04 4.93344E 04
3.54031E 04 2.49086E 04 1.69199E 04 9.90343E 03 4.47841E 03
1.73934E 03 6.59830E 02
 TERMS= 1    T= 1.00000E 00
 SIG= 0.              M= 1.57000E 02    KAP=-0.
 XS
0.           0.           0.           0.           0.
```



```
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.
```

IDENT	P-DECKS
16466- 11	-1

```
 XA
2.72170E 04 9.05218E 03 6.02191E 03 3.87093E 03 2.97893E 03
2.52027E 03 2.27811E 03 2.07558E 03 1.90317E 03 1.75566E 03
1.62786E 03 1.50814E 03 1.39297E 03 1.28358E 03 1.18052E 03
1.08480E 03 9.93740E C2 9.02900E 02 7.86930E 02 6.34930E 02
4.80490E 02 3.47250E C2
 TERMS= 1    T= 1.0000CE 00
 SIG= 0.              M= 1.64000E 02    KAP=-0.
 XS
0.           0.           0.           0.           0.
0.           0.           C.           0.           0.
0.           0.           0.           0.           0.
0.           0.           C.           C.           0.
0.           0.
```

IDENT	P-DECKS
17671- 31	-1

```
 XA
1.52149E 04 5.18846E 03 3.60810E 03 2.52797E 03 2.17447E 03
2.05168E 03 2.02732E 03 2.04492E 03 2.10638E 03 2.22153E 03
2.40266E 03 2.67848E 03 3.13048E 03 3.91153E 03 5.35564E 03
7.98378E 03 1.17047E 04 1.C1426E 04 3.9467CE 03 7.92380E 02
1.89560E 02 6.77200E 01
 TERMS= 1    T= 1.COOCCE CC
 SIG= 0.              M= 1.76000E 02    KAP=-0.
 XS
0.           0.           0.           0.           0.
0.           0.           0.           0.           0.
0.           0.           C.           0.           C.
0.           0.           0.           0.           0.
0.           0.
```

IDENT	P-DECKS
23592- 1	-1

```
 XA
7.70016E 03 2.55463E 03 1.69032E 03 1.07506E 03 8.17260E 02
6.83240E 02 6.12270E 02 5.52646E 02 5.02250E 02 4.58960E 02
4.22010E 02 3.87550E 02 3.5477CE C2 3.24590E 02 2.97280E 02
2.73140E C2 2.52030E 02 2.340SCE 02 2.1720CE 02 2.30400E 02
1.66500E 02 8.93100E 01
 TERMS= 1    T= 1.00000E 00
 SIG= 1.00000E 01    M= 2.35000E 02    KAP=-0.
 XS
1.23349E 01 1.02619E 01 1.00943E 01 1.00481E 01 1.00291E 01
1.00213E 01 1.00176E 01 1.00148E 01 1.00126E 01 1.00109E 01
1.00095E 01 1.00083E 01 1.00072E 01 1.00063E 01 1.00054E 01
1.00047E 01 1.00041E 01 1.00035E 01 1.00029E C1 1.00021E 01
1.00015E 01 1.00010E 01
```

IDENT	P-DECKS

```
 -----------  -------
 23592-    2    -1
 XA
6.54842E 03 2.17072E 03 1.43659E 03 9.14530E 02 6.95790E 02
5.82630E 02 5.22870E 02 4.72560E 02 4.29580E 02 3.92830E 02
3.61140E 02 3.3165CE 02 3.0334CE 02 2.76820E 02 2.52210E 02
2.30350E 02 2.11360E 02 1.9461CE 02 1.7763CE 02 1.84360E 02
1.40180E 02 7.965CCE 01
 TERMS= 1   T= 1.00000E 00
 SIG= 1.00000E C1   M= 2.35000E 02   KAP=-0.
 XS
1.23349E 01 1.02619E 01 1.00943E 01 1.00481E 01 1.00291E 01
1.00213E 01 1.00176E 01 1.00148E 01 1.00126E 01 1.00109E 01
1.00095E 01 1.00083E C1 1.00072E 01 1.00063E 01 1.00054E 01
1.00047E 01 1.00041E 01 1.00035E 01 1.00029E 01 1.00021E 01
1.00015E 01 1.00010E 01

    IDENT      P-DECKS
 -----------  -------
 23692-    1    -1
 XA
6.31579E 01 2.10526E 01 1.26316E C1 9.02256E C0 7.01754E 00
6.00000E 00 5.45455E 00 5.0000CE 00 4.61538E 00 4.28571E 00
4.000C0E 00 3.73832E 00 3.48837E 00 3.25203E 00 3.03030E 00
2.82686E 00 2.63447E 00 2.44395E 00 2.20183E 00 1.88976E 00
1.57895E 00 1.31148E 00
 TERMS= 1   T= 1.000C0E 00
 SIG= 1.00000E 01   M= 2.36000E 02   KAP=-0.
 XS
1.23253E C1 1.02608E 01 1.00939E 01 1.00479E 01 1.00290E 01
1.00212E 01 1.00175E 01 1.00147E 01 1.00125E 01 1.00108E 01
1.00094E 01 1.00082E 01 1.00072E 01 1.00062E 01 1.00054E 01
1.00047E 01 1.00041E 01 1.00035E 01 1.00029E 01 1.00021E 01
1.00015E 01 1.00010E 01

    IDENT      P-DECKS
 -----------  -------
 23892-    1    -1
 XA
2.85263E 01 9.50877E 00 5.70526E 00 4.07519E 00 3.16959E 00
2.71000E 00 2.46364E 00 2.25833E 00 2.08462E 00 1.93571E 00
1.80667E 00 1.68847E 00 1.57558E 00 1.46883E 00 1.36869E 00
1.27680E 00 1.18990E 00 1.10387E 00 9.94495E-01 8.53543E-01
7.13158E-01 5.92350E-01
 TERMS= 1   T= 1.00 00E 00
 SIG= 8.30000E 00   M= 2.38000E 02   KAP=-0.
 XS
1.02142E 01 8.51467E 00 8.37728E 00 8.33943E 00 8.32385E 00
8.31744E 00 8.31441E 00 8.31211E 00 8.31032E 00 8.30890E 00
8.30775E 00 8.30677E C0 8.30589E 00 8.30512E 00 8.30445E 00
8.30387E 00 8.30336E 00 8.30289E 00 8.30235E 00 8.30173E 00
8.30121E 00 8.30083E 00

    IDENT      P-DECKS
 -----------  -------
 23994-   24    -1
 XA
1.02856E 04 3.44464E 03 2.31392E 03 1.51575E 03 1.19395E 03
1.03250E C3 9.49220E 02 8.81780E 02 8.26740E 02 7.82730E 02
7.49090E 02 7.22450E C2 7.04330E 02 6.98840E 02 7.05640E 02
```



```
7.25230E C2 7.7330CE C2 8.7974CE C2 1.256C9E 03 3.61225E 03
2.27748E 03 2.8337CE 02
 TERMS= 1   T= 1.COOCCE OC
 SIG= 1.00000E C1   M= 2.39000E 02   KAP=-C.
 XS
1.22969E 01 1.02576E C1 1.CC927E 01 1.00473E C1 1.00286E C1
1.00209E 01 1.00173E 01 1.00145E 01 1.00124E 01 1.00107E 01
1.00093E 01 1.00081E C1 1.00071E C1 1.00C61E 01 1.00053E 01
1.00046E C1 1.00040E 01 1.00035E C1 1.00028E C1 1.00021E 01
1.00014E 01 1.00010E 01

    IDENT      P-CECKS
 -----------  -------
 23994-  124    -1
 XA
7.62015E 03 2.54408E 03 1.70008E 03 1.10411E 03 9.63680E 02
7.42960E 02 6.80770E 02 6.30060E 02 5.88220E 02 5.54690E 02
5.2804CE 02 5.05610E 02 4.8738CE 02 4.7485CE 02 4.68870E 02
4.71810E 02 4.92820E 02 5.4885CE 02 7.6148CE 02 2.13033E 03
1.35238E 03 1.78430E 02
 TERMS= 1   T= 1.COCCCE CC
 SIG= 1.00000E 01   M= 2.39000E 02   KAP=-0.
 XS
1.22969E 01 1.02576E C1 1.00927E 01 1.00473E 01 1.00286E 01
1.00209E 01 1.00173E 01 1.00145E 01 1.00124E 01 1.00107E 01
1.00093E 01 1.00081E C1 1.00071E 01 1.00C61E 01 1.00053E 01
1.00046E C1 1.00040E 01 1.00035E 01 1.00028E C1 1.00021E 01
1.00014E 01 1.00010E 01

    IDENT      P-CECKS
 -----------  -------
 24C94-    1    -1
 XA
2.27642E 03 8.20850E 02 5.66500E 02 3.9662CE 02 3.16730E 02
2.76390E 02 2.5551CE 02 2.3633CE 02 2.20540E 02 2.06540E 02
1.96190E 02 1.9673CE 02 1.7855CE 02 1.7151CE 02 1.65370E 02
1.59330E 02 1.56060E 02 1.5048CE 02 1.4846CE 02 1.55810E 02
1.63270E 02 2.11480E 02
 TERMS= 1   T= 1.COCCCE CC
 SIG= 9.60000E 00   M= 2.400C0E 02   KAP=-0.
 XS
1.17961E C1 9.84623E 00 9.68864E 00 9.64523E 00 9.62736E 00
9.62000E 00 9.61653E 00 9.61389E 00 9.61183E 00 9.61020E 00
9.60889E 00 9.60776E 00 9.60676E C0 9.60588E 00 9.60510E 00
9.60444E 00 9.60386E 00 9.60332E 00 9.60269E 00 9.60198E 00
9.60138E 00 9.60096E 00

    IDENT      P-CECKS
 -----------  -------
 24194-    1    -1
 XA
1.07034E 04 3.88606E 03 2.72326E 03 1.90180E 03 1.53041E 03
1.33017E 03 1.22816E 03 1.14817E 03 1.07916E 03 1.00526E 03
9.56710E 02 9.12240E 02 8.67050E 02 8.3027CE 02 8.09000E 02
8.12350E 02 8.5407CE 02 9.2774CE 02 1.2574CE C3 2.03198E 03
5.87220E C2 8.169C0E 01
 TERMS= 1   T= 1.C000CE CO
 SIG= 9.60000E 00   M= 2.41000E 02   KAP=-0.
 XS
1.17873E 01 9.84521E CC 9.68827E 00 9.645C4E 00 9.62725E 00
```

```
9.61992E 00 9.61646E 00 9.61383E 00 9.61178E 00 9.61016E 00
9.60885E 00 9.60773E 00 9.60673E 00 9.60585E 00 9.60508E 00
9.60442E 00 9.60384E 00 9.60336E 00 9.60268E 00 9.60198E 00
9.60138E 00 9.60095E 00

    IDENT      P-DECKS
 -----------   -------
 24194-    2     -1
 XA
7.96592E 03 2.89300E 03 2.02632E 03 1.41532E 03 1.13896E 03
9.89900E 02 9.14090E 02 8.54470E 02 8.03080E 02 7.48090E 02
7.12070E 02 6.78980E 02 6.45210E 02 6.17840E 02 6.02070E 02
6.04580E 02 6.35550E 02 6.90370E 02 9.35670E 02 1.51267E 03
4.36970E 02 6.07900E 01
 TERMS= 1    T= 1.00000E 00
 SIG=-0.              M= 2.41000E 02    KAP=-0.
 XS
0.          0.          0.          0.          0.
0.          0.          0.          0.          0.
0.          0.          0.          0.          0.
0.          0.          0.          0.          0.
0.          0.

    IDENT      P-DECKS
 -----------   -------
 24294-    1     -1
 XA
3.15789E 02 1.05263E 02 6.31579E 01 4.51128E 01 3.50877E 01
3.00000E 01 2.72727E 01 2.50000E 01 2.30769E 01 2.14286E 01
2.00000E 01 1.86916E 01 1.74419E 01 1.62602E 01 1.51515E 01
1.41343E 01 1.31723E 01 1.22200E 01 1.10092E 01 9.44882E 00
7.89474E 00 6.55738E 00
 TERMS= 1    T= 1.00000E 00
 SIG= 9.60000E 00    M= 2.42000E 02    KAP=-0.
 XS
1.17785E 01 9.84419E 00 9.68791E 00 9.64485E 00 9.62713E 00
9.61983E 00 9.61639E 00 9.61377E 00 9.61174E 00 9.61012E 00
9.60882E 00 9.60770E 00 9.60677E 00 9.60583E 00 9.60506E 00
9.60440E 00 9.60382E 00 9.60329E 00 9.60267E 00 9.60197E 00
9.60137E 00 9.60095E 00

    IDENT      P-DECKS
 -----------   -------
  2000-   20      1
 XA
0.          -0.         -0.         -0.         -0.
0.          -0.         -0.         -0.         -0.
0.          -0.         -0.         -0.         -0.
0.          -0.         -0.         -0.         -0.
0.          -0.
 P DECK 2000-0    K=22    JO= 1    T= 0.10000E 01
 XS
9.50000E-02 2.85000E-01 4.74989E-01 6.64992E-01 8.54994E-01
```



```
0.00000E-01 1.10000E 00 1.20000E 00 1.30000E 00 1.40000E 00
1.50000E 00 1.60498E 00 1.72000E 00 1.84499E 00 1.98000E 00
2.12250E 00 2.27750E 00 2.45499E 00 2.72499E 00 3.17512E 00
3.80000E 00 4.57508E 00

    IDENT      P-DECKS
 -----------   -------
    18-   50      1
 XA
3.49474E 00 1.16491E 00 6.98947E-01 4.99248E-01 3.88304E-01
3.32000E-01 3.01818E-01 2.76667E-01 2.55385E-01 2.37143E-01
2.21333E-01 2.06854E-01 1.93023E-01 1.79946E-01 1.67677E-01
1.56419E-01 1.45774E-01 1.35234E-01 1.21835E-01 1.04567E-01
8.73684E-02 7.25683E-02
 P DECK16309-0    K=22    JO= 1    T= 0.10000E 01
 XS
2.32873E 02 9.74429E 01 7.36294E 01 6.25834E 01 5.42913E 01
4.83500E 01 4.47264E 01 4.13343E 01 3.82766E 01 3.58280E 01
3.42582E 01 3.34787E 01 3.30836E 01 3.23267E 01 3.09991E 01
2.95649E 01 2.87655E 01 2.69703E 01 2.66618E 01 2.56383E 01
2.27375E 01 2.09790E 01
```

APPENDIX II FORM Library for Gd nat.

GROUP	ENERGY RANGE	SIGMA
1	10.0 MEV - 7.79 MEV	0.002
2	7.79 MEV - 6.07 MEV	0.005
3	6.07 MEV - 4.72 MEV	0.01
4	4.72 MEV - 3.68 MEV	0.015
5	3.68 MEV - 2.86 MEV	0.030
6	2.86 MEV - 2.23 MEV	0.060
7	2.23 MEV - 1.74 MEV	0.085
8	1.74 MEV - 1.35 MEV	0.10
9	1.35 MEV - 1.05 MEV	0.11
10	1.05 MEV - 821. KEV	0.11
11	821. KEV - 639. KEV	0.11
12	639. KEV - 498. KEV	0.11
13	498. KEV - 387. KEV	0.13
14	387. KEV - 302. KEV	0.14
15	302. KEV - 235. KEV	0.18
16	235. KEV - 183. KEV	0.26
17	183. KEV - 143. KEV	0.35
18	143. KEV - 111. KEV	0.45
19	111. KEV - 86.5 KEV	0.50
20	86.5 KEV - 67.4 KEV	0.60
21	67.4 KEV - 40.9 KEV	0.77
22	40.9 KEV - 24.8 KEV	1.15
23	24.8 KEV - 15.0 KEV	1.5
24	15.0 KEV - 9.12 KEV	2.15
25	9.12 KEV - 5.53 KEV	2.55
26	5.53 KEV - 3.35 KEV	3.6
27	3.35 KEV - 2.03 KEV	5.7

GROUP	ENERGY RANGE	SIGMA
28	2.03 KEV - 1.23 KEV	8.0
29	1.23 KEV - 750. EV	9.5
30	750. EV - 454. EV	13.75
31	454. EV - 275. EV	29.0
32	275. EV - 167. EV	30.0
33	167. EV - 130. EV	30.0
34	130. EV - 101. EV	30.0
35	101. EV - 78.7 EV	30.0
36	78.7 EV - 61.3 EV	30.0
37	61.3 EV - 47.8 EV	30.0
38	47.8 EV - 37.2 EV	30.0
39	37.2 EV - 29.0 EV	30.0
40	29.0 EV - 23.6 EV	30.0
41	23.6 EV - 17.6 EV	108.8
42	17.6 EV - 13.7 EV	74.98
43	13.7 EV - 10.7 EV	12.21
44	10.7 EV - 8.32 EV	3.518
45	8.32 EV - 6.50 EV	30.79
46	6.50 EV - 5.10 EV	73.41
47	5.10 EV - 3.97 EV	3.093
48	3.97 EV - 3.06 EV	10.67
49	3.06 EV - 2.38 EV	402.2
50	2.38 EV - 1.855 EV	108.9
51	1.855 EV - 1.440 EV	23.10
52	1.440 EV - 1.125 EV	19.54
53	1.125 EV - 0.835 EV	30.83
54	0.835 EV - 0.625 EV	59.38

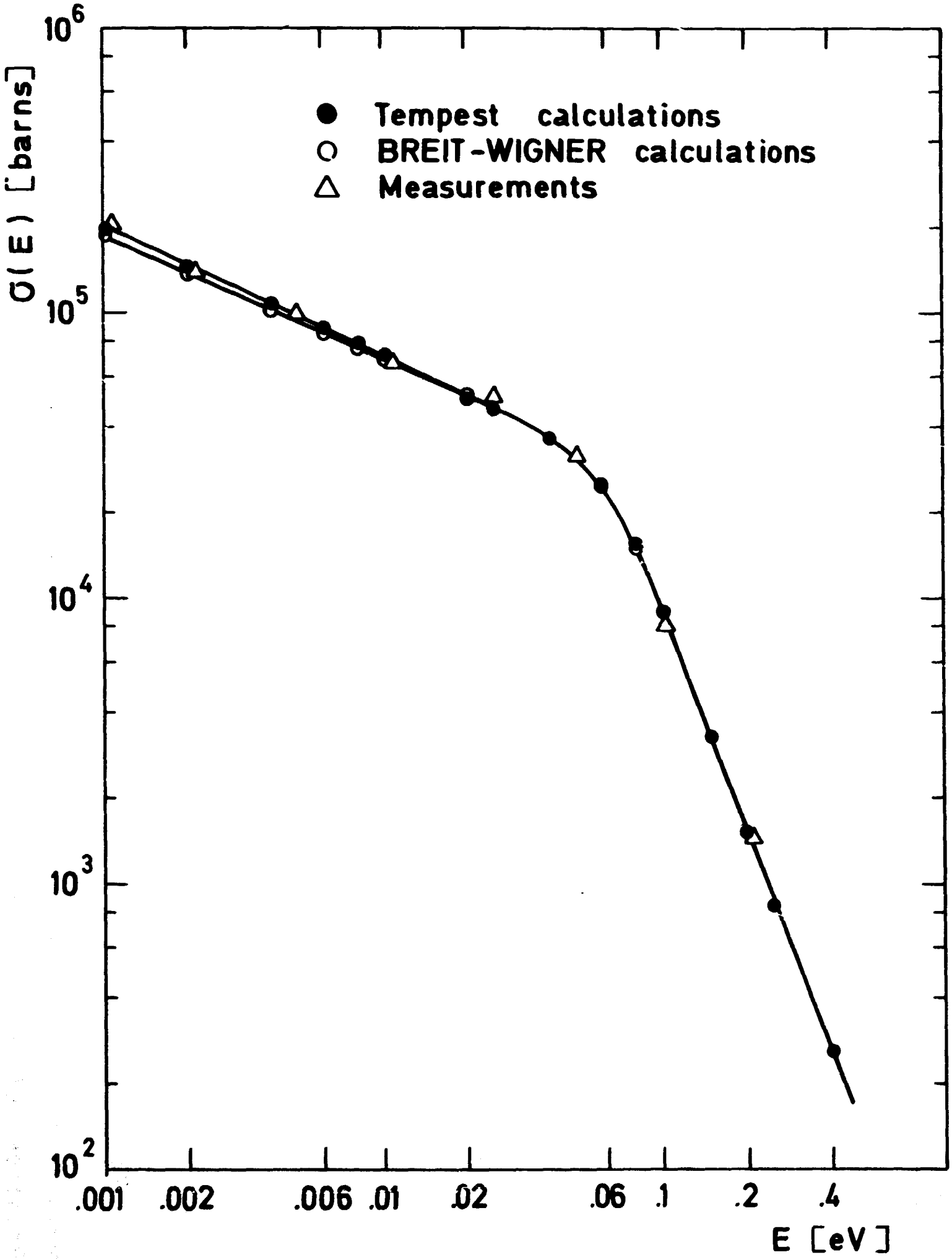

FIG. 1 - Microscopic Absorption Cross Section of Gd-nat vs. Energy

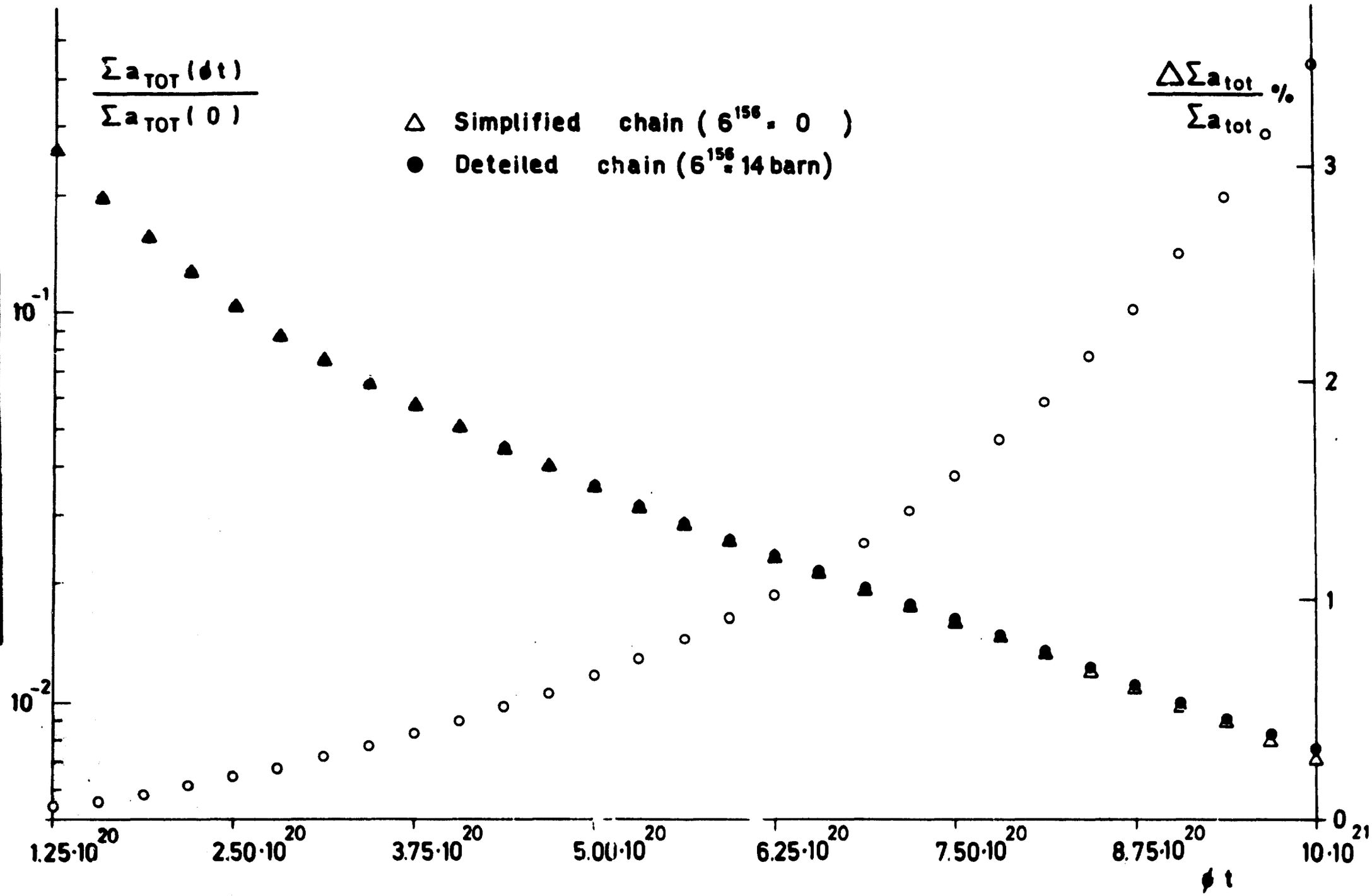

FIG. 2 – Macroscopic Absorption Cross Section of Poision vs. Burn-up Considering the Presence of Gd-156 or not