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KNOLLS
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Evaluated Cross Sections for the Hafnium Isotopes

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ABSTRACT

Evaluated libraries of cross sections have been prepared for natural hafnium and its isotopes Hf^{174}, Hf^{176}, Hf^{177}, Hf^{178}, Hf^{179}, and Hf^{180}. The libraries contain total, elastic, capture, inelastic, (n,p), and (n,2n) cross sections and elastic scattering Legendre moments below 15 Mev. The most recent experimental data were used in the evaluation, and whenever data were not available, theoretical calculations were made.

EVALUATED CROSS SECTIONS FOR THE HAFNIUM ISOTOPES

J. T. Reynolds, C. R. Lubitz
I. Itkin, D. R. Harris

INTRODUCTION

Cross sections for natural hafnium and its isotopes, Hf^{174}, Hf^{176}, Hf^{177}, Hf^{178}, Hf^{179}, and Hf^{180} have been evaluated and detailed cross section libraries compiled. The libraries contain total, elastic, capture, inelastic, (n,p), and (n,2n) cross sections and elastic scattering Legendre moments. Below 1234 ev, the cross sections are given by resonance parameters plus smooth point-by-point cross sections to represent the elastic potential scattering, negative energy resonances, and unresolved positive energy resonances. Between 1234 ev and 15 Mev, the compilation is a point-by-point representation of smoothly varying cross sections. The most recent experimental data were used in the evaluation; whenever data were not available, theoretical calculations were used. The evaluation procedures are summarized below.

SUMMARY OF EVALUATION PROCEDURES

Total Cross Section, $\sigma(n,T)$

0.001 to 101.3 ev: Given as two contributions: A single-level Breit-Wigner cross section (for which resonance parameters and a potential scattering cross section are supplied) plus an extra 1/v contribution to represent negative energy resonances. The Breit-Wigner formula in which these parameters are used should include its own 1/v tails.

101.3 to 1234 ev: Same as preceding, but with an additional contribution representing unresolved resonances. The negative energy 1/v contribution and the unresolved resonance contribution are combined into a single background cross section.

1234 ev to 0.5 Mev: Calculated with use of statistical formulas given in the text (Lane and Lynn).[1]

0.5 to 2.4 Mev: Interpolated between calculated value at 0.5 Mev and measurements starting at 2.4 Mev.

2.4 to 15 Mev: Experimental data.

Capture Cross Section, $\sigma(n,\gamma)$

0.001 to 1234 ev: Same prescription as Total Cross Section. (Resonance parameters plus 1/v plus unresolved.)

1234 ev to 34 kev: Statistical formula calculation (Lane and Lynn).[1]

34 kev to 15 Mev: Shape of curve based on measured values for Hf^{180}, normalized to pass through calculated value at 34 kev.

Elastic Scattering, $\sigma(n,n)$

0.001 to 101.3 ev: Resonance parameters plus potential scattering.

101.3 ev to the Threshold for Inelastic Scattering (0.0932 Mev for Hf^{178}, 0.113 Mev for Hf^{177}. The other even and odd isotopes were arbitrarily set equal to these, respectively.)

Taken as the difference between the total and the capture cross sections.

Threshold for Inelastic Scattering up to the Point Where the Energy Levels Are No Longer Known (1.0 Mev for Hf^{177}, 1.5 Mev for Hf^{178}. Hf^{179} was given same level structure as Hf^{177}, while Hf^{174}, Hf^{176}, and Hf^{180} were taken to be the same as Hf^{178}.)

Optical model plus Hauser-Feshbach calculations[2] gave total, shape elastic, compound elastic, and (compound) inelastic. The sum of the latter two was reduced by the amount of the (n,γ) cross section, keeping their ratio unchanged, since the ABACUS-2 program does not include gamma-ray competition in its Hauser-Feshbach calculation. The resultant elastic cross section (shape plus reduced compound) was then multiplied point-by-point by the ratio of the experimental total cross section to the optical-model total cross section, thus normalizing in an approximate way to the experimental data.

From Point Where Hauser-Feshbach Calculations Stopped, to 2 Mev: Compound elastic cross section extrapolated smoothly to zero. Total elastic then obtained with same procedure as in preceding energy range.

2 to 15 Mev: Shape elastic, normalized to total cross section as in previous two energy ranges.

(n,p) Cross Section

The measured W^{186} (n,p) cross section was used to give the shape of the cross section. It was shifted in energy to allow for the differences in Q-values and shifted in height to pass through calculated 14-Mev values obtained from Reference 3 (Gardner).

Inelastic Cross Section, $\sigma(nn')$

Threshold to 1.0 Mev for the Odd, 1.5 Mev for the Even, Isotopes: (See Elastic Scattering description, p. 2).

Hauser-Feshbach calculations used for individual levels.

From Top of Hauser-Feshbach Region to 15 Mev: The optical-model reaction cross section was "normalized" to the experimental total by the ratio: experimental total/optical total. From the cross section were subtracted (n,p) and (n,γ) to give (n,n') + (n,2n). The Hauser-Feshbach level excitation cross sections were extrapolated to 15 Mev to represent direct inelastic. These were then subtracted from (n,n') + (n,2n) to give (n,2n) + compound inelastic. The latter two were split up using Pearlstein's method[4] for (n,2n) cross sections.

(n,2n) Cross Section

As described in Inelastic Cross Section, above.

Legendre Moments of the Elastic Scattering Cross Section

Optical model plus Hauser-Feshbach calculations gave shape plus compound-elastic moments at all energies.

Resonance Parameters

The resonance parameters used are given in Table 2, p. 5. Table 8, p. 38 and Figures 2 through 8, p. 23 through p. 35 show the smooth background to which the resonance cross sections must be added. The single-level Breit-Wigner formalism was employed (see Equations 1 and 2, p. 10.

RESONANCE INTEGRALS

The most recent determination of hafnium resonance parameters is that of Fuketa, Russell, and Hockenbury[5,6] who made measurements for all six stable isotopes and observed over 200 resonances below 1200 ev. Since the resonances below 1200 ev make up most of the resonance integrals, these resonance parameters can be used to compute (approximate) resonance integrals for the different isotopes and natural hafnium. These resonance integrals are shown in Table 1 along with the values obtained after a contribution has been added to represent the unresolved resonances and the smooth background [formulas given in section on (n,γ) Cross Section, p. 7]. Resonance integrals have been measured by Scoville, Fast, and Rogers[7] for natural hafnium and the separated isotopes; these, also, are shown in Table 1. Another recent resonance integral measurement by Vidal,[8] is shown in the last column of Table 1. As can be seen in Table 2, the measured isotopic integrals differ appreciably from those

TABLE 1. ISOTOPIC AND NATURAL HAFNIUM RESONANCE INTEGRALS

Hafnium Isotope	Resonance Integrals, barns: Calculated: From Fuketa Resonances[5,6]	Calculated: From Fuketa Resonances*	Measured: Scoville, Fast, and Rogers[7]: Isotopic	Measured: Scoville, Fast, and Rogers[7]: Natural Hafnium	Measured: Vidal[8]: Natural Hafnium
Hf^{174}	268.7	453.2			
Hf^{176}	329.0	339.3	400 ± 20		
Hf^{177}	7131.0	7192.3	8685 ± 760		
Hf^{178}	1876.2	1882.8	1330 ± 40		
Hf^{179}	450.9	497.0	640 ± 20		
Hf^{180}	30.0	35.8	11 ± 6		
Natural hafnium	1918.6**	1941.2**	2080 ± 157**	2320 ± 150	2125 ± 50

*Plus addition to represent unresolved resonances and smooth background.

**Calculated from isotopic values using abundances 0.0018, 0.052, 0.185, 0.2714, 0.1375, 0.3523 for Hf^{174}, Hf^{176}, Hf^{177}, Hf^{178}, Hf^{179}, and Hf^{180}, respectively.

calculated from Fuketa's resonance parameters (e.g., 8685 and 7192 barns for Hf^{177}). It is unlikely that missed resonances or errors in the measured resonance energies and widths are large enough to account for the large differences; adverse experimental conditions (such as an undetected crack in the target) can produce systematic errors in the measurements of Γ_n large enough to account for these differences. Previous independent measurements[9] of the isotopic Γ_n's, however, are not systematically different from Fuketa's, and they, also, predict a resonance integral in natural hafnium of <2000 barns. The values of Γ_γ were measured for only three resonances (all in Hf^{177}); except for Hf^{178}, however, the isotopic resonance integrals are not very sensitive to the Γ_γ's. This is because the largest resonances have Γ_n's that are small compared with their corresponding Γ_γ's (which are not expected to differ much from the average value of 60 mv for the three measured Γ_γ's). In the case of Hf^{178}, almost all of the integral (1860 barns) is due to the resonance at 7.78 ev, which has a measured Γ_n of 51 mv. With this Γ_n, a value of Γ_γ = 32 mv is required to yield a resonance integral consistent with the measured integral of 1330 barns; and it is unlikely that Γ_γ differs this much from the average value of 60 mv which was used.

TABLE II. HAFNIUM RESONANCE PARAMETERS (ENERGIES IN EV, WIDTHS IN MV)

HF-174 RESONANCES

EO	GAMN	GAMG	G
4.250	.017	60.0	1.0000
13.380	4.800	60.0	1.0000
29.940	32.000	60.0	1.0000
70.500	12.000	60.0	1.0000
77.900	65.000	60.0	1.0000
107.100	122.000	60.0	1.0000
124.600	50.000	60.0	1.0000
147.600	120.000	60.0	1.0000
153.500	85.000	60.0	1.0000
211.000	180.000	60.0	1.0000

HF-176 RESONANCES

EO	GAMN	GAMG	G
7.800	3.400	60.0	1.0000
48.300	125.000	60.0	1.0000
53.200	2.000	60.0	1.0000
67.100	20.000	60.0	1.0000
123.800	48.000	60.0	1.0000
177.000	50.000	60.0	1.0000
201.000	37.000	60.0	1.0000
243.300	22.000	60.0	1.0000
255.000	95.000	60.0	1.0000
286.700	285.000	60.0	1.0000
304.500	21.000	60.0	1.0000
347.200	173.000	60.0	1.0000
435.100	167.000	60.0	1.0000
444.300	173.000	60.0	1.0000
577.000	335.000	60.0	1.0000
626.000	640.000	60.0	1.0000
656.000	269.000	60.0	1.0000
870.000	280.000	60.0	1.0000
921.000	146.000	60.0	1.0000
956.000	300.000	60.0	1.0000
994.000	270.000	60.0	1.0000
1068.000	250.000	60.0	1.0000

HF-177 RESONANCES

EO	GAMN	GAMG	G
1.099	2.240	67.0	.4375
2.385	8.044	60.0	.5625
5.890	5.829	60.0	.4375
6.570	8.444	44.0	.5625
8.870	5.956	60.0	.5625
10.940	.503	60.0	.4375
13.650	.533	60.0	.5625
13.940	3.429	60.0	.4375
22.040	2.933	60.0	.5625
23.470	1.500	60.0	.5000
25.680	.410	60.0	.5000
26.950	2.600	60.0	.5000
32.700	1.300	60.0	.5000
36.250	5.000	60.0	.5000

36.900	7.000	60.0	.5000
42.900	4.700	60.0	.5000
45.200	3.800	60.0	.5000
46.300	7.300	60.0	.5000
48.900	35.000	60.0	.5000
49.600	7.000	60.0	.5000
54.800	19.500	60.0	.5000
56.500	14.500	60.0	.5000
57.200	3.000	60.0	.5000
59.400	3.500	60.0	.5000
62.300	4.000	60.0	.5000
63.600	78.000	60.0	.5000
66.800	43.000	60.0	.5000
71.600	18.000	60.0	.5000
76.100	18.000	60.0	.5000
84.900	40.000	60.0	.5000
88.600	3.800	60.0	.5000
93.200	5.000	60.0	.5000
97.300	20.000	60.0	.5000
103.300	55.000	60.0	.5000
111.500	4.500	60.0	.5000
115.200	3.600	60.0	.5000
123.100	14.000	60.0	.5000
132.100	55.000	60.0	.5000
136.900	12.000	60.0	.5000
140.100	12.000	60.0	.5000
142.800	35.000	60.0	.5000
146.700	12.000	60.0	.5000
149.200	10.000	60.0	.5000
163.400	45.000	60.0	.5000
170.900	24.000	60.0	.5000
176.500	160.000	60.0	.5000
199.300	25.000	60.0	.5000
201.700	13.000	60.0	.5000
208.800	52.000	60.0	.5000
219.600	11.000	60.0	.5000
224.800	153.000	60.0	.5000
238.700	30.000	60.0	.5000
241.000	20.000	60.0	.5000
249.100	24.000	60.0	.5000
258.200	4.000	60.0	.5000
264.700	81.000	60.0	.5000
267.900	38.000	60.0	.5000
272.700	70.000	60.0	.5000
285.000	170.000	60.0	.5000
298.900	55.000	60.0	.5000
307.200	107.000	60.0	.5000
320.300	24.000	60.0	.5000
323.800	80.000	60.0	.5000
327.600	90.000	60.0	.5000
330.700	137.000	60.0	.5000
333.700	13.000	60.0	.5000
342.500	40.000	60.0	.5000
348.900	70.000	60.0	.5000
357.700	40.000	60.0	.5000
362.900	17.000	60.0	.5000
368.000	60.000	60.0	.5000
389.900	28.000	60.0	.5000

406.800	50.000	60.0	.5000
415.200	95.000	60.0	.5000
426.300	100.000	60.0	.5000
433.700	100.000	60.0	.5000
436.200	100.000	60.0	.5000
444.400	37.000	60.0	.5000
447.000	60.000	60.0	.5000
457.900	146.000	60.0	.5000
471.500	66.000	60.0	.5000
475.500	95.000	60.0	.5000
479.800	105.000	60.0	.5000
489.200	129.000	60.0	.5000
500.200	80.000	60.0	.5000
507.600	55.000	60.0	.5000
512.900	50.000	60.0	.5000
525.800	110.000	60.0	.5000
549.400	96.000	60.0	.5000
578.000	120.000	60.0	.5000
613.000	102.000	60.0	.5000
629.000	114.000	60.0	.5000
647.000	101.000	60.0	.5000
686.000	100.000	60.0	.5000
696.000	73.000	60.0	.5000
714.000	118.000	60.0	.5000
727.000	100.000	60.0	.5000
809.000	350.000	60.0	.5000
844.000	80.000	60.0	.5000
887.000	177.000	60.0	.5000
895.000	329.000	60.0	.5000
928.000	162.000	60.0	.5000
1019.000	250.000	60.0	.5000

HF-178 RESONANCES

EO	GAMN	GAMG	G
7.780	51.000	60.0	1.0000
104.400	9.000	60.0	1.0000
164.400	14.000	60.0	1.0000
255.900	280.000	60.0	1.0000
275.700	260.000	60.0	1.0000
353.100	8.000	60.0	1.0000
383.500	420.000	60.0	1.0000
447.700	132.000	60.0	1.0000
504.300	50.000	60.0	1.0000
528.700	151.000	60.0	1.0000
580.100	414.000	60.0	1.0000
723.000	1050.000	60.0	1.0000
785.000	870.000	60.0	1.0000
866.000	155.000	60.0	1.0000
889.000	27.000	60.0	1.0000
1096.000	670.000	60.0	1.0000
1163.000	1280.000	60.0	1.0000

HF-179 RESONANCES

EO	GAMN	GAMG	G
5.680	4.200	60.0	.5000
17.620	2.150	60.0	.5000
19.050	.120	60.0	.5000
23.550	8.300	60.0	.5000

26.440	1.000	60.0	.5000
27.230	.430	60.0	.5000
31.020	7.500	60.0	.5000
36.300	30.000	60.0	.5000
40.000	25.000	60.0	.5000
42.100	13.000	60.0	.5000
50.900	2.200	60.0	.5000
54.800	5.300	60.0	.5000
69.000	10.000	60.0	.5000
73.800	7.000	60.0	.5000
76.600	3.000	60.0	.5000
83.100	6.000	60.0	.5000
85.200	8.000	60.0	.5000
92.400	50.000	60.0	.5000
101.300	130.000	60.0	.5000
103.800	10.000	60.0	.5000
107.700	13.000	60.0	.5000
117.000	39.000	60.0	.5000
122.100	29.000	60.0	.5000
129.600	12.000	60.0	.5000
137.300	50.000	60.0	.5000
144.400	30.000	60.0	.5000
147.100	9.000	60.0	.5000
156.000	50.000	60.0	.5000
166.400	20.000	60.0	.5000
173.500	160.000	60.0	.5000
178.800	28.000	60.0	.5000
185.900	20.000	60.0	.5000
187.400	20.000	60.0	.5000
203.100	90.000	60.0	.5000
206.500	134.000	60.0	.5000
213.800	62.000	60.0	.5000
225.200	245.000	60.0	.5000
228.600	67.000	60.0	.5000
242.400	67.000	60.0	.5000
246.200	46.000	60.0	.5000
254.200	61.000	60.0	.5000
263.900	9.000	60.0	.5000
276.700	50.000	60.0	.5000
301.700	35.000	60.0	.5000
323.900	8.000	60.0	.5000
328.600	34.000	60.0	.5000
339.600	60.000	60.0	.5000
347.700	65.000	60.0	.5000
366.000	70.000	60.0	.5000
383.700	345.000	60.0	.5000
391.500	100.000	60.0	.5000
425.500	60.000	60.0	.5000
431.500	185.000	60.0	.5000
462.800	210.000	60.0	.5000
491.000	75.000	60.0	.5000
514.000	30.000	60.0	.5000
531.500	140.000	60.0	.5000
545.500	260.000	60.0	.5000
570.500	133.000	60.0	.5000
583.000	292.000	60.0	.5000
587.000	110.000	60.0	.5000
630.000	185.000	60.0	.5000

652.000	210.000	60.0	.5000
658.000	242.000	60.0	.5000
689.000	270.000	60.0	.5000
733.000	80.000	60.0	.5000
751.000	78.000	60.0	.5000
848.000	125.000	60.0	.5000
893.000	150.000	60.0	.5000
900.000	100.000	60.0	.5000
927.000	170.000	60.0	.5000
971.000	634.000	60.0	.5000
1010.000	220.000	60.0	.5000
1050.000	150.000	60.0	.5000

HF-180 RESONANCES

EO	GAMN	GAMG	G
72.500	55.000	60.0	1.0000
171.900	119.000	60.0	1.0000
448.700	208.000	60.0	1.0000
477.000	107.000	60.0	1.0000
587.000	77.000	60.0	1.0000
914.000	85.000	60.0	1.0000

Both Scoville's and Vidal's resonance integrals for natural hafnium are larger (by more than 180 barns) than the value obtained from Fuketa's parameters. It is therefore tempting to use Scoville's isotopic values as a guide, and thus, to increase the measured Γ_n's (or Γ_γ's) for some of the isotopes. However, the discrepancy between Scoville's isotopic and natural-element measurements indicates that the resonance integrals are difficult to measure accurately; hence, it is not certain that the experimental values are better than the ones computed from Fuketa's parameters. Also, even if a decision were made to increase the calculated resonance integral, it is not clear how or by what amount the isotopic values should be modified. It was therefore decided to use Fuketa's values unmodified and accept the resonance integrals computed from these resonances plus the contribution added for unresolved resonances and smooth background. The fact that these integrals differ so much from the measured integrals means that large uncertainties exist and that there is a strong need for more measurements of both differential and resonance-integral data.

(n,γ) CROSS SECTIONS

The resonance parameters measured by Fuketa, Russell, and Hockenbury[5,6] are listed in Table 2. The partial width, Γ_γ, was measured for only three resonances. The average value of Γ_γ = 60 mv that is assigned to the other resonances is also the value used in analyzing the data for these resonances. The parameters for the 7.8 ev resonance in Hf^{176} were given to us in a private communication from Fuketa. They were not given in the published Fuketa references (5 and 6) because Hf^{178} has a very large resonance at 7.78 ev; hence, the Hf^{178} in the Hf^{176} sample had shielded the Hf^{176} cross section to such an extent that the existence of the Hf^{176} resonance was considered uncertain. Its existence was verified, however, by J. A. Harvey of Oak Ridge, who checked the original data for us. Inclusion of this resonance, as was done to obtain the calculated integral in Table 1, also brings the calculated resonance integral much closer to the measured integral value.

In Table 3, the contributions of the resonances to the (n,γ) cross sections at 0.0253 ev are compared with the measured values for each isotope. The experimental values actually represent weighted averages of several measurements[6] from Table 3A. In Table 3A, there are listed privately communicated cross sections for $Hf^{179}(n,\gamma)5.5h\ Hf^{180m}$ and for $Hf^{180}(n,\gamma)45d\ Hf^{181}$ measured recently by G. Scharff-Goldhaber and M. McKeown by activation techniques. These data came to our attention too late to be included in the analysis of low energy (n,γ) cross sections; if included, they would slightly increase the value of the $Hf^{180}(n,\gamma)45d\ Hf^{181}$ cross section at 0.0253 ev. The practical effect of such an increase would, however, be small.

TABLE 3. (n,γ) CROSS SECTIONS AT 0.0253 ev

Isotope	Experiment, barns	Calculated Resonance Contribution, barns
Hf^{174}	400 ± 50	4.468
Hf^{176}	15 ± 15	7.276
Hf^{177}	380 ± 30	373.25
Hf^{178}	80 ± 10	74.90
Hf^{179}	70 ± 15	9.288
Hf^{180}	10 ± 2	0.398
Natural hafnium	106.66 ± 11.90	91.183

For each isotope, the measured thermal (n,γ) cross section is larger than that calculated. The contribution of the unresolved resonances to the thermal cross section is small; therefore, this difference is attributed to negative energy resonances. These negative energy resonances are represented by a 1/v cross section with the coefficient chosen so that the value at 0.0253 ev is the difference between the measured and calculated (n,γ) cross sections. This 1/v term is continued up to the unresolved resonance region where it is small enough, compared with the rest of the smooth cross section, to be neglected. Since the negative energy resonances actually fall off faster than 1/v, this must be considered an upper limit to these resonances (provided the value at thermal energy is correct). An alternative to this procedure is to represent the negative energy resonances by one or two explicit resonances with suitably chosen energies and partial widths; in this case, however, one runs the risk of underestimating the cross section at higher energies. In any event, the effect on the resonance integral of the non-1/v character of this cross section is small, and it makes little difference which procedure is chosen. The overestimate is probably largest in Hf^{174}, which has the smallest abundance.

In addition to the explicit resonances and the 1/v cross sections, there are unresolved resonances which must be considered. These are treated by the use of a statistical model[1] which represents a distribution of s-wave resonances by an "equivalent" smoothly varying cross section. The Breit-Wigner forms for the (n,γ) and elastic scattering cross sections for a resonance at energy E_o with partial widths, Γ_n and Γ_γ, are given by Equations 1 and 2 on p. 10.

TABLE 3A. MEASUREMENTS OF AND RECOMMENDED VALUES FOR (n,γ) CROSS SECTIONS AT 0.0253 ev FOR HAFNIUM ISOTOPES[10]

(n,γ) Cross Sections	ORNL[a]	ANL	BNL-325[d]	New Measurements	Recommended Values
4.3×10^{15}y Hf^{174}(n,γ)70d Hf^{175}	525±500	~1000[b]	1500±1000	390±55[e]	400±50
Hf^{176}(n,γ) Hf^{177}	16±15		15±15		15±15
Hf^{177}(n,γ)	390±30	350±50[b]	380±30		380±30
Hf^{177}(n,γ)4.8s Hf^{178m}				1.4±0.6[f]	1.4±0.6
Hf^{177}(n,γ) Hf^{178}					380±30
Hf^{178}(n,γ)	76±11	90±20[b]	75±10		80±10
Hf^{178}(n,γ)19s Hf^{179m}				50±15[f]	50±15
Hf^{178}(n,γ) Hf^{179}					30±18
Hf^{179}(n,γ)	52±20	75±15[b]	65±15	73[g]	70±15
Hf^{179}(n,γ)5.5h Hf^{180m}				0.18±0.07[h]	0.18±0.07
				0.340±0.025[k]	
Hf^{179}(n,γ) Hf^{180}					70±15
5.5h Hf^{180m}(n,γ)45d Hf^{181}				(j)	100
Hf^{180}(n,γ)45d Hf^{181}	14±5	10±2[c]		12.6±0.7[k]	10±2
45d Hf^{181}(n,γ)9.2×10^{6}y Hf^{182}				40^{+40}_{-20}[i]	40^{+40}_{-20}

(a) Pomerance, H., Phys. Rev. 88. 1952. P. 412. Values increased by 5% for change in gold standard cross section from the 95 barns assumed at that time to the present 98.8 barns.

(b) Bollinger, L. M., et al. Phys. Rev. 92. 1953. P. 1527.

(c) Seren, L., et al. Phys. Rev. 72. 1947. P. 888.

(d) Hughes, D. J., and R. B. Schwartz. BNL-325, Sec. Ed. 1958.

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(f) Alexander, K. F., and H. F. Brinckmann. Nuc. Phys. 32. 1962. P. 482.

(g) Fuketa, T. From transmission data supplied in private communication. (RPI)

(h) Gvozdev, V. S., et al. Nuc. Phys. 6. 1958. P. 561.

(i) Wing, J., et al. Phys. Rev. 123. 1961. P. 1354.

(j) Petrov, Yu. V. Atomnaya Energiya 11. 1961. P. 250. Estimated by Petrov to be of order 10^{2}b-10^{4}b.

(k) Scharff-Goldhaber, G., and M. McKeown. Private communication listed by M. D. Goldberg et al. BNL-325, Second Ed., Supp. No. 2, Vol. IIC. 1966.

y = years, d = days, h = hours, m = minutes, s = seconds

$$\sigma_\gamma(E) = \frac{\pi}{k_o^2}\sqrt{\frac{E_o}{E}}\,\frac{g\Gamma_n\Gamma_\gamma}{(E - E_o)^2 + \frac{1}{4}(\Gamma_\gamma + \sqrt{E/E_o}\,\Gamma_n)^2}\,, \tag{1}$$

and

$$\sigma_n(E) = \frac{\pi}{k_o^2}\,\frac{g\Gamma_n^2}{(E - E_o)^2 + \frac{1}{4}(\Gamma_\gamma + \sqrt{E/E_o}\,\Gamma_n)^2}$$

$$+ \frac{4\pi Rg}{k}\,\frac{\Gamma_n(E - E_o)}{(E - E_o)^2 + \frac{1}{4}(\Gamma_\gamma + \sqrt{E/E_o}\,\Gamma_n)^2} + 4\pi R^2\,. \tag{2}$$

In these equations, k_o is the wave number for a neutron of energy, E_o, $4\pi R^2$ is the potential elastic scattering, and g is the statistical factor $(2J+1)/2(2I+1)$ where I and J are the spins of the target and compound nucleus, respectively. Γ_n is a constant, its energy dependence in the numerator being absorbed into the multiplicative factor. If the average spacing between resonances of spin J is denoted by $< D_J >$, the average cross sections may be written as follows:

$$< \sigma_\gamma(E) > = \frac{2\pi^2}{k^2}\sum_J \frac{1}{< D_J >}\,\frac{g_J < \Gamma_n^J >< \Gamma_\gamma^J >}{< \Gamma_n^J + \Gamma_\gamma^J >}\,R_\gamma^J(E)\,, \tag{3}$$

and

$$< \sigma_n(E) > = \frac{2\pi^2}{k^2}\sum_J \frac{1}{< D_J >}\,\frac{g_J < \Gamma_n^J >^2}{< \Gamma_n^J + \Gamma_\gamma^J >}\,R_n^J(E) + 4\pi R^2\,, \tag{4}$$

where $< >$ denotes an average over resonances and the factors R_γ^J and R_n^J are defined by Equations 5 and 6:

$$R_\gamma^J(E) = \frac{\left\langle \frac{\Gamma_n^J\Gamma_\gamma^J}{\Gamma_n^J + \Gamma_\gamma^J} \right\rangle}{\frac{< \Gamma_n^J >< \Gamma_\gamma^J >}{< \Gamma_n^J + \Gamma_\gamma^J >}}\,, \tag{5}$$

and

$$R_n^J(E) = \frac{\left\langle \frac{\Gamma_n^J\Gamma_n^J}{\Gamma_n^J + \Gamma_\gamma^J} \right\rangle}{\frac{< \Gamma_n^J >< \Gamma_n^J >}{< \Gamma_n^J + \Gamma_\gamma^J >}} = 1 + \frac{< \Gamma_\gamma^J >}{< \Gamma_n^J >}\,[1 - R_\gamma^J(E)]\,. \tag{6}$$

In terms of the distribution functions, $P_\gamma^J(\Gamma_\gamma^J)$ and $P_n^J(\Gamma_n^J)$, of the radiative capture and elastic scattering widths, R_γ^J is given explicitly by

$$R_\gamma^J(E) = \frac{<\Gamma_n^J> + <\Gamma_\gamma^J>}{<\Gamma_n^J><\Gamma_\gamma^J>} \int_0^\infty \int_0^\infty \frac{\Gamma_n^J \Gamma_\gamma^J}{\Gamma_n^J + \Gamma_\gamma^J} P_n^J(\Gamma_n^J) P_\gamma^J(\Gamma_\gamma^J) d\Gamma_n^J d\Gamma_\gamma^J \ . \qquad (7)$$

If it is assumed that Γ_γ^J is the same for all resonances and that the Γ_n^J's have a Porter-Thomas distribution, $R_\gamma^J(E)$ reduces to

$$R_\gamma^J(E) = \left(1 + \frac{<\Gamma_\gamma^J>}{<\Gamma_n^J>}\right)\left[1 - \sqrt{\frac{1}{2\pi}\frac{<\Gamma_\gamma^J>}{<\Gamma_n^J>}} \int_{-\infty}^{\infty} \frac{1}{1+t^2} \exp - \left(\frac{<\Gamma_\gamma^J>}{<\Gamma_n^J>}\frac{t^2}{2}\right) dt \ \right], \qquad (8)$$

a function which has been calculated and given in the literature.[11]

According to the Fermi gas model, the $<D_J>$'s have a J-dependence given by

$$<D_J> = \frac{D_o}{2J+1} e^{J(J+1)/2\sigma^2} \ . \qquad (9)$$

The constant σ is taken to be 4 (see Reference 12) and D_o is determined from the average spacing between all observed resonances, D_{obs}, by the equation

$$\frac{1}{D_{obs}} = \frac{1}{D_o} \sum_J (2J+1) e^{-J(J+1)/2\sigma^2} \ . \qquad (10)$$

In the kev region, the p-wave resonance capture becomes significant compared with the s-wave resonance capture and therefore must be considered. For simplicity, it is assumed that $\Gamma_{n,\ell=1}^J \ll \Gamma_{\gamma,\ell=1}^J$, an approximation that should be good in the energy region (up to 34 kev) in which the statistical formulas are used. The average p-wave capture cross section may then be written as follows:

$$<\sigma_{\gamma,\ell=1}(E)> = \frac{2\pi^2}{k^2} \sum_J \frac{1}{<D_{J,\ell=1}>} \frac{g_J <\Gamma_{n,\ell=1}^J><\Gamma_{\gamma,\ell=1}^J>}{<\Gamma_{n,\ell=1}^J + \Gamma_{\gamma,\ell=1}^J>} R_{\gamma,\ell=1}^J(E) \ ,$$

$$\lesssim \frac{2\pi^2}{k^2} \sum_J \frac{g_J <\Gamma_{n,\ell=1}^J>}{<D_{J,\ell=1}>} \ ,$$

$$\simeq \frac{6\pi^2}{k^2} \frac{<\Gamma_{n,\ell=1}>}{<D_{\ell=1}>}$$

(equation continued on p. 12)

$$= \frac{6\pi^2}{k^2} \frac{\sqrt{E}\,(kR)^2}{1 + (kR)^2} S^1 \ , \qquad (11)$$

where S^1 is the p-wave strength function.

The average values of $\Gamma_n^0 = \Gamma_n/\sqrt{E_0}$ and the average spacings, D_{obs}, used for the hafnium isotopes (listed in Table 4) were obtained from an analysis of all of Fuketa's resonance parameters. The p-wave strength function for natural hafnium has been measured[13] to be $S^1 = (0.50 \pm 0.25) \times 10^{-4}$. It was found that, with use of the lower limit of this range $S^1 = 0.25 \times 10^{-4}$, the calculated statistical (n,γ) cross sections for both Hf^{180} and natural hafnium agreed with the experimental value at 34 kev; therefore, this value was used for all isotopes.

To estimate the effect of resonances missed in the energy region where the measurements were made, the energy range between 101 and 1234 ev was divided into six energy groups with the group boundaries as shown in Table 5. In each group, the resonance integrals of the radiative capture,

TABLE 4. AVERAGE VALUES OF Γ_n^o AND D_{obs}

Isotope	$\langle \Gamma_n^o \rangle$, mv	D_{obs}, ev
Hf^{174}	4.48	16
Hf^{176}	6.4	32
Hf^{177}	1.32	2.2
Hf^{178}	10.8	45
Hf^{179}	1.76	4.2
Hf^{180}	6.3	90

TABLE 5. BOUNDARIES OF GROUPS USED BELOW 1234 ev

Group	Lower Energy, ev	Upper Energy, ev
1	101.3	130.1
2	130.1	167
3	167	275.4
4	275.4	454
5	454	748.5
6	748.5	1234

$I_\gamma^T(\bar{E},\underline{E}) = \int_{\underline{E}}^{\bar{E}} < \sigma_\gamma(E) > \frac{dE}{E}$, were computed using the statistical model and compared with the integrals obtained from the observed resonances, $I_\gamma^E(\bar{E},\underline{E})$. The differences were used to obtain smooth cross sections to represent the missed resonances. These smooth cross sections were taken to be constant in the group with values given by

$$\left[I_\gamma^T(\bar{E},\underline{E}) - I_\gamma^E(\bar{E},\underline{E})\right] \Big/ \int_{\underline{E}}^{\bar{E}} \frac{dE}{E} .$$

In Hf^{174} (for which resonances were measured up to only 211 ev) a smooth contribution had to be included in Groups 3 through 6. For the other even isotopes, the average spacing between resonances is nearly constant up to about 500 ev (indicating that few resonances were missed) and for Hf^{176} and Hf^{178}, smooth cross sections were added to Groups 5 and 6. For Hf^{180}, I_γ^T is less than I_γ^E in Group 5; and so only Group 6 has a smooth contribution. In Hf^{177}, the average spacing between resonances starts increasing at about 100 ev, thus indicating that resonances were missed above this point. Also, since I_γ^T is greater than I_γ^E for each of the six groups, a smooth contribution was added to all six. In Hf^{179}, I_γ^E is greater than than I_γ^T in Groups 1, 2, and 3; therefore, a smooth background was included in Groups 4, 5, and 6, only.

Between 1234 ev and 34 kev, the (n,γ) cross sections are based entirely on the statistical formulas. Between 1234 and 8000 ev, this cross section for natural hafnium is 10 to 15% lower than data measured by Block, et al.[14,15] The normalization of the data from that experiment however, is uncertain by 20 to 25%. At 34 kev, the calculated cross sections for both Hf^{180} and natural hafnium agree with experiment.[16,17] The data points for Hf^{180} extend between 34 kev and 4 Mev, and the evaluated cross section was obtained from a smooth curve fit to them. Between 4 and 15 Mev, this curve was extended as a straight line on a log-log plot. Experimental data[15,17,18] indicate that different elements that do not differ much in mass often have (n,γ) cross sections that are nearly parallel on a log-log plot. Therefore, the (n,γ) cross sections for the other hafnium isotopes, for which no data exist above 34 kev, were taken to have the same shape as the Hf^{180} cross section, normalized to have the calculated values at 34 kev. The resulting natural hafnium cross section agrees with a measured value[16] at 65 kev.

TOTAL CROSS SECTIONS

The potential elastic cross section used at low energies for all isotopes is the recently measured[13] value of 6.05 barns. Below 101.3 ev,

this value is added to the 1/v component of the (n,γ) cross section to obtain the smooth background to the total cross section. Between 101.3 and 1234 ev, additional terms representing the elastic scattering from unresolved resonances were added in those groups in which unresolved resonance contributions were added to the (n,γ) cross sections. These additional terms were taken to be $\left[I_n^T(E,\underline{E}) - I_n^E(\bar{E},\underline{E})\right] \int_{\underline{E}}^{\bar{E}} \frac{dE}{E}$ when this quantity was positive; otherwise, the terms were taken to be zero.

Between 1234 ev and 0.5 Mev, the total cross sections for the isotopes were calculated using the statistical model (Equations 3 and 4, p. 10). Between 0.5 and 2.4 Mev, these cross sections were extended by smooth curves drawn to join smoothly to total cross section data[19] for natural hafnium measured by D. G. Foster and D. W. Glasgow. The resulting cross section for natural hafnium between 0.5 and 2.4 Mev is in agreement with data[20] in this region. Between 2.4 and 15 Mev, a smooth curve fit to the detailed data of Reference 19 was used for all isotopes.

ELASTIC CROSS SECTIONS

Below the thresholds for inelastic scattering, the elastic cross sections are simply the resonance contributions plus the differences between the smooth total and (n,γ) cross sections already discussed. Above the thresholds (where data exist at only one energy)[21,22] an optical model calculation had to be made to obtain the fraction of the total cross section which is elastic scattering. Because of the scarcity of data, no data analyses have been made to determine optical parameters; hence, the parameters determined for nearby nuclei must be used. Since the excited-state spectra for the even hafnium isotopes (which are similar to each other) are quite different from those of the odd isotopes, and since the couplings between the ground state and excited states are different, two sets of optical parameters are preferred to represent the even and odd isotopes. Auerbach and Moore[23] have published optical parameters for Ta^{181} and W^{184} which provide simultaneous fits to the total cross sections, inelastic cross sections for exciting individual levels, and the differential elastic cross sections for these nuclei up to 1.5 Mev. The optical potential used has the form:

$$V(r) = -\frac{V_{RE}}{1 + \exp\left[(r-R)/a\right]} - iV_{Im} \exp\left[-(r-R)^2/b^2\right]$$

$$+ V_{SR}\left(\frac{\hbar}{\mu_\pi c}\right)^2 \frac{1}{ar}\frac{\exp\left[(r-R)/a\right]}{\left\{1 + \exp\left[(r-R)/a\right]\right\}^2}(\vec{\ell}\cdot\vec{s}) , \qquad (12)$$

where μ_π is the pion mass* and $\vec{l}$ and $\vec{s}$ are the orbital momentum and spin operators of the neutron. Their parameters for Ta^{181} (which were used for Hf^{177} and Hf^{179}) and W^{184} (which were used for Hf^{174}, Hf^{176}, Hf^{178}, and Hf^{180}) are shown in Table 6.

TABLE 6. OPTICAL PARAMETERS USED FOR THE HAFNIUM ISOTOPES

Optical Parameters	Odd Isotopes	Even Isotopes
V_{RE}, Mev	37.3	43.8
V_{IM}, Mev	12.1	13.2
V_{SR}, Mev	7.0	7.0
R, fm	$1.32A^{1/3}$	$1.31A^{1/3}$
a, fm	0.63	0.49
b, fm	1.0	1.0

With use of these parameters, the elastic (both direct and compound) and inelastic cross sections for each isotope were calculated from threshold to 15 Mev by means of ABACUS [24] program, and normalized by the ratio of the evaluated total cross section just discussed to the calculated total cross section. In these calculations, inelastic cross sections for exciting individual levels (which are included up to 1 Mev for the odd isotopes and up to 1.5 Mev for the even isotopes) were computed using Hauser-Feshbach theory.[2,25] In these energy ranges in which all inelastic levels are included, the inelastic and compound elastic cross sections are further reduced (without changing the ratios of the two) by subtracting out the (n,γ) cross section which is assumed to be a compound nucleus reaction. To take into account the effect of the unknown excited states above 1 Mev, the compound elastic cross sections in the odd isotopes between 1 and 2 Mev were reduced by a linear cutoff function which decreased from unity to zero in this range. Similarly, the compound elastic scattering in the even isotopes was cut off between 1.5 and 2 Mev. Above 2 Mev, the elastic cross section was assumed to be direct scattering only.

The elastic scattering Legendre moments in the center-of-mass system, f_l^{CM}, are defined in terms of the differential cross section by the following equation:

*The quantity $\left(\frac{\lambda\!\!\!^{-}}{\mu_\pi c}\right)^2$ is taken to be 2 square fermis.

$$\sigma_{e\ell}(\theta\phi) = \frac{\sigma_{e\ell}}{4\pi} \sum_{\ell=0}^{\infty} (2\ell + 1)\, f_{\ell}^{CM} P_{\ell}\ (\cos\theta) \text{ barns/steradian,} \qquad (13)$$

where $\sigma_{e\ell}$ is the integrated cross section. The contribution to the f_{ℓ}^{CM}'s of the compound elastic scattering was computed by ABACUS while the direct scattering contribution was obtained with OPTIC[26] program.

(n,p) CROSS SECTIONS

No data exist for this reaction in the hafnium isotopes. However, this reaction has been measured[27] for W^{186} and, since (n,p) cross sections for nearby nuclei often have similar shapes,[28] the shape for W^{186} was used for all the hafnium isotopes. To account for the differences in Q values in W^{186} and the hafnium isotopes (shown in Table 7) the curves were shifted by these amounts. The curves were then normalized to pass through theoretical[3] 14 Mev (n,p) cross sections.

TABLE 7. Q VALUES FOR (n,p) AND (n,2n) REACTIONS

Isotope	Q Values, Mev (n,p)*	(n,2n)**
Hf^{174}	0.71	-7.0
Hf^{176}	-0.24	-7.0
Hf^{177}	0.29	-6.4
Hf^{178}	-1.47	-7.76
Hf^{179}	-0.57	-6.09
Hf^{180}	-2.52	-7.73
W^{186}	-2.94	-

*See Reference 29.
**See Reference 30.

INELASTIC CROSS SECTIONS

The only inelastic scattering data known to us are from a measurement[31] of inelastic γ-rays for natural hafnium. Only the γ-rays with ~230 kev of energy were measured, however, and some of these were cascade γ-rays; therefore, the cross sections were calculated using the optical potentials used for the elastic scattering. Most excited levels in Hf^{178} are known[32,33] up to 1.5 Mev; these are shown with their spins and parities

in Figure 1. Not as many levels have been measured in the other even isotopes, but the known levels are very close to the corresponding levels in Hf^{178}; therefore, the Hf^{178} spectrum was used for these isotopes as well. Most excited states in Hf^{177} have been measured up to 1.0 Mev. The energies of the known levels in Hf^{179} are close to those of Hf^{177}, hence the Hf^{177} spectrum is used for Hf^{179} also.

The inelastic cross sections for the even isotopes calculated up to 1.5 Mev, using Hauser-Feshbach theory, then consist entirely of cross sections for exciting individual levels. These are normalized so that they add up to the total minus the elastic and (n,γ) cross sections already discussed in the section on Elastic Cross Section, p. 14. Similarly, the inelastic cross sections for Hf^{177} and Hf^{179} consist of individual level cross sections up to 1.0 Mev.

The cross sections for calculating these known levels in the even isotopes cannot be computed in this way above 1.5 Mev (or for the odd isotopes above 1.0 Mev) because of competition with unknown higher energy levels; they must therefore be extrapolated to higher energies. The cross section at 14 Mev for the odd isotopes is taken to have the value, 0.17 barns, measured[34] for Ta^{181}; the even isotopes are assumed to have the W^{184} value[35] of 0.56 barn. The statistical model used to compute (n,2n) cross sections (p. 19) predicts that the compound inelastic cross section at 14 Mev is small, and so these values of 0.17 and 0.56 Mev are assumed to correspond to direct inelastic scattering. Since most of the direct inelastic scattering is expected to correspond to low level excitations, it is assumed to be made up entirely of cross sections for exciting the known levels just mentioned. Therefore, the cross sections for exciting the levels in the odd isotopes are linearly extrapolated between 1.0 and 10 Mev (between 1.5 and 10 Mev for the even isotopes) so that, at 10 Mev, the cross sections add up to 0.17 barns for the odd and 0.56 for the even isotopes. Between 10 and 15 Mev they are taken to be constant.

The difference between the total and the elastic, (n,γ), (n,p), and inelastic level cross sections is the compound nucleus cross section for reactions involving only neutrons in the exit channels (the other charged-particle reaction cross sections are small).[36] The way in which this is divided up into the inelastic and (n,2n) reactions is shown in the next section, (n,2n) Cross Sections, p. 19. The neutrons that inelastically scatter through compound nucleus formation are assumed to have a Maxwellian distribution[37] of energies given by the equation:

$$\sigma_{max}(E \rightarrow E') = N(E)E'e^{-E'/T(E)} \quad . \qquad (14)$$

In Equation 14, E and E′ are the initial and final energies, N(E) is a

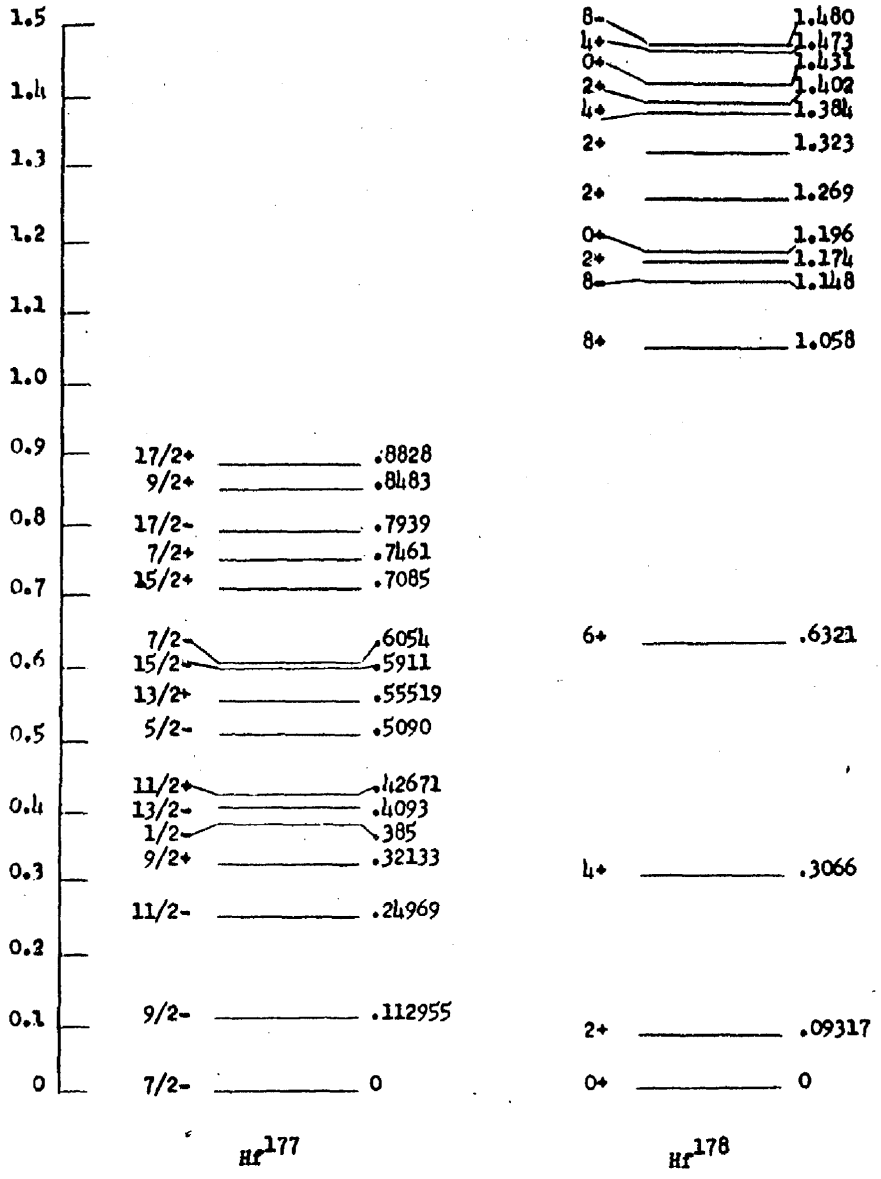

FIGURE 1. Energy Levels of the Hafnium Isotopes.
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normalization constant, and T(E) is the nuclear temperature with an energy dependence given by

$$T(E) = \sqrt{\frac{E}{a}} . \qquad (15)$$

Since the excited levels have already been accounted for up to 1.0 Mev for the odd (1.5 for the even) isotopes, the distribution is cut off at this energy so that these neutrons always scatter to levels above this energy.[38] The values of "a" in Equation 15 that were measured[39] for Ta (ε = 22.1 Mev^{-1}) and for W (a = 24.0 Mev^{-1}) were used for the odd and the even isotopes, respectively.

(n,2n) CROSS SECTIONS

In this section, a statistical model[4] is used to compute the ratio, $\sigma_{(n,2n)}(E)/\sigma_{n,M}(E)$, where $\sigma_{(n,2n)}$ is the (n,2n) cross section and $\sigma_{n,M}$ is the compound nucleus cross section for reactions involving only neutrons in the exit channel [(n,2n) plus inelastic]. The density of nuclear states $\omega(E^*)$ at energy E^* above the ground state of a nucleus is predicted by the Fermi gas model to be

$$\omega(E) \cong e^{\sqrt{4aE^*}} , \qquad (16)$$

where "a" is the same constant as given in Equation 15. If a neutron of energy E interacts to form a compound nucleus, the probability of disintegration into a particular channel can be shown from reciprocity[37] to be proportional to $E'\sigma_c(E')$ where E' is the energy of the emitted particle. Here $\sigma_c(E')$ is the cross section for compound nucleus formation by the interaction between the emitted particle and excited target. The energy distribution of neutrons emitted from the compound nucleus is then given by the equation:

$$I(E,E') = CE'\sigma_c(E')\, e^{\sqrt{4a(E-E')}} . \qquad (17)$$

The constant C determines the magnitude of the cross section which is the integral of Equation 17 over E' from 0 to E.

If the energy of the residual nucleus, $E-E'$, is greater than the binding energy, EB, of the least bound neutron it is possible for another neutron to be emitted. It is assumed that this multiple emission will occur whenever it is energetically possible. Calculations[4] based on this assumption have been in good agreement with (n,2n) data for many nuclei. The ratio, $\sigma_{n,2n}/\sigma_{n,M}$, is then written as follows:

$$\frac{\sigma_{n,2n}(E)}{\sigma_{n,M}(E)} = \frac{\int_0^{E-EB} CE'\sigma_c(E')e^{\sqrt{4a(E-E')}}\,dE'}{\int_0^{E} CE'\sigma_c(E')e^{\sqrt{4a(E-E')}}\,dE'} . \qquad (18)$$

The cross section $\sigma_c(E')$ is assumed to be constant; this reduces to

$$\frac{\sigma_{n,2n}(E)}{\sigma_{n,M}(E)} = 1 - \frac{e^{p^{1/2}}\left[\left(1-\frac{1}{s}\right)p^{3/2} - \left(3-\frac{1}{s}\right)p + 6p^{1/2} - 6\right] + 6 - \frac{p}{s}}{\exp\left[\left(\frac{p}{s}\right)^{1/2}\right]\left[-2\left(\frac{p}{s}\right) + 6\left(\frac{p}{s}\right)^{1/2} - 6\right] + 6 - \frac{p}{s}} , \qquad (19)$$

where $p = 4aEB$ and $s = EB/E$.

The Q value ($-EB$) for the (n,2n) reaction is given in Table 8 for each of the hafnium isotopes.[30] The cross section $\sigma_{n,M}(E)$ is the difference between the total and the elastic, (n,γ), (n,p), and the inelastic level data (see previous sections in this report). Equation 19 is then used to divide this value into the (n,2n) and compound inelastic cross sections.

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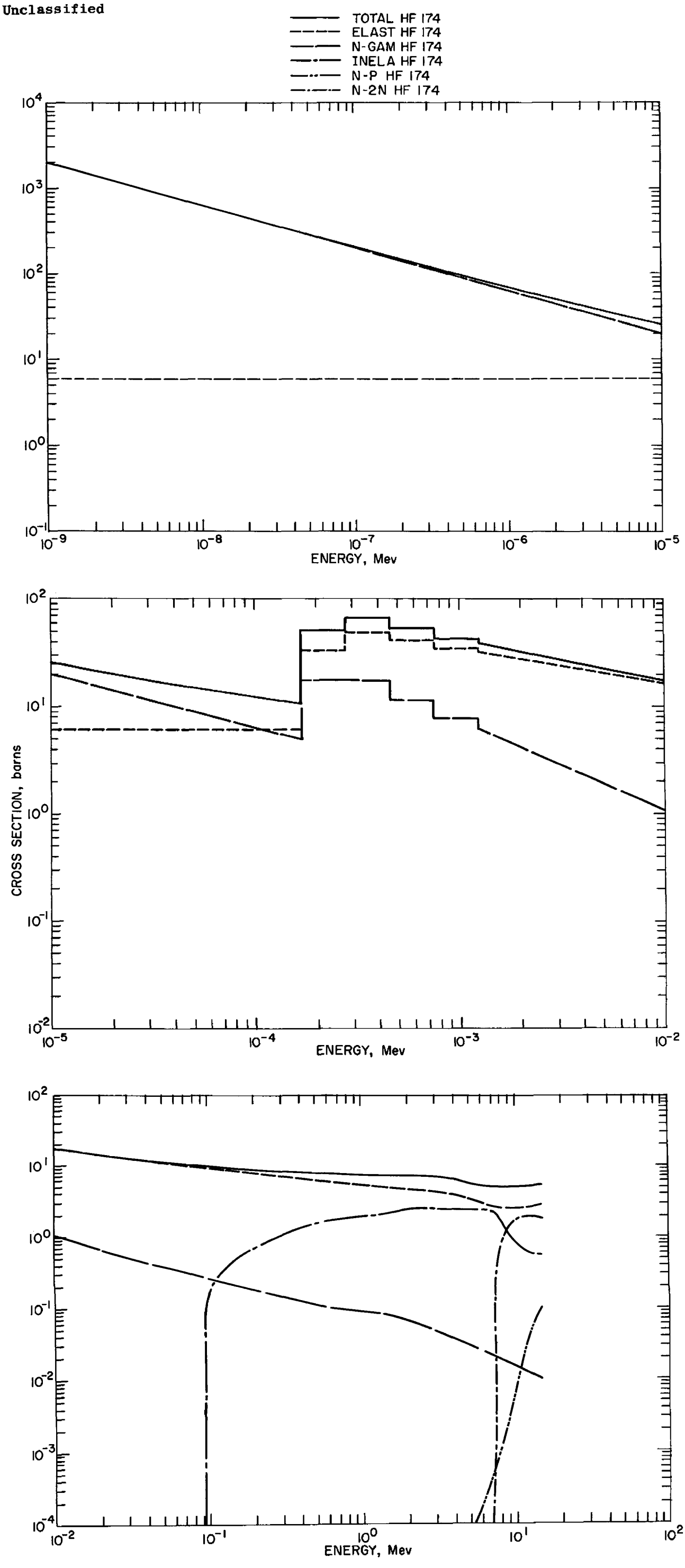
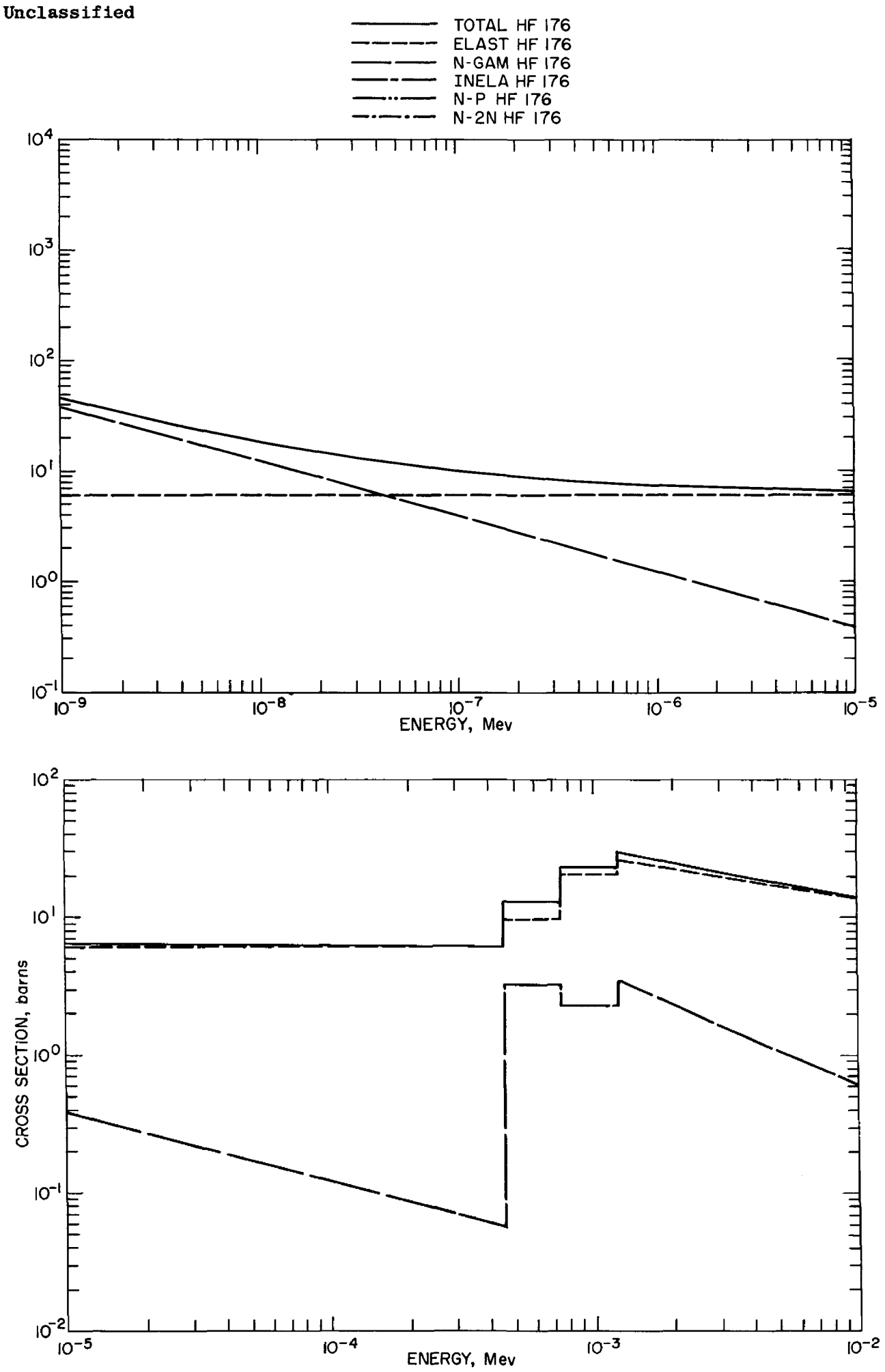


FIGURE 2. Plots of Smooth Hf^{174} Cross Sections.

KS-66526



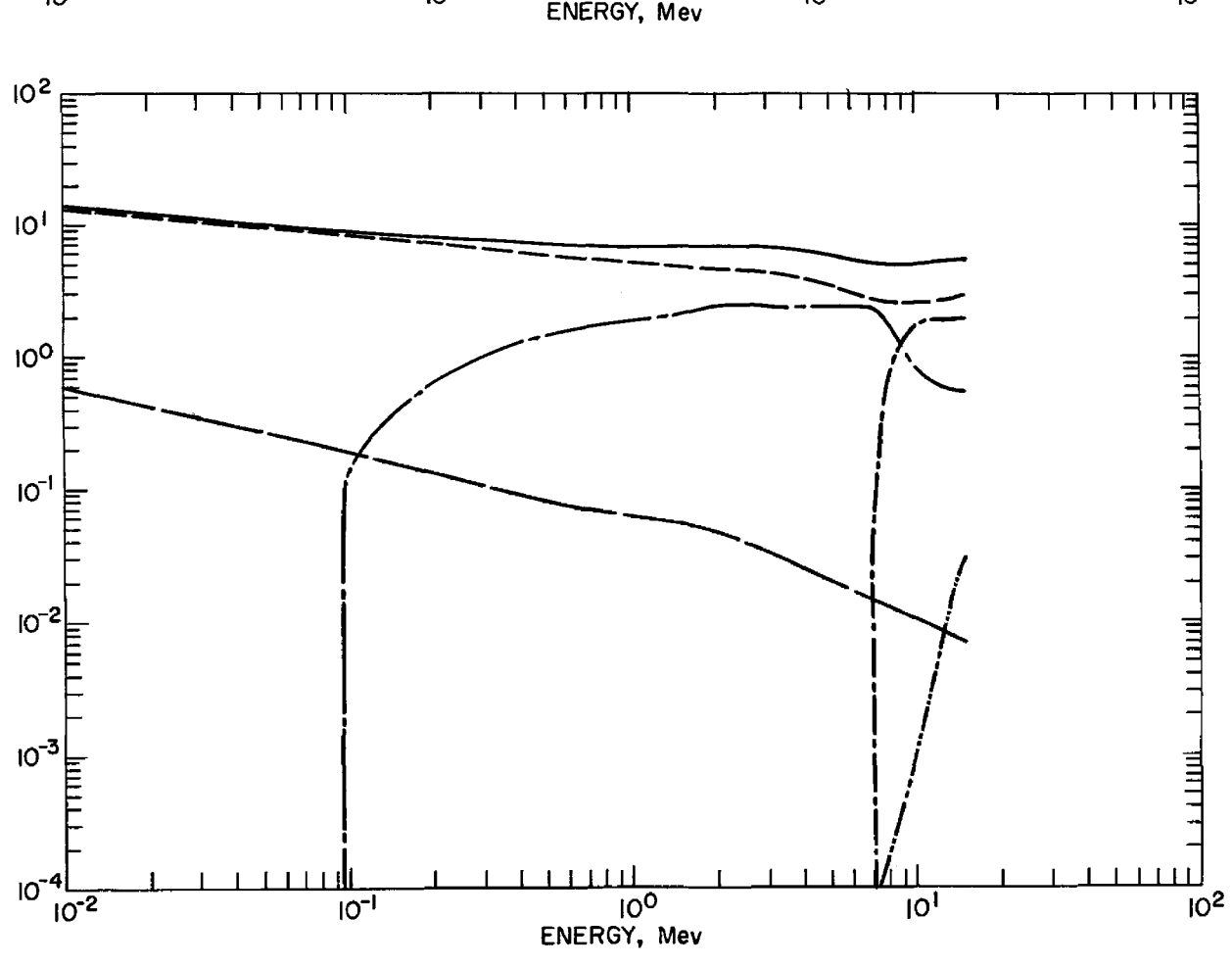


FIGURE 3. Plots of Smooth Hf^{176} Cross Sections.

KS-66527

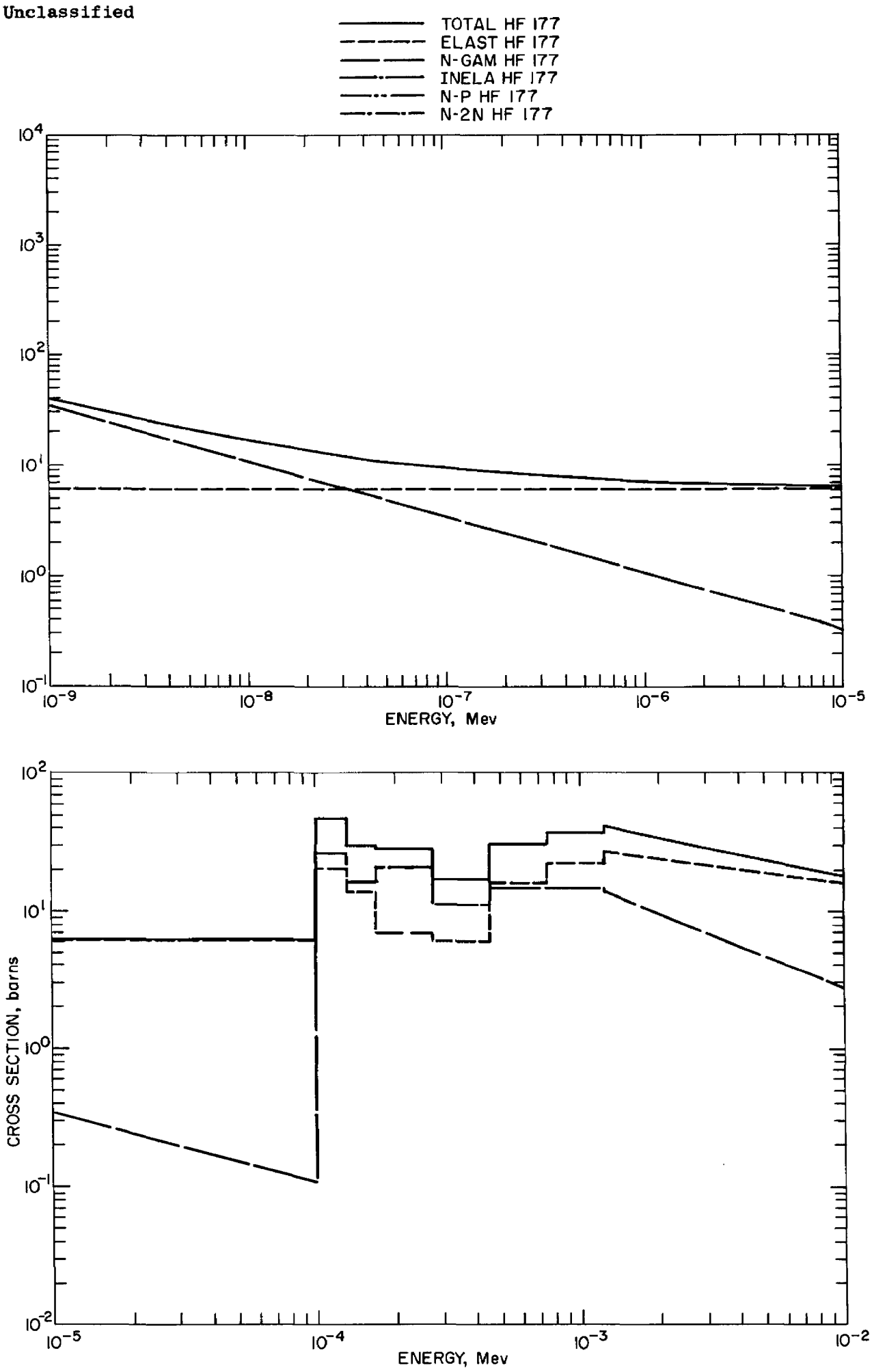


FIGURE 4. Plots of Smooth Hf^{177} Cross Sections.

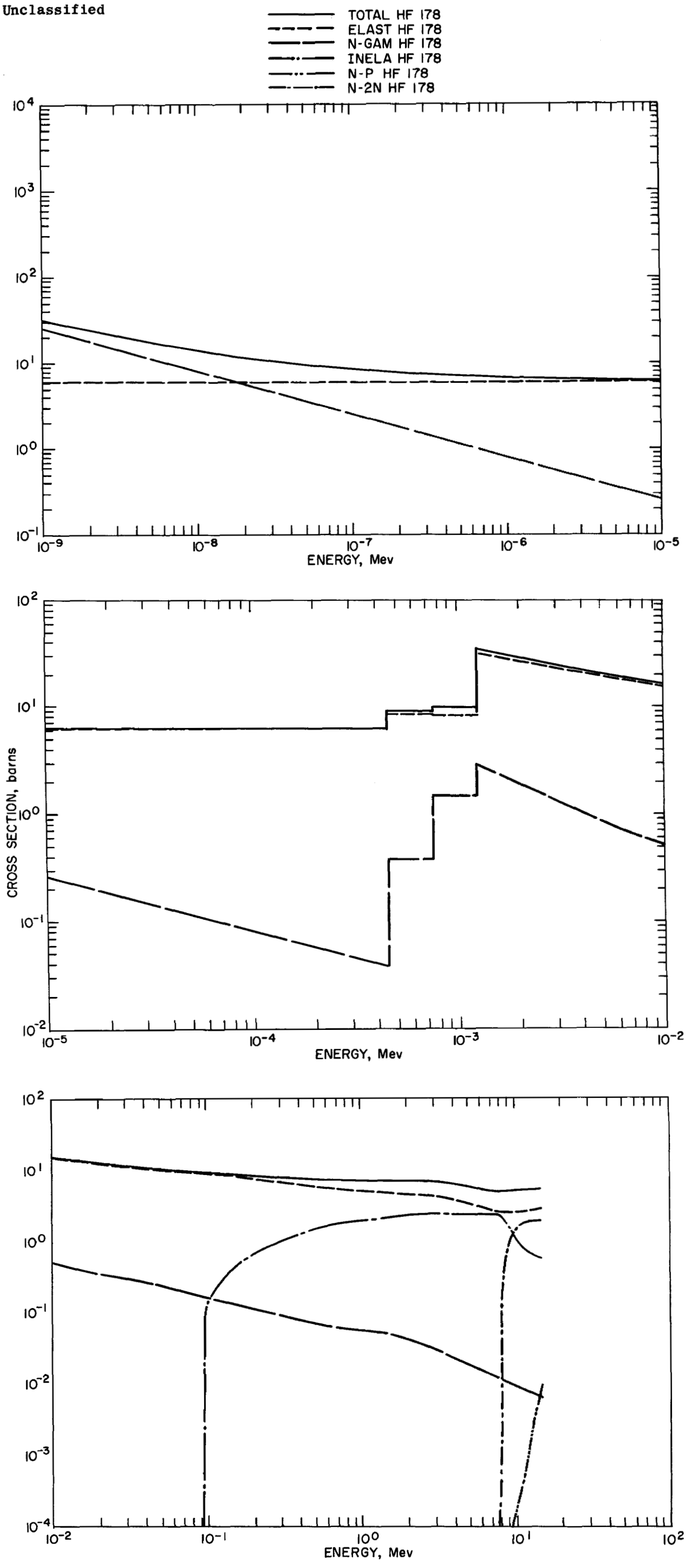


FIGURE 5. Plots of Smooth Hf^{178} Cross Sections.

KS-66529

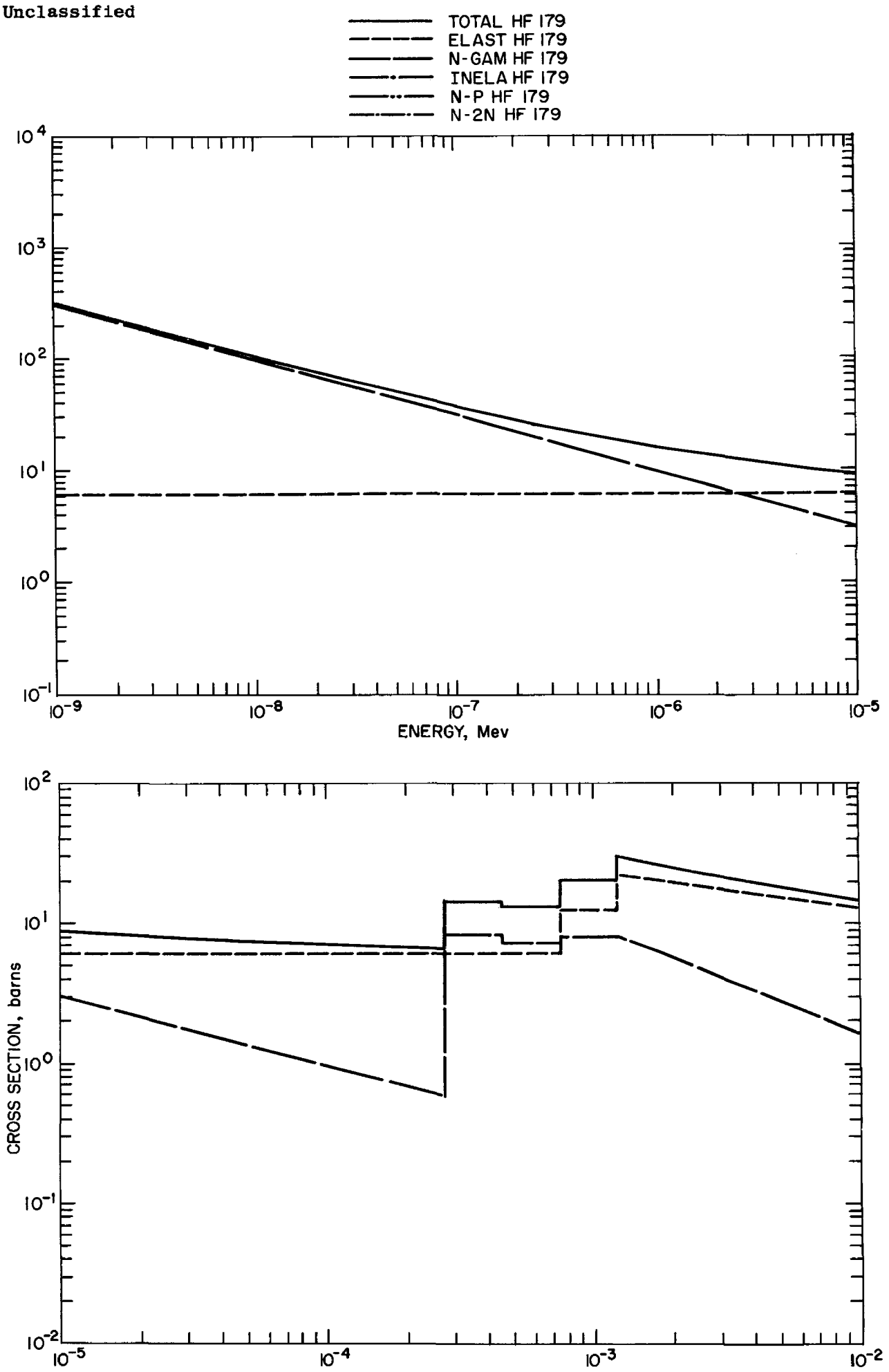


FIGURE 6. Plots of Smooth Hf^{179} Cross Sections.

KS-66530

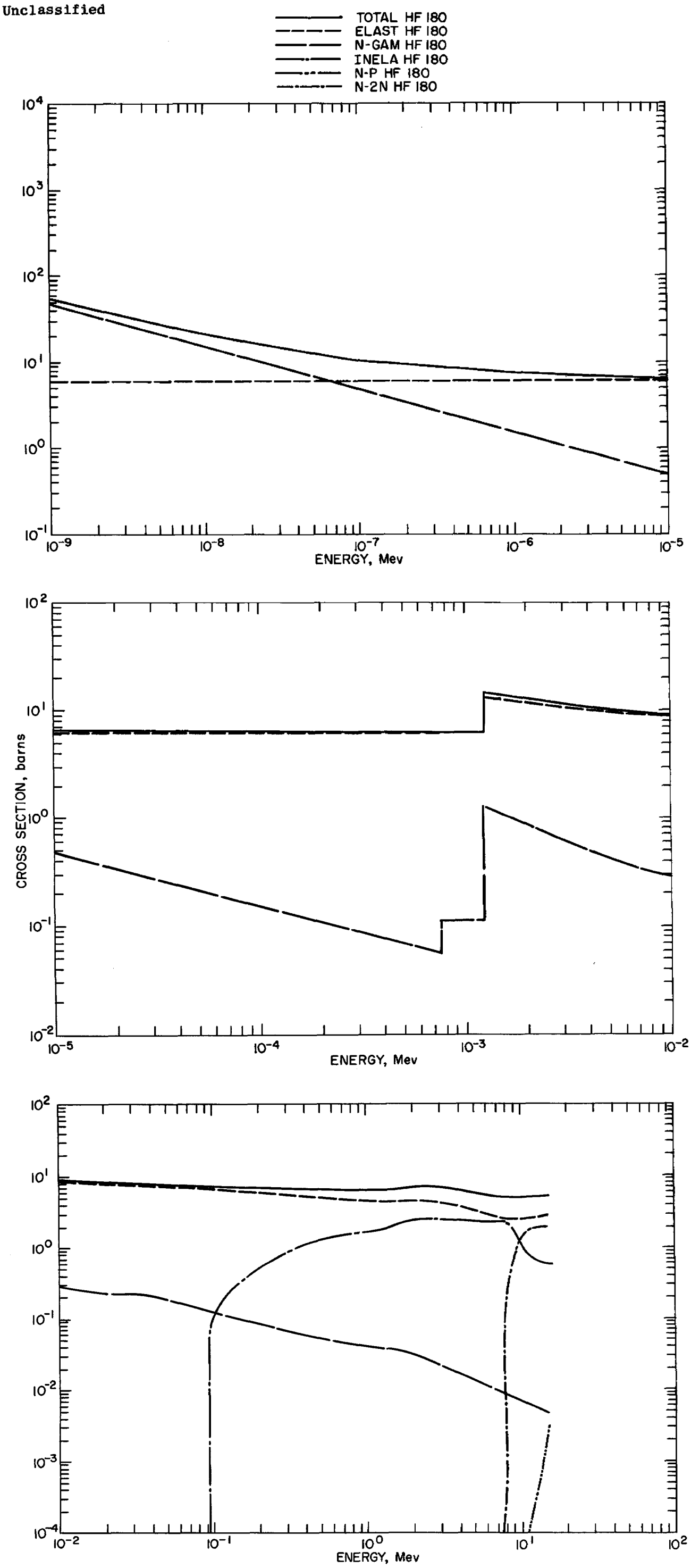


FIGURE 7. Plots of Smooth Hf^{180} Cross Sections.

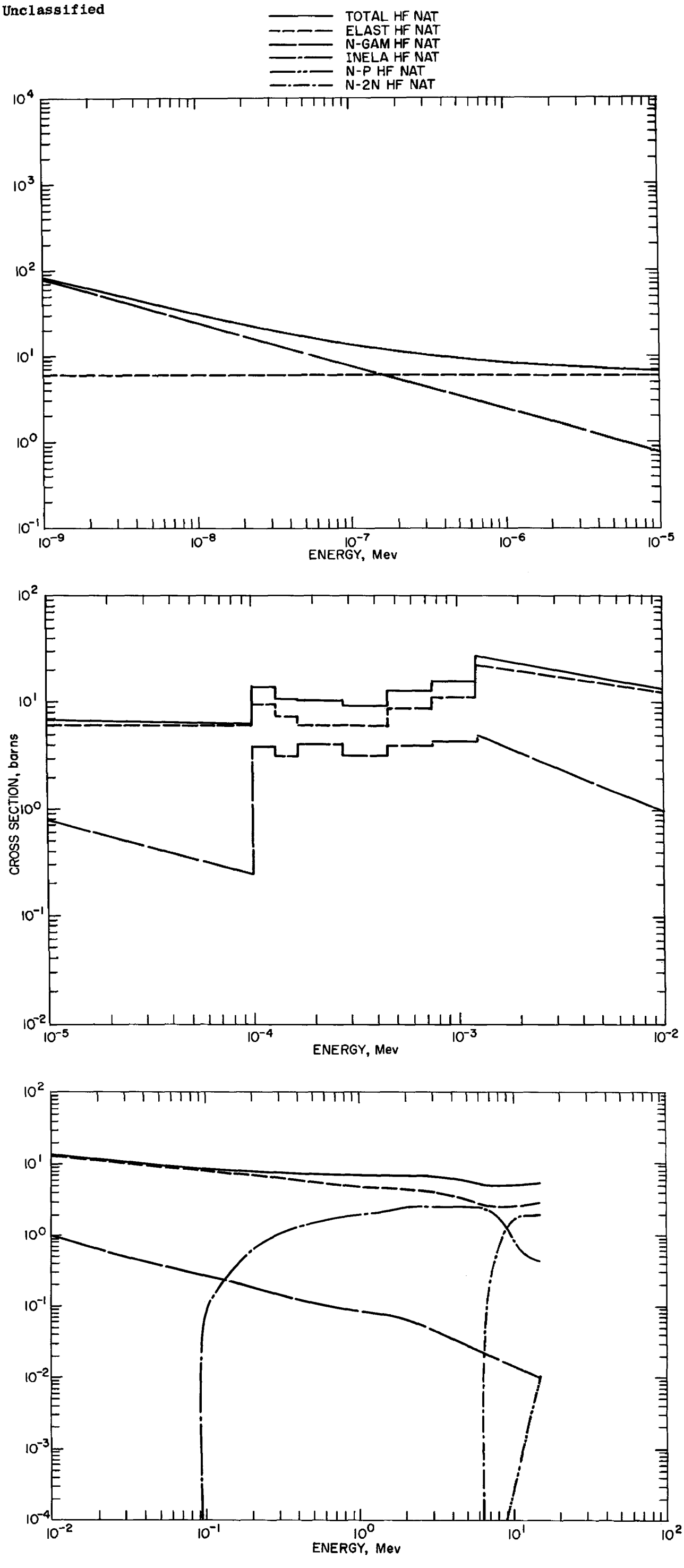


FIGURE 8. Plots of Smooth Natural Hafnium Cross Sections.
KS-66532

TABLE VIII. SMOOTH HAFNIUM CROSS SECTIONS

HF-174 CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N
1.000E-09	1995.5305	6.0500	1989.4805			
1.100E-09	1902.9452	6.0500	1896.8952			
1.200E-09	1822.1889	6.0500	1816.1389			
1.300E-09	1750.9398	6.0500	1744.8898			
1.400E-09	1687.4679	6.0500	1681.4179			
1.500E-09	1630.4540	6.0500	1624.4040			
1.600E-09	1578.8724	6.0500	1572.8224			
1.700E-09	1531.9119	6.0500	1525.8619			
1.800E-09	1488.9212	6.0500	1482.8712			
1.900E-09	1449.3708	6.0500	1443.3208			
2.000E-09	1412.8251	6.0500	1406.7751			
2.200E-09	1347.3574	6.0500	1341.3074			
2.400E-09	1290.2541	6.0500	1284.2041			
2.600E-09	1239.8734	6.0500	1233.8234			
2.800E-09	1194.9920	6.0500	1188.9420			
3.000E-09	1154.6771	6.0500	1148.6271			
3.200E-09	1118.2034	6.0500	1112.1534			
3.400E-09	1084.9973	6.0500	1078.9473			
3.700E-09	1040.3316	6.0500	1034.2816			
4.000E-09	1000.7902	6.0500	994.7402			
4.300E-09	965.4627	6.0500	959.4127			
4.600E-09	933.6500	6.0500	927.6000			
5.000E-09	895.7727	6.0500	889.7227			
5.500E-09	854.3673	6.0500	848.3173			
6.000E-09	818.2520	6.0500	812.2020			
6.500E-09	786.3884	6.0500	780.3384			
7.000E-09	758.0029	6.0500	751.9529			
7.500E-09	732.5055	6.0500	726.4555			
8.000E-09	709.4376	6.0500	703.3876			
8.500E-09	688.4362	6.0500	682.3862			
9.000E-09	669.2102	6.0500	663.1602			
9.500E-09	651.5227	6.0500	645.4727			
1.000E-08	635.1790	6.0500	629.1290			
1.100E-08	605.9009	6.0500	599.8509			
1.200E-08	580.3635	6.0500	574.3135			
1.300E-08	557.8326	6.0500	551.7826			
1.400E-08	537.7610	6.0500	531.7110			
1.500E-08	519.7316	6.0500	513.6816			
1.600E-08	503.4201	6.0500	497.3701			
1.700E-08	488.5699	6.0500	482.5199			
1.800E-08	474.9750	6.0500	468.9250			
1.900E-08	462.4681	6.0500	456.4181			
2.000E-08	450.9114	6.0500	444.8614			
2.200E-08	430.2087	6.0500	424.1587			
2.400E-08	412.1510	6.0500	406.1010			
2.600E-08	396.2192	6.0500	390.1692			
2.800E-08	382.0265	6.0500	375.9765			
3.000E-08	369.2778	6.0500	363.2278			
3.200E-08	357.7438	6.0500	351.6938			
3.400E-08	347.2431	6.0500	341.1931			
3.700E-08	333.1186	6.0500	327.0686			

4.000E-08	320.6145	6.0500	314.5645
4.300E-08	309.4429	6.0500	303.3929
4.600E-08	299.3829	6.0500	293.3329
5.000E-08	287.4050	6.0500	281.3550
5.500E-08	274.3115	6.0500	268.2615
6.000E-08	262.8908	6.0500	256.8408
6.500E-08	252.8147	6.0500	246.7647
7.000E-08	243.8384	6.0500	237.7884
7.500E-08	235.7754	6.0500	229.7254
8.000E-08	228.4807	6.0500	222.4307
8.500E-08	221.8395	6.0500	215.7895
9.000E-08	215.7597	6.0500	209.7097
1.000E-07	204.9980	6.0500	198.9480
1.100E-07	195.7395	6.0500	189.6895
1.200E-07	187.6639	6.0500	181.6139
1.300E-07	180.5390	6.0500	174.4890
1.400E-07	174.1918	6.0500	168.1418
1.500E-07	168.4904	6.0500	162.4404
.00000016	163.33224	6.05000	157.28224
.00000017	158.63618	6.05000	152.58618
.00000018	154.33711	6.05000	148.28711
.00000019	150.38208	6.05000	144.33208
.00000020	146.72751	6.05000	140.67751
.00000022	140.18074	6.05000	134.13074
.00000024	134.47040	6.05000	128.42040
.00000026	129.43234	6.05000	123.38234
.00000028	124.94419	6.05000	118.89419
.00000030	120.91270	6.05000	114.86270
.00000033	115.56729	6.05000	109.51729
.00000036	110.90482	6.05000	104.85482
.00000040	105.52402	6.05000	99.47402
.00000043	101.99126	6.05000	95.94126
.00000046	98.81000	6.05000	92.76000
.00000050	95.02227	6.05000	88.97227
.00000055	90.88173	6.05000	84.83173
.00000060	87.27019	6.05000	81.22019
.00000065	84.08384	6.05000	78.03384
.00000070	81.24529	6.05000	75.19529
.00000075	78.69555	6.05000	72.64555
.00000080	76.38875	6.05000	70.33875
.00000085	74.28861	6.05000	68.23861
.00000090	72.36601	6.05000	66.31601
.00000100	68.96289	6.05000	62.91289
.00000110	66.03509	6.05000	59.98509
.00000120	63.48135	6.05000	57.43135
.00000130	61.22825	6.05000	55.17825
.00000140	59.22110	6.05000	53.17110
.00000150	57.41816	6.05000	51.36816
.00000160	55.78701	6.05000	49.73701
.00000170	54.30198	6.05000	48.25198
.00000180	52.94250	6.05000	46.89250
.00000190	51.69180	6.05000	45.64180
.00000200	50.53613	6.05000	44.48613
.00000220	48.46586	6.05000	42.41586
.00000240	46.66009	6.05000	40.61009
.00000260	45.06692	6.05000	39.01692
.00000280	43.64764	6.05000	37.59764
.00000300	42.37277	6.05000	36.32277

.00000330	40.68241	6.05000	34.63241
.00000360	39.20800	6.05000	33.15800
.00000400	37.50644	6.05000	31.45644
.00000430	36.38929	6.05000	30.33929
.00000460	35.38328	6.05000	29.33328
.00000500	34.18550	6.05000	28.13550
.00000550	32.87614	6.05000	26.82614
.00000600	31.73408	6.05000	25.68408
.00000650	30.72646	6.05000	24.67646
.00000700	29.82883	6.05000	23.77883
.00000750	29.02254	6.05000	22.97254
.00000800	28.29306	6.05000	22.24306
.00000850	27.62894	6.05000	21.57894
.00000900	27.02096	6.05000	20.97096
.00001000	25.94480	6.05000	19.89480
.00001100	25.01895	6.05000	18.96895
.00001200	24.21138	6.05000	18.16138
.00001300	23.49889	6.05000	17.44889
.00001400	22.86417	6.05000	16.81417
.00001500	22.29403	6.05000	16.24403
.00001600	21.77822	6.05000	15.72822
.00001700	21.30861	6.05000	15.25861
.00001800	20.87871	6.05000	14.82871
.00001900	20.48320	6.05000	14.43320
.00002000	20.11775	6.05000	14.06775
.00002200	19.46307	6.05000	13.41307
.00002400	18.89204	6.05000	12.84204
.00002600	18.38823	6.05000	12.33823
.00002800	17.93941	6.05000	11.88941
.00003000	17.53627	6.05000	11.48627
.00003300	17.00172	6.05000	10.95172
.00003600	16.53548	6.05000	10.48548
.00004000	15.99740	6.05000	9.94740
.00004300	15.64412	6.05000	9.59412
.00004600	15.32600	6.05000	9.27600
.00005000	14.94722	6.05000	8.89722
.00005500	14.53317	6.05000	8.48317
.00006000	14.17201	6.05000	8.12201
.00006500	13.85338	6.05000	7.80338
.00007000	13.56952	6.05000	7.51952
.00007500	13.31455	6.05000	7.26455
.00008000	13.08387	6.05000	7.03387
.00008500	12.87386	6.05000	6.82386
.00009000	12.68160	6.05000	6.63160
.00010000	12.34128	6.05000	6.29128
.00010130	12.30079	6.05000	6.25079
.00010140	12.29770	6.05000	6.24770
.00011000	12.04850	6.05000	5.99850
.00012000	11.79313	6.05000	5.74313
.00013010	11.56570	6.05000	5.51570
.00013020	11.56358	6.05000	5.51358
.00014000	11.36711	6.05000	5.31711
.00015000	11.18681	6.05000	5.13681
.00016000	11.02370	6.05000	4.97370
.00016700	10.91834	6.05000	4.86834
.00016710	50.766	33.252	17.514
.00017000	50.766	33.252	17.514
.00018000	50.766	33.252	17.514

.00019000	50.766	33.252	17.514
.00020000	50.766	33.252	17.514
.00022000	50.766	33.252	17.514
.00024000	50.766	33.252	17.514
.00026000	50.766	33.252	17.514
.00027540	50.766	33.252	17.514
.00027550	66.560	49.180	17.380
.00030000	66.560	49.180	17.380
.00033000	66.560	49.180	17.380
.00036000	66.560	49.180	17.380
.00040000	66.560	49.180	17.380
.00043000	66.560	49.180	17.380
.00045400	66.560	49.180	17.380
.00045410	53.130	41.510	11.620
.00050000	53.130	41.510	11.620
.00055000	53.130	41.510	11.620
.00060000	53.130	41.510	11.620
.00065000	53.130	41.510	11.620
.00070000	53.130	41.510	11.620
.00074850	53.130	41.510	11.620
.00074860	42.703	34.990	7.713
.00080000	42.703	34.990	7.713
.00090000	42.703	34.990	7.713
.00100000	42.703	34.990	7.713
.00110000	42.703	34.990	7.713
.00120000	42.703	34.990	7.713
.00123400	42.703	34.990	7.713
.00123410	38.684724	32.519421	6.165303
.001300	37.800619	31.849783	5.950836
.001400	36.648249	31.054921	5.593328
.001500	35.613215	30.334354	5.278861
.001600	34.676880	29.676916	4.999964
.001700	33.824496	29.073677	4.750819
.001800	33.044238	28.517180	4.527058
.001900	32.326474	28.000512	4.325962
.002000	31.663300	27.520162	4.143138
.002200	30.475433	26.652416	3.823017
.002400	29.439502	25.887706	3.551796
.002600	28.525677	25.206761	3.318916
.002800	27.711734	24.595052	3.116682
.003000	26.980726	24.040859	2.939867
.003200	26.319476	23.535919	2.783557
.003400	25.717562	23.073291	2.644271
.003700	24.908086	22.446508	2.461578
.004000	24.191649	21.887218	2.304431
.004300	23.551714	21.383937	2.167777
.004600	22.975586	20.927221	2.048365
.005000	22.289812	20.378735	1.911077
.005500	21.540426	19.774594	1.765832
.006000	20.887035	19.243639	1.643396
.006500	20.310787	18.772016	1.538771
.007000	19.797633	18.349307	1.448326
.007500	19.336864	17.967402	1.369462
.008000	18.920151	17.620119	1.300032
.008500	18.540911	17.302490	1.238421
.009000	18.193858	17.010474	1.183384
.010000	17.579878	16.490630	1.089248
.011000	17.052031	16.040308	1.011723

.012000	16.591940	15.644898	.947042			
.013000	16.186293	15.294107	.892186			
.014000	15.825166	14.980119	.845047			
.015000	15.500995	14.696863	.804132			
.016000	15.207900	14.439591	.768309			
.017000	14.941231	14.204525	.736706			
.018000	14.697256	13.988639	.708617			
.019000	14.472942	13.789530	.683412			
.020000	14.265791	13.605014	.660777			
.022000	13.895021	13.273179	.621842			
.024000	13.571984	12.982363	.589621			
.026000	13.287283	12.724702	.562581			
.028000	13.033920	12.494300	.539620			
.030000	12.806560	12.286546	.520014			
.032000	12.601058	12.098000	.503058			
.034000	12.414135	11.925867	.488268			
.037000	12.159331	11.693605	.465726			
.040000	11.933334	11.487286	.446048			
.043000	11.730944	11.302389	.428555			
.046000	11.550872	11.135436	.415436			
.050000	11.331851	10.936093	.395758			
.055000	11.093534	10.717455	.376079			
.060000	10.886895	10.526121	.360774			
.065000	10.702288	10.356820	.345468			
.070000	10.533582	10.205606	.327976			
.075000	10.388678	10.069448	.319230			
.080000	10.252110	9.945999	.306111			
.085000	10.130757	9.833392	.297365			
.090000	10.018741	9.730122	.288619			
.100000	9.820209	9.397906	.273313	.148989		
.200000	8.730884	7.868182	.185853	.676847		
.300000	8.245428	7.042710	.149775	1.052942		
.400000	7.953967	6.485928	.127910	1.340128		
.500000	7.755032	6.090875	.113698	1.550458		
.600000	7.609536	5.785603	.104952	1.718980		
.700000	7.495799	5.594736	.097736	1.803325		
.800000	7.406064	5.443292	.094019	1.868752		
.900000	7.332086	5.331797	.091396	1.908892		
1.000000	7.268805	5.248076	.088553	1.932175		
1.100000	7.205000	5.175550	.086585	1.942864		
1.200000	7.165000	5.094367	.085273	1.985359		
1.300000	7.145000	4.992166	.084399	2.068434		
1.400000	7.130000	4.918394	.082650	2.128955		
1.500000	7.120000	4.844126	.080026	2.195847		
1.600000	7.110000	4.801507	.077621	2.230871		
1.700000	7.095000	4.701826	.074997	2.318176		
1.800000	7.085000	4.628588	.073029	2.383382		
1.900000	7.075000	4.567999	.070842	2.436157		
2.000000	7.070000	4.520306	.068656	2.481037		
2.200000	7.110000	4.550224	.062971	2.496803	0.000000	0.000000
2.400000	7.110000	4.544840	.058379	2.506779	0.000000	0.000000
2.600000	7.040000	4.487891	.054006	2.498101	0.000000	0.000000
2.800000	6.930000	4.400357	.050071	2.479571	0.000000	0.000000
3.000000	6.840000	4.319217	.047010	2.473772	0.000000	0.000000
3.200000	6.740000	4.230403	.044167	2.465429	0.000000	0.000000
3.400000	6.680000	4.162776	.041762	2.475461	0.000000	0.000000
3.600000	6.560000	4.056787	.039575	2.463637	0.000000	0.000000
3.800000	6.440000	3.949027	.037608	2.453364	0.000000	0.000000

4.000000	6.300000	3.829151	.035640	2.435208	0.000000	0.000000
4.200000	6.190000	3.727573	.034109	2.428317	0.000000	0.000000
4.400000	6.050000	3.609369	.032622	2.408008	0.000000	0.000000
4.600000	5.950000	3.515773	.031267	2.402959	0.000000	0.000000
4.800000	5.850000	3.424656	.030042	2.395301	0.000000	0.000000
5.000000	5.780000	3.351228	.028861	2.399909	0.000000	0.000000
5.200000	5.610000	3.221893	.027790	2.360316	0.000000	0.000000
5.400000	5.550000	3.157033	.026762	2.366092	.000111	0.000000
5.600000	5.540000	3.123175	.025822	2.390869	.000133	0.000000
5.800000	5.490000	3.066772	.025035	2.398023	.000168	0.000000
6.000000	5.430000	3.007134	.024248	2.398428	.000189	0.000000
6.200000	5.370000	2.950278	.023505	2.395992	.000225	0.
6.400000	5.310000	2.893419	.022783	2.393524	.000273	0.
6.600000	5.230000	2.826292	.022105	2.381277	.000325	0.
6.800000	5.170000	2.770603	.021449	2.377552	.000395	0.
7.000000	5.160000	2.742024	.020815	2.396690	.000470	0.
7.200000	5.130000	2.707101	.020225	2.353582	.000560	.048531
7.400000	5.060000	2.651946	.019722	2.225776	.000680	.161875
7.600000	4.990000	2.597295	.019241	2.067181	.000810	.305472
7.800000	5.020000	2.594838	.018782	1.935069	.000970	.470340
8.000000	5.100000	2.617830	.018344	1.814325	.001150	.648350
8.200000	5.040000	2.574936	.017907	1.649527	.001400	.796228
8.400000	5.010000	2.548086	.017492	1.506605	.001670	.936146
8.600000	5.040000	2.551752	.017098	1.390795	.002000	1.078353
8.800000	5.050000	2.545200	.016726	1.282303	.002400	1.203369
9.000000	5.090000	2.553653	.016376	1.190753	.002850	1.326367
9.200000	5.120000	2.565120	.016027	1.105595	.003800	1.429457
9.400000	5.060000	2.531012	.015699	1.020675	.004100	1.488513
9.600000	5.180000	2.586892	.015371	.966441	.004900	1.606395
9.800000	5.130000	2.557818	.015065	.903178	.005900	1.648038
10.000000	5.130000	2.553714	.014780	.853169	.007100	1.701235
10.200000	5.200000	2.591160	.014518	.813883	.008400	1.772038
10.400000	5.260000	2.623688	.014256	.779145	.010300	1.832610
10.600000	5.240000	2.616332	.013993	.745480	.012000	1.852193
10.800000	5.240000	2.618952	.013753	.717717	.014300	1.875277
11.000000	5.240000	2.621048	.013512	.694133	.017100	1.894206
11.200000	5.250000	2.632875	.013272	.674114	.020000	1.909738
11.400000	5.250000	2.639700	.013053	.656870	.023000	1.917376
11.600000	5.250000	2.646525	.012834	.642231	.026800	1.921604
11.800000	5.250000	2.653350	.012616	.629822	.031000	1.923211
12.000000	5.240000	2.655108	.012419	.619142	.036000	1.917330
12.200000	5.240000	2.663492	.012244	.610180	.042000	1.912083
12.400000	5.230000	2.666777	.012069	.602492	.048000	1.900661
12.600000	5.210000	2.664915	.011894	.595942	.052300	1.884948
12.800000	5.170000	2.652727	.011719	.590235	.058300	1.857018
13.000000	5.150000	2.650190	.011544	.585575	.065000	1.837690
13.200000	5.180000	2.674434	.011369	.581937	.070000	1.842258
13.400000	5.240000	2.714320	.011194	.578985	.074000	1.861499
13.600000	5.310000	2.759607	.011041	.576463	.080000	1.882887
13.800000	5.350000	2.789490	.010888	.574198	.083000	1.892422
14.000000	5.360000	2.804352	.010735	.572151	.087000	1.885760
14.200000	5.370000	2.819250	.010604	.570400	.092000	1.877744
14.400000	5.370000	2.828916	.010473	.568895	.095000	1.866715
14.600000	5.360000	2.833296	.010342	.567598	.097000	1.851763
14.800000	5.380000	2.853552	.010211	.566543	.099000	1.850693
15.000000	5.460000	2.904720	.010079	.565731	.100000	1.879468

HF-176 CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N

1.000E-09	44.9010	6.0500	38.8510
1.100E-09	43.0930	6.0500	37.0430
1.200E-09	41.5159	6.0500	35.4659
1.300E-09	40.1246	6.0500	34.0746
1.400E-09	38.8851	6.0500	32.8351
1.500E-09	37.7717	6.0500	31.7217
1.600E-09	36.7644	6.0500	30.7144
1.700E-09	35.8473	6.0500	29.7973
1.800E-09	35.0078	6.0500	28.9578
1.900E-09	34.2355	6.0500	28.1855
2.000E-09	33.5218	6.0500	27.4718
2.200E-09	32.2433	6.0500	26.1933
2.400E-09	31.1282	6.0500	25.0782
2.600E-09	30.1444	6.0500	24.0944
2.800E-09	29.2679	6.0500	23.2179
3.000E-09	28.4806	6.0500	22.4306
3.200E-09	27.7684	6.0500	21.7184
3.400E-09	27.1199	6.0500	21.0699
3.700E-09	26.2477	6.0500	20.1977
4.000E-09	25.4755	6.0500	19.4255
4.300E-09	24.7856	6.0500	18.7356
4.600E-09	24.1644	6.0500	18.1144
5.000E-09	23.4247	6.0500	17.3747
5.500E-09	22.6161	6.0500	16.5661
6.000E-09	21.9108	6.0500	15.8608
6.500E-09	21.2886	6.0500	15.2386
7.000E-09	20.7343	6.0500	14.6843
7.500E-09	20.2364	6.0500	14.1864
8.000E-09	19.7859	6.0500	13.7359
8.500E-09	19.3758	6.0500	13.3258
9.000E-09	19.0003	6.0500	12.9503
9.500E-09	18.6549	6.0500	12.6049
1.000E-08	18.3358	6.0500	12.2858
1.100E-08	17.7640	6.0500	11.7140
1.200E-08	17.2653	6.0500	11.2153
1.300E-08	16.8253	6.0500	10.7753
1.400E-08	16.4334	6.0500	10.3834
1.500E-08	16.0813	6.0500	10.0313
1.600E-08	15.7627	6.0500	9.7127
1.700E-08	15.4727	6.0500	9.4227
1.800E-08	15.2073	6.0500	9.1573
1.900E-08	14.9630	6.0500	8.9130
2.000E-08	14.7373	6.0500	8.6873
2.200E-08	14.3331	6.0500	8.2831
2.400E-08	13.9804	6.0500	7.9304
2.600E-08	13.6693	6.0500	7.6193
2.800E-08	13.3921	6.0500	7.3421
3.000E-08	13.1432	6.0500	7.0932
3.200E-08	12.9179	6.0500	6.8679
3.400E-08	12.7129	6.0500	6.6629
3.700E-08	12.4371	6.0500	6.3871
4.000E-08	12.1929	6.0500	6.1429
4.300E-08	11.9747	6.0500	5.9247
4.600E-08	11.7783	6.0500	5.7283
5.000E-08	11.5444	6.0500	5.4944
5.500E-08	11.2887	6.0500	5.2387
6.000E-08	11.0656	6.0500	5.0156
6.500E-08	10.8689	6.0500	4.8189

7.000E-08	10.6936	6.0500	4.6436
7.500E-08	10.5361	6.0500	4.4861
8.000E-08	10.3937	6.0500	4.3437
8.500E-08	10.2640	6.0500	4.2140
9.000E-08	10.1453	6.0500	4.0953
1.000E-07	9.9351	6.0500	3.8851
1.100E-07	9.7543	6.0500	3.7043
1.200E-07	9.5966	6.0500	3.5466
1.300E-07	9.4575	6.0500	3.4075
1.400E-07	9.3335	6.0500	3.2835
1.500E-07	9.2222	6.0500	3.1722
.00000016	9.12144	6.05000	3.07144
.00000017	9.02973	6.05000	2.97973
.00000018	8.94578	6.05000	2.89578
.00000019	8.86854	6.05000	2.81854
.00000020	8.79718	6.05000	2.74718
.00000022	8.66933	6.05000	2.61933
.00000024	8.55782	6.05000	2.50782
.00000026	8.45943	6.05000	2.40943
.00000028	8.37179	6.05000	2.32179
.00000030	8.29306	6.05000	2.24306
.00000033	8.18867	6.05000	2.13867
.00000036	8.09762	6.05000	2.04762
.00000040	7.99255	6.05000	1.94255
.00000043	7.92356	6.05000	1.87356
.00000046	7.86143	6.05000	1.81143
.00000050	7.78747	6.05000	1.73747
.00000055	7.70661	6.05000	1.65661
.00000060	7.63608	6.05000	1.58608
.00000065	7.57386	6.05000	1.52386
.00000070	7.51843	6.05000	1.46843
.00000075	7.46863	6.05000	1.41863
.00000080	7.42359	6.05000	1.37359
.00000085	7.38257	6.05000	1.33257
.00000090	7.34503	6.05000	1.29503
.00000100	7.27857	6.05000	1.22857
.00000110	7.22140	6.05000	1.17140
.00000120	7.17153	6.05000	1.12153
.00000130	7.12753	6.05000	1.07753
.00000140	7.08833	6.05000	1.03833
.00000150	7.05312	6.05000	1.00312
.00000160	7.02127	6.05000	.97127
.00000170	6.99227	6.05000	.94227
.00000180	6.96572	6.05000	.91572
.00000190	6.94130	6.05000	.89130
.00000200	6.91873	6.05000	.86873
.00000220	6.87830	6.05000	.82830
.00000240	6.84304	6.05000	.79304
.00000260	6.81193	6.05000	.76193
.00000280	6.78421	6.05000	.73421
.00000300	6.75931	6.05000	.70931
.00000330	6.72630	6.05000	.67630
.00000360	6.69751	6.05000	.64751
.00000400	6.66428	6.05000	.61428
.00000430	6.64247	6.05000	.59247
.00000460	6.62282	6.05000	.57282
.00000500	6.59943	6.05000	.54943
.00000550	6.57386	6.05000	.52386

.00000600	6.55156	6.05000	.50156
.00000650	6.53188	6.05000	.48188
.00000700	6.51435	6.05000	.46435
.00000750	6.49861	6.05000	.44861
.00000800	6.48436	6.05000	.43436
.00000850	6.47139	6.05000	.42139
.00000900	6.45952	6.05000	.40952
.00001000	6.43851	6.05000	.38851
.00001100	6.42043	6.05000	.37043
.00001200	6.40465	6.05000	.35465
.00001300	6.39074	6.05000	.34074
.00001400	6.37835	6.05000	.32835
.00001500	6.36721	6.05000	.31721
.00001600	6.35714	6.05000	.30714
.00001700	6.34797	6.05000	.29797
.00001800	6.33957	6.05000	.28957
.00001900	6.33185	6.05000	.28185
.00002000	6.32471	6.05000	.27471
.00002200	6.31193	6.05000	.26193
.00002400	6.30078	6.05000	.25078
.00002600	6.29094	6.05000	.24094
.00002800	6.28217	6.05000	.23217
.00003000	6.27430	6.05000	.22430
.00003300	6.26386	6.05000	.21386
.00003600	6.25476	6.05000	.20476
.00004000	6.24425	6.05000	.19425
.00004300	6.23735	6.05000	.18735
.00004600	6.23114	6.05000	.18114
.00005000	6.22374	6.05000	.17374
.00005500	6.21566	6.05000	.16566
.00006000	6.20860	6.05000	.15860
.00006500	6.20238	6.05000	.15238
.00007000	6.19684	6.05000	.14684
.00007500	6.19186	6.05000	.14186
.00008000	6.18735	6.05000	.13735
.00008500	6.18325	6.05000	.13325
.00009000	6.17950	6.05000	.12950
.00010000	6.17285	6.05000	.12285
.00010130	6.17206	6.05000	.12206
.00010140	6.17200	6.05000	.12200
.00011000	6.16714	6.05000	.11714
.00012000	6.16215	6.05000	.11215
.00013010	6.15771	6.05000	.10771
.00013020	6.15767	6.05000	.10767
.00014000	6.15383	6.05000	.10383
.00015000	6.15031	6.05000	.10031
.00016000	6.14712	6.05000	.09712
.00016700	6.14507	6.05000	.09507
.00016710	6.14504	6.05000	.09504
.00017000	6.14422	6.05000	.09422
.00018000	6.14157	6.05000	.09157
.00019000	6.13913	6.05000	.08913
.00020000	6.13687	6.05000	.08687
.00022000	6.13283	6.05000	.08283
.00024000	6.12930	6.05000	.07930
.00026000	6.12619	6.05000	.07619
.00027540	6.12403	6.05000	.07403
.00027550	6.12401	6.05000	.07401

.00030000	6.12093	6.05000	.07093
.00033000	6.11763	6.05000	.06763
.00036000	6.11475	6.05000	.06475
.00040000	6.11142	6.05000	.06142
.00043000	6.10924	6.05000	.05924
.00045400	6.10765	6.05000	.05765
.00045410	12.950	9.710	3.240
.00050000	12.950	9.710	3.240
.00055000	12.950	9.710	3.240
.00060000	12.950	9.710	3.240
.00065000	12.950	9.710	3.240
.00070000	12.950	9.710	3.240
.00074850	12.950	9.710	3.240
.00074860	23.119	20.860	2.259
.00080000	23.119	20.860	2.259
.00090000	23.119	20.860	2.259
.00100000	23.119	20.860	2.259
.00110000	23.119	20.860	2.259
.00120000	23.119	20.860	2.259
.00123400	23.119	20.860	2.259
.00123410	29.661582	26.048121	3.613461
.001300	28.739034	25.425749	3.313285
.001400	27.916291	24.806400	3.109891
.001500	27.177342	24.245306	2.932036
.001600	26.508879	23.734189	2.774690
.001700	25.900375	23.265919	2.634456
.001800	25.343374	22.834721	2.508653
.001900	24.831007	22.435871	2.395136
.002000	24.357618	22.065448	2.292170
.002200	23.509739	21.397259	2.112480
.002400	22.770358	20.807768	1.962590
.002600	22.118172	20.283941	1.834231
.002800	21.537308	19.814268	1.723040
.003000	21.015662	19.389899	1.625763
.003200	20.543828	19.003900	1.539928
.003400	20.114360	18.650743	1.463617
.003700	19.536843	18.172929	1.363914
.004000	19.025752	17.747302	1.278450
.004300	18.569282	17.364941	1.204341
.004600	18.158362	17.018897	1.139465
.005000	17.669295	16.604715	1.064580
.005500	17.134935	16.149202	.985733
.006000	16.669098	15.749180	.919918
.006500	16.258324	15.394382	.863942
.007000	15.892583	15.076818	.815765
.007500	15.564227	14.790345	.773882
.008000	15.267312	14.530157	.737155
.008500	14.997136	14.292433	.704703
.009000	14.749927	14.074162	.675765
.010000	14.312679	13.686214	.626465
.011000	13.936878	13.350654	.586224
.012000	13.609408	13.056582	.552826
.013000	13.320769	12.796046	.524723
.014000	13.063879	12.563064	.500815
.015000	12.833338	12.352988	.480350
.016000	12.624952	12.162355	.462597
.017000	12.435404	11.988322	.447082
.018000	12.262030	11.828596	.433434

.019000	12.102666	11.681308	.421358			
.020000	11.955532	11.544913	.410619			
.022000	11.692276	11.299861	.392415			
.024000	11.463016	11.085384	.377632			
.026000	11.261052	10.895558	.365494			
.028000	11.081395	10.725975	.355420			
.030000	10.920242	10.573258	.346984			
.032000	10.774638	10.434773	.339865			
.034000	10.642247	10.308428	.333819			
.037000	10.456472	10.138065	.318407			
.040000	10.291807	9.986854	.304953			
.043000	10.144441	9.851447	.292994			
.046000	10.013283	9.729258	.284025			
.050000	9.854032	9.583461	.270571			
.055000	9.680804	9.423687	.257117			
.060000	9.530659	9.284006	.246653			
.065000	9.396692	9.160503	.236189			
.070000	9.274496	9.050266	.224230			
.075000	9.169322	8.951071	.218251			
.080000	9.070467	8.861186	.209281			
.085000	8.982537	8.779235	.203302			
.090000	8.901440	8.704118	.197322			
.100000	8.757787	8.435473	.186858	.135455		
.200000	7.971448	7.216232	.127063	.628152		
.300000	7.621953	6.532510	.102398	.987044		
.400000	7.412462	6.060796	.087449	1.264216		
.500000	7.269585	5.722452	.077733	1.469399		
.600000	7.165102	5.458136	.071753	1.635211		
.700000	7.083490	5.296097	.066820	1.720572		
.800000	7.019059	5.166986	.064279	1.787793		
.900000	6.965947	5.072985	.062485	1.830476		
1.000000	6.920552	5.003470	.060542	1.856538		
1.100000	6.900000	4.962916	.059196	1.877887		
1.200000	6.901000	4.912511	.058299	1.930189		
1.300000	6.903000	4.827955	.057701	2.017343		
1.400000	6.920000	4.777622	.056506	2.085871		
1.500000	6.932000	4.719444	.054712	2.157843		
1.600000	6.950000	4.696152	.053067	2.200780		
1.700000	6.978000	4.626031	.051274	2.300694		
1.800000	7.000000	4.574081	.049928	2.375990		
1.900000	7.020000	4.532937	.048433	2.438629		
2.000000	7.070000	4.520306	.046938	2.502755		
2.200000	7.110000	4.550224	.043052	2.516722	0.000000	0.000000
2.400000	7.110000	4.544840	.039913	2.525246	0.000000	0.000000
2.600000	7.040000	4.487891	.036923	2.515185	0.000000	0.000000
2.800000	6.930000	4.400357	.034232	2.495410	0.000000	0.000000
3.000000	6.840000	4.319217	.032139	2.488643	0.000000	0.000000
3.200000	6.740000	4.230403	.030196	2.479400	0.000000	0.000000
3.400000	6.680000	4.162776	.028552	2.488671	0.000000	0.000000
3.600000	6.560000	4.056787	.027057	2.476155	0.000000	0.000000
3.800000	6.440000	3.949027	.025711	2.465260	0.000000	0.000000
4.000000	6.300000	3.829151	.024366	2.446481	0.000000	0.000000
4.200000	6.190000	3.727573	.023320	2.439106	0.000000	0.000000
4.400000	6.050000	3.609369	.022303	2.418327	0.000000	0.000000
4.600000	5.950000	3.515773	.021376	2.412850	0.000000	0.000000
4.800000	5.850000	3.424656	.020539	2.404804	0.000000	0.000000
5.000000	5.780000	3.351228	.019732	2.409039	0.000000	0.000000
5.200000	5.610000	3.221893	.018999	2.369106	0.000000	0.000000

5.400000	5.550000	3.157033	.018297	2.374669	0.000000	0.000000
5.600000	5.540000	3.123175	.017654	2.399170	0.000000	0.000000
5.800000	5.490000	3.066772	.017116	2.406111	0.000000	0.000000
6.000000	5.430000	3.007134	.016578	2.406287	0.000000	0.000000
6.200000	5.370000	2.950278	.016069	2.403652	0.	0.
6.400000	5.310000	2.893419	.015576	2.401004	0.	0.
6.600000	5.230000	2.826292	.015113	2.388594	0.	0.
6.800000	5.170000	2.770603	.014664	2.384732	0.	0.
7.000000	5.160000	2.742024	.014231	2.403744	0.	0.
7.200000	5.130000	2.707101	.013827	2.360356	0.	.048715
7.400000	5.060000	2.651946	.013483	2.231990	.000100	.162479
7.600000	4.990000	2.597295	.013154	2.072815	.000120	.306614
7.800000	5.020000	2.594838	.012840	1.940112	.000143	.472065
8.000000	5.100000	2.617830	.012541	1.818796	.000170	.650661
8.200000	5.040000	2.574936	.012243	1.653492	.000203	.799126
8.400000	5.010000	2.548086	.011958	1.510104	.000245	.939606
8.600000	5.040000	2.551752	.011689	1.393890	.000295	1.082372
8.800000	5.050000	2.545200	.011435	1.285057	.000350	1.207957
9.000000	5.090000	2.553653	.011196	1.193205	.000420	1.331524
9.200000	5.120000	2.565120	.010957	1.107910	.000490	1.435522
9.400000	5.060000	2.531012	.010733	1.022678	.000590	1.494986
9.600000	5.180000	2.586892	.010508	.968269	.000710	1.613619
9.800000	5.130000	2.557818	.010299	.904871	.000840	1.656170
10.000000	5.130000	2.553714	.010105	.854749	.001030	1.710401
10.200000	5.200000	2.591160	.009925	.815361	.001200	1.782353
10.400000	5.260000	2.623688	.009746	.780572	.001450	1.844543
10.600000	5.240000	2.616332	.009567	.746819	.001720	1.865561
10.800000	5.240000	2.618952	.009402	.719005	.002050	1.890590
11.000000	5.240000	2.621048	.009238	.695384	.002450	1.911878
11.200000	5.250000	2.632875	.009073	.675312	.002950	1.929788
11.400000	5.250000	2.639700	.008924	.658009	.003450	1.939916
11.600000	5.250000	2.646525	.008774	.643329	.004100	1.947270
11.800000	5.250000	2.653350	.008625	.630876	.004900	1.952247
12.000000	5.240000	2.655108	.008490	.620163	.005800	1.950437
12.200000	5.240000	2.663492	.008371	.611179	.006800	1.950157
12.400000	5.230000	2.666777	.008251	.603448	.008100	1.943423
12.600000	5.210000	2.664915	.008132	.596817	.009300	1.930835
12.800000	5.170000	2.652727	.008012	.591054	.010900	1.907306
13.000000	5.150000	2.650190	.007892	.586344	.012600	1.892972
13.200000	5.180000	2.674434	.007773	.582635	.014300	1.900857
13.400000	5.240000	2.714320	.007653	.579603	.016300	1.922122
13.600000	5.310000	2.759607	.007549	.577031	.018000	1.947812
13.800000	5.350000	2.789490	.007444	.574693	.020000	1.958372
14.000000	5.360000	2.804352	.007339	.572589	.022000	1.953718
14.200000	5.370000	2.819250	.007250	.570794	.024000	1.948705
14.400000	5.370000	2.828916	.007160	.569240	.025700	1.938983
14.600000	5.360000	2.833296	.007070	.567896	.027300	1.924436
14.800000	5.380000	2.853552	.006981	.566803	.028700	1.923964
15.000000	5.460000	2.904720	.006891	.565954	.030000	1.952434

HF-177 CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N
1.000E-09	39.9917	6.0500	33.9417			
1.100E-09	38.4122	6.0500	32.3622			
1.200E-09	37.0344	6.0500	30.9844			
1.300E-09	35.8189	6.0500	29.7689			
1.400E-09	34.7360	6.0500	28.6860			
1.500E-09	33.7633	6.0500	27.7133			
1.600E-09	32.8833	6.0500	26.8333			

1.700E-09	32.0821	6.0500	26.0321
1.800E-09	31.3487	6.0500	25.2987
1.900E-09	30.6739	6.0500	24.6239
2.000E-09	30.0504	6.0500	24.0004
2.200E-09	28.9335	6.0500	22.8835
2.400E-09	27.9593	6.0500	21.9093
2.600E-09	27.0998	6.0500	21.0498
2.800E-09	26.3341	6.0500	20.2841
3.000E-09	25.6463	6.0500	19.5963
3.200E-09	25.0240	6.0500	18.9740
3.400E-09	24.4575	6.0500	18.4075
3.700E-09	23.6955	6.0500	17.6455
4.000E-09	23.0209	6.0500	16.9709
4.300E-09	22.4182	6.0500	16.3682
4.600E-09	21.8754	6.0500	15.8254
5.000E-09	21.2292	6.0500	15.1792
5.500E-09	20.5228	6.0500	14.4728
6.000E-09	19.9067	6.0500	13.8567
6.500E-09	19.3630	6.0500	13.3130
7.000E-09	18.8788	6.0500	12.8288
7.500E-09	18.4438	6.0500	12.3938
8.000E-09	18.0502	6.0500	12.0002
8.500E-09	17.6919	6.0500	11.6419
9.000E-09	17.3639	6.0500	11.3139
9.500E-09	17.0622	6.0500	11.0122
1.000E-08	16.7833	6.0500	10.7333
1.100E-08	16.2838	6.0500	10.2338
1.200E-08	15.8481	6.0500	9.7981
1.300E-08	15.4637	6.0500	9.4137
1.400E-08	15.1213	6.0500	9.0713
1.500E-08	14.8137	6.0500	8.7637
1.600E-08	14.5354	6.0500	8.4854
1.700E-08	14.2821	6.0500	8.2321
1.800E-08	14.0501	6.0500	8.0001
1.900E-08	13.8368	6.0500	7.7868
2.000E-08	13.6396	6.0500	7.5896
2.200E-08	13.2864	6.0500	7.2364
2.400E-08	12.9783	6.0500	6.9283
2.600E-08	12.7065	6.0500	6.6565
2.800E-08	12.4644	6.0500	6.4144
3.000E-08	12.2469	6.0500	6.1969
3.200E-08	12.0501	6.0500	6.0001
3.400E-08	11.8710	6.0500	5.8210
3.700E-08	11.6300	6.0500	5.5800
4.000E-08	11.4167	6.0500	5.3667
4.300E-08	11.2261	6.0500	5.1761
4.600E-08	11.0544	6.0500	5.0044
5.000E-08	10.8501	6.0500	4.8001
5.500E-08	10.6267	6.0500	4.5767
6.000E-08	10.4319	6.0500	4.3819
6.500E-08	10.2600	6.0500	4.2100
7.000E-08	10.1068	6.0500	4.0568
7.500E-08	9.9693	6.0500	3.9193
8.000E-08	9.8448	6.0500	3.7948
8.500E-08	9.7315	6.0500	3.6815
9.000E-08	9.6278	6.0500	3.5778
1.000E-07	9.4442	6.0500	3.3942
1.100E-07	9.2862	6.0500	3.2362

1.200E-07	9.1484	6.0500	3.0984
1.300E-07	9.0269	6.0500	2.9769
1.400E-07	8.9186	6.0500	2.8686
1.500E-07	8.8213	6.0500	2.7713
.00000016	8.73333	6.05000	2.68333
.00000017	8.65321	6.05000	2.60321
.00000018	8.57987	6.05000	2.52987
.00000019	8.51239	6.05000	2.46239
.00000020	8.45005	6.05000	2.40005
.00000022	8.33835	6.05000	2.28835
.00000024	8.24093	6.05000	2.19093
.00000026	8.15498	6.05000	2.10498
.00000028	8.07841	6.05000	2.02841
.00000030	8.00963	6.05000	1.95963
.00000033	7.91843	6.05000	1.86843
.00000036	7.83889	6.05000	1.78889
.00000040	7.74709	6.05000	1.69709
.00000043	7.68682	6.05000	1.63682
.00000046	7.63254	6.05000	1.58254
.00000050	7.56792	6.05000	1.51792
.00000055	7.49728	6.05000	1.44728
.00000060	7.43566	6.05000	1.38566
.00000065	7.38130	6.05000	1.33130
.00000070	7.33288	6.05000	1.28288
.00000075	7.28938	6.05000	1.23938
.00000080	7.25002	6.05000	1.20002
.00000085	7.21419	6.05000	1.16419
.00000090	7.18139	6.05000	1.13139
.00000100	7.12333	6.05000	1.07333
.00000110	7.07338	6.05000	1.02338
.00000120	7.02981	6.05000	.97981
.00000130	6.99137	6.05000	.94137
.00000140	6.95713	6.05000	.90713
.00000150	6.92637	6.05000	.87637
.00000160	6.89854	6.05000	.84854
.00000170	6.87321	6.05000	.82321
.00000180	6.85001	6.05000	.80001
.00000190	6.82867	6.05000	.77867
.00000200	6.80896	6.05000	.75896
.00000220	6.77364	6.05000	.72364
.00000240	6.74283	6.05000	.69283
.00000260	6.71565	6.05000	.66565
.00000280	6.69144	6.05000	.64144
.00000300	6.66969	6.05000	.61969
.00000330	6.64085	6.05000	.59085
.00000360	6.61569	6.05000	.56569
.00000400	6.58666	6.05000	.53666
.00000430	6.56760	6.05000	.51760
.00000460	6.55044	6.05000	.50044
.00000500	6.53001	6.05000	.48001
.00000550	6.50767	6.05000	.45767
.00000600	6.48818	6.05000	.43818
.00000650	6.47099	6.05000	.42099
.00000700	6.45568	6.05000	.40568
.00000750	6.44192	6.05000	.39192
.00000800	6.42948	6.05000	.37948
.00000850	6.41815	6.05000	.36815
.00000900	6.40777	6.05000	.35777

.00001000	6.38941	6.05000	.33941
.00001100	6.37362	6.05000	.32362
.00001200	6.35984	6.05000	.30984
.00001300	6.34768	6.05000	.29768
.00001400	6.33686	6.05000	.28686
.00001500	6.32713	6.05000	.27713
.00001600	6.31833	6.05000	.26833
.00001700	6.31032	6.05000	.26032
.00001800	6.30298	6.05000	.25298
.00001900	6.29623	6.05000	.24623
.00002000	6.29000	6.05000	.24000
.00002200	6.27883	6.05000	.22883
.00002400	6.26909	6.05000	.21909
.00002600	6.26049	6.05000	.21049
.00002800	6.25284	6.05000	.20284
.00003000	6.24596	6.05000	.19596
.00003300	6.23684	6.05000	.18684
.00003600	6.22888	6.05000	.17888
.00004000	6.21970	6.05000	.16970
.00004300	6.21368	6.05000	.16368
.00004600	6.20825	6.05000	.15825
.00005000	6.20179	6.05000	.15179
.00005500	6.19472	6.05000	.14472
.00006000	6.18856	6.05000	.13856
.00006500	6.18313	6.05000	.13313
.00007000	6.17828	6.05000	.12828
.00007500	6.17393	6.05000	.12393
.00008000	6.17000	6.05000	.12000
.00008500	6.16641	6.05000	.11641
.00009000	6.16313	6.05000	.11313
.00010000	6.15733	6.05000	.10733
.00010130	6.15664	6.05000	.10664
.00010140	46.650	26.550	20.100
.00011000	46.650	26.550	20.100
.00012000	46.650	26.550	20.100
.00013010	46.650	26.550	20.100
.00013020	30.140	13.770	16.370
.00014000	30.140	13.770	16.370
.00015000	30.140	13.770	16.370
.00016000	30.140	13.770	16.370
.00016700	30.140	13.770	16.370
.00016710	28.450	6.950	21.500
.00017000	28.450	6.950	21.500
.00018000	28.450	6.950	21.500
.00019000	28.450	6.950	21.500
.00020000	28.450	6.950	21.500
.00022000	28.450	6.950	21.500
.00024000	28.450	6.950	21.500
.00026000	28.450	6.950	21.500
.00027540	28.450	6.950	21.500
.00027550	17.120	6.050	11.070
.00030000	17.120	6.050	11.070
.00033000	17.120	6.050	11.070
.00036000	17.120	6.050	11.070
.00040000	17.120	6.050	11.070
.00043000	17.120	6.050	11.070
.00045400	17.120	6.050	11.070
.00045410	31.020	16.060	14.960

.00050000	31.020	16.060	14.960
.00055000	31.020	16.060	14.960
.00060000	31.020	16.060	14.960
.00065000	31.020	16.060	14.960
.00070000	31.020	16.060	14.960
.00074850	31.020	16.060	14.960
.00074860	37.280	22.250	15.030
.00080000	37.280	22.250	15.030
.00090000	37.280	22.250	15.030
.00100000	37.280	22.250	15.030
.00110000	37.280	22.250	15.030
.00120000	37.280	22.250	15.030
.00123400	37.280	22.250	15.030
.00123410	41.275154	27.333143	13.942011
.001300	40.066011	26.833137	13.232874
.001400	38.831237	26.309126	12.522111
.001500	37.722184	25.830819	11.891365
.001600	36.718876	25.391555	11.327321
.001700	35.805525	24.985999	10.819526
.001800	34.969452	24.609806	10.359646
.001900	34.200343	24.259393	9.940950
.002000	33.489716	23.931778	9.557938
.002200	32.216855	23.331523	8.885332
.002400	31.106787	22.796345	8.310442
.002600	30.127552	22.315838	7.811714
.002800	29.255340	21.880847	7.374493
.003000	28.471991	21.484271	6.987720
.003200	27.763387	21.120503	6.642884
.003400	27.118360	20.781658	6.336702
.003700	26.250896	20.317607	5.933289
.004000	25.483122	19.900566	5.582556
.004300	24.797321	19.522776	5.274545
.004600	24.179891	19.178194	5.001697
.005000	23.444942	18.762264	4.682678
.005500	22.641798	18.296794	4.345004
.006000	21.941519	17.882984	4.058535
.006500	21.323902	17.512891	3.811011
.007000	20.773896	17.179066	3.594830
.007500	20.280022	16.875749	3.404273
.008000	19.833361	16.598407	3.234954
.008500	19.426856	16.342695	3.084161
.009000	19.054840	16.106093	2.948747
.010000	18.396677	15.682221	2.714456
.011000	17.830817	15.312136	2.518681
.012000	17.337572	14.985045	2.352527
.013000	16.902674	14.692965	2.209709
.014000	16.515488	14.428583	2.086905
.015000	16.167909	14.188855	1.979054
.016000	15.853637	13.970081	1.883556
.017000	15.567687	13.769298	1.798389
.018000	15.306063	13.584111	1.721952
.019000	15.065510	13.412550	1.652960
.020000	14.843355	13.252983	1.590372
.022000	14.445708	12.964003	1.481705
.024000	14.099226	12.709030	1.390196
.026000	13.793841	12.481918	1.311923
.028000	13.522050	12.277838	1.244212
.030000	13.278139	12.093072	1.185067

.032000	13.057662	11.924696	1.132966			
.034000	12.857106	11.770257	1.086849			
.037000	12.597558	11.560887	1.036671			
.040000	12.366873	11.374005	.992868			
.043000	12.159722	11.205790	.953932			
.046000	11.978009	11.053279	.924730			
.050000	11.751313	10.870386	.880927			
.055000	11.505510	10.668386	.837124			
.060000	11.293657	10.490602	.803055			
.065000	11.101626	10.332640	.768986			
.070000	10.921074	10.191024	.730050			
.075000	10.773665	10.063083	.710582			
.080000	10.628100	9.946720	.681380			
.085000	10.502156	9.840244	.661912			
.090000	10.384766	9.742322	.642444			
.100000	10.176331	9.567955	.608375	0.000000		
.150000	9.451185	8.247075	.485239	.718870		
.200000	9.012598	7.652495	.413695	.946407		
.250000	8.712371	7.292230	.367458	1.052682		
.300000	8.488818	6.936663	.333389	1.218766		
.350000	8.313527	6.605279	.306621	1.401626		
.400000	8.171082	6.346969	.284719	1.539393		
.450000	8.053658	6.131861	.267685	1.654111		
.500000	7.953738	5.957841	.253084	1.742812		
.550000	7.870318	5.711140	.243350	1.915827		
.600000	7.796090	5.554224	.233616	2.008249		
.650000	7.729280	5.378654	.223882	2.126743		
.700000	7.671965	5.266269	.217554	2.188140		
.750000	7.622646	5.180621	.214148	2.227876		
.800000	7.576148	5.086059	.209281	2.280807		
.850000	7.534758	5.018737	.205874	2.310146		
.900000	7.497486	4.956198	.203440	2.337847		
.950000	7.461972	4.904611	.200033	2.357327		
1.000000	7.429338	4.861151	.197113	2.371073		
1.100000	7.362000	4.745174	.192733	2.424092		
1.200000	7.307000	4.659356	.189813	2.457830		
1.300000	7.246000	4.590276	.186893	2.468831		
1.400000	7.185000	4.521196	.183972	2.479831		
1.500000	7.150000	4.402093	.178376	2.569532		
1.600000	7.115000	4.282990	.172778	2.659231		
1.700000	7.097000	4.272607	.167667	2.656726		
1.800000	7.078000	4.262223	.162557	2.653219		
1.900000	7.074000	4.201110	.157690	2.715200		
2.000000	7.070000	4.139966	.152823	2.777210		
2.200000	7.110000	4.140280	.140169	2.829550	0.000000	0.000000
2.400000	7.110000	4.106254	.129948	2.873796	0.000000	0.000000
2.600000	7.040000	4.024057	.120214	2.895727	0.000000	0.000000
2.800000	6.930000	3.914372	.111454	2.904172	0.000000	0.000000
3.000000	6.840000	3.813375	.104640	2.921984	0.000000	0.000000
3.200000	6.740000	3.705099	.098313	2.936587	0.000000	0.000000
3.400000	6.680000	3.619068	.092959	2.967971	0.000000	0.000000
3.600000	6.560000	3.502288	.088092	2.969619	0.000000	0.000000
3.800000	6.440000	3.387951	.083712	2.968336	0.000000	0.000000
4.000000	6.300000	3.264323	.079332	2.956344	0.000000	0.000000
4.200000	6.190000	3.161063	.075925	2.953011	0.000000	0.000000
4.400000	6.050000	3.045398	.072615	2.931986	0.000000	0.000000
4.600000	5.950000	2.954657	.069598	2.925744	0.000000	0.000000
4.800000	5.850000	2.867025	.066872	2.916102	0.000000	0.000000

5.000000	5.780000	2.800472	.064244	2.915283	0.000000	0.000000
5.200000	5.610000	2.687591	.061859	2.860549	0.000000	0.000000
5.400000	5.550000	2.639257	.059572	2.851170	0.000000	0.000000
5.600000	5.540000	2.617120	.057479	2.865400	0.000000	0.000000
5.800000	5.490000	2.581588	.055727	2.852684	0.000000	0.000000
6.000000	5.430000	2.545584	.053975	2.830441	0.000000	0.000000
6.200000	5.370000	2.521215	.052320	2.796464	0.	0.
6.400000	5.310000	2.496762	.050714	2.762523	0.	0.
6.600000	5.230000	2.462807	.049205	2.644600	0.	.073386
6.800000	5.170000	2.436104	.047745	2.444667	0.	.241483
7.000000	5.160000	2.436552	.046333	2.222985	0.	.454128
7.200000	5.130000	2.435724	.045019	1.975075	0.	.674181
7.400000	5.060000	2.415644	.043900	1.722768	0.	.877687
7.600000	4.990000	2.395200	.042829	1.492641	0.	1.059328
7.800000	5.020000	2.422652	.041807	1.313138	0.	1.242402
8.000000	5.100000	2.475540	.040834	1.162799	.000112	1.420714
8.200000	5.040000	2.462040	.039860	1.002818	.000135	1.535145
8.400000	5.010000	2.462916	.038936	.870930	.000160	1.637057
8.600000	5.040000	2.493288	.038059	.766271	.000195	1.742186
8.800000	5.050000	2.513890	.037232	.674173	.000233	1.824470
9.000000	5.090000	2.550599	.036453	.598328	.000280	1.904338
9.200000	5.120000	2.581504	.035675	.532942	.000330	1.969548
9.400000	5.060000	2.566938	.034945	.471503	.000395	1.986218
9.600000	5.180000	2.643872	.034215	.430177	.000470	2.071265
9.800000	5.130000	2.634255	.033533	.386528	.000560	2.075123
10.000000	5.130000	2.649132	.032900	.352199	.000680	2.095087
10.200000	5.200000	2.700360	.032316	.325617	.000810	2.140895
10.400000	5.260000	2.746772	.031732	.302651	.000950	2.177894
10.600000	5.240000	2.751524	.031148	.281249	.001150	2.174928
10.800000	5.240000	2.766720	.030613	.263728	.001380	2.177558
11.000000	5.240000	2.781392	.030078	.249024	.001640	2.177865
11.200000	5.250000	2.800875	.029542	.236818	.001950	2.180813
11.400000	5.250000	2.815050	.029055	.226414	.002290	2.177190
11.600000	5.250000	2.828175	.028569	.217682	.002690	2.172883
11.800000	5.250000	2.842350	.028082	.210309	.003150	2.166108
12.000000	5.240000	2.851084	.027644	.204027	.003700	2.153543
12.200000	5.240000	2.863136	.027255	.198832	.004200	2.146576
12.400000	5.230000	2.869701	.026865	.194396	.004900	2.134137
12.600000	5.210000	2.870710	.026476	.190613	.005600	2.116599
12.800000	5.170000	2.860561	.026087	.187357	.006400	2.089594
13.000000	5.150000	2.860825	.025697	.184690	.007300	2.071487
13.200000	5.180000	2.886296	.025308	.182591	.008100	2.077704
13.400000	5.240000	2.928636	.024919	.180869	.08900	2.096676
13.600000	5.310000	2.976786	.024578	.179408	.009600	2.119627
13.800000	5.350000	3.008305	.024237	.178098	.010400	2.128958
14.000000	5.360000	3.024112	.023896	.176930	.011000	2.124060
14.200000	5.370000	3.036198	.023604	.175946	.011600	2.122651
14.400000	5.370000	3.042642	.023312	.175095	.012000	2.116949
14.600000	5.360000	3.042872	.023020	.174362	.012500	2.107244
14.800000	5.380000	3.060144	.022728	.173760	.012900	2.110466
15.000000	5.460000	3.112200	.022436	.173282	.013300	2.138781

HF-178 CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N
1.000E-09	31.6975	6.0500	25.6475			
1.100E-09	30.5039	6.0500	24.4539			
1.200E-09	29.4628	6.0500	23.4128			
1.300E-09	28.5443	6.0500	22.4943			
1.400E-09	27.7261	6.0500	21.6761			

1.500E-09	26.9911	6.0500	20.9411
1.600E-09	26.3261	6.0500	20.2761
1.700E-09	25.7207	6.0500	19.6707
1.800E-09	25.1665	6.0500	19.1165
1.900E-09	24.6566	6.0500	18.6066
2.000E-09	24.1855	6.0500	18.1355
2.200E-09	23.3415	6.0500	17.2915
2.400E-09	22.6054	6.0500	16.5554
2.600E-09	21.9559	6.0500	15.9059
2.800E-09	21.3773	6.0500	15.3273
3.000E-09	20.8576	6.0500	14.8076
3.200E-09	20.3874	6.0500	14.3374
3.400E-09	19.9593	6.0500	13.9093
3.700E-09	19.3835	6.0500	13.3335
4.000E-09	18.8737	6.0500	12.8237
4.300E-09	18.4183	6.0500	12.3683
4.600E-09	18.0082	6.0500	11.9582
5.000E-09	17.5199	6.0500	11.4699
5.500E-09	16.9861	6.0500	10.9361
6.000E-09	16.5205	6.0500	10.4705
6.500E-09	16.1098	6.0500	10.0598
7.000E-09	15.7438	6.0500	9.6938
7.500E-09	15.4151	6.0500	9.3651
8.000E-09	15.1177	6.0500	9.0677
8.500E-09	14.8470	6.0500	8.7970
9.000E-09	14.5992	6.0500	8.5492
9.500E-09	14.3711	6.0500	8.3211
1.000E-08	14.1604	6.0500	8.1104
1.100E-08	13.7830	6.0500	7.7330
1.200E-08	13.4538	6.0500	7.4038
1.300E-08	13.1633	6.0500	7.1133
1.400E-08	12.9046	6.0500	6.8546
1.500E-08	12.6721	6.0500	6.6221
1.600E-08	12.4619	6.0500	6.4119
1.700E-08	12.2704	6.0500	6.2204
1.800E-08	12.0952	6.0500	6.0452
1.900E-08	11.9339	6.0500	5.8839
2.000E-08	11.7849	6.0500	5.7349
2.200E-08	11.5181	6.0500	5.4681
2.400E-08	11.2853	6.0500	5.2353
2.600E-08	11.0799	6.0500	5.0299
2.800E-08	10.8969	6.0500	4.8469
3.000E-08	10.7326	6.0500	4.6826
3.200E-08	10.5839	6.0500	4.5339
3.400E-08	10.4485	6.0500	4.3985
3.700E-08	10.2664	6.0500	4.2164
4.000E-08	10.1052	6.0500	4.0552
4.300E-08	9.9612	6.0500	3.9112
4.600E-08	9.8315	6.0500	3.7815
5.000E-08	9.6771	6.0500	3.6271
5.500E-08	9.5083	6.0500	3.4583
6.000E-08	9.3611	6.0500	3.3111
6.500E-08	9.2312	6.0500	3.1812
7.000E-08	9.1155	6.0500	3.0655
7.500E-08	9.0115	6.0500	2.9615
8.000E-08	8.9175	6.0500	2.8675
8.500E-08	8.8319	6.0500	2.7819
9.000E-08	8.7535	6.0500	2.7035

1.000E-07	8.6147	6.0500	2.5647
1.100E-07	8.4954	6.0500	2.4454
1.200E-07	8.3913	6.0500	2.3413
1.300E-07	8.2994	6.0500	2.2494
1.400E-07	8.2176	6.0500	2.1676
1.500E-07	8.1441	6.0500	2.0941
.00000016	8.07761	6.05000	2.02761
.00000017	8.01707	6.05000	1.96707
.00000018	7.96165	6.05000	1.91165
.00000019	7.91066	6.05000	1.86066
.00000020	7.86355	6.05000	1.81355
.00000022	7.77915	6.05000	1.72915
.00000024	7.70553	6.05000	1.65553
.00000026	7.64059	6.05000	1.59059
.00000028	7.58273	6.05000	1.53273
.00000030	7.53075	6.05000	1.48075
.00000033	7.46184	6.05000	1.41184
.00000036	7.40174	6.05000	1.35174
.00000040	7.33237	6.05000	1.28237
.00000043	7.28683	6.05000	1.23683
.00000046	7.24582	6.05000	1.19582
.00000050	7.19699	6.05000	1.14699
.00000055	7.14361	6.05000	1.09361
.00000060	7.09705	6.05000	1.04705
.00000065	7.05597	6.05000	1.00597
.00000070	7.01938	6.05000	.96938
.00000075	6.98651	6.05000	.93651
.00000080	6.95677	6.05000	.90677
.00000085	6.92970	6.05000	.87970
.00000090	6.90491	6.05000	.85491
.00000100	6.86104	6.05000	.81104
.00000110	6.82330	6.05000	.77330
.00000120	6.79037	6.05000	.74037
.00000130	6.76133	6.05000	.71133
.00000140	6.73545	6.05000	.68545
.00000150	6.71221	6.05000	.66221
.00000160	6.69118	6.05000	.64118
.00000170	6.67204	6.05000	.62204
.00000180	6.65451	6.05000	.60451
.00000190	6.63839	6.05000	.58839
.00000200	6.62349	6.05000	.57349
.00000220	6.59680	6.05000	.54680
.00000240	6.57352	6.05000	.52352
.00000260	6.55298	6.05000	.50298
.00000280	6.53469	6.05000	.48469
.00000300	6.51825	6.05000	.46825
.00000330	6.49646	6.05000	.44646
.00000360	6.47745	6.05000	.42745
.00000400	6.45552	6.05000	.40552
.00000430	6.44112	6.05000	.39112
.00000460	6.42815	6.05000	.37815
.00000500	6.41271	6.05000	.36271
.00000550	6.39583	6.05000	.34583
.00000600	6.38110	6.05000	.33110
.00000650	6.36811	6.05000	.31811
.00000700	6.35654	6.05000	.30654
.00000750	6.34615	6.05000	.29615
.00000800	6.33674	6.05000	.28674

.00000850	6.32818	6.05000	.27818
.00000900	6.32034	6.05000	.27034
.00001000	6.30647	6.05000	.25647
.00001100	6.29453	6.05000	.24453
.00001200	6.28412	6.05000	.23412
.00001300	6.27494	6.05000	.22494
.00001400	6.26676	6.05000	.21676
.00001500	6.25941	6.05000	.20941
.00001600	6.25276	6.05000	.20276
.00001700	6.24670	6.05000	.19670
.00001800	6.24116	6.05000	.19116
.00001900	6.23606	6.05000	.18606
.00002000	6.23135	6.05000	.18135
.00002200	6.22291	6.05000	.17291
.00002400	6.21555	6.05000	.16555
.00002600	6.20905	6.05000	.15905
.00002800	6.20327	6.05000	.15327
.00003000	6.19807	6.05000	.14807
.00003300	6.19118	6.05000	.14118
.00003600	6.18517	6.05000	.13517
.00004000	6.17823	6.05000	.12823
.00004300	6.17368	6.05000	.12368
.00004600	6.16958	6.05000	.11958
.00005000	6.16469	6.05000	.11469
.00005500	6.15936	6.05000	.10936
.00006000	6.15470	6.05000	.10470
.00006500	6.15059	6.05000	.10059
.00007000	6.14693	6.05000	.09693
.00007500	6.14365	6.05000	.09365
.00008000	6.14067	6.05000	.09067
.00008500	6.13797	6.05000	.08797
.00009000	6.13549	6.05000	.08549
.00010000	6.13110	6.05000	.08110
.00010130	6.13058	6.05000	.08058
.00010140	6.13054	6.05000	.08054
.00011000	6.12733	6.05000	.07733
.00012000	6.12403	6.05000	.07403
.00013010	6.12110	6.05000	.07110
.00013020	6.12107	6.05000	.07107
.00014000	6.11854	6.05000	.06854
.00015000	6.11622	6.05000	.06622
.00016000	6.11411	6.05000	.06411
.00016700	6.11276	6.05000	.06276
.00016710	6.11274	6.05000	.06274
.00017000	6.11220	6.05000	.06220
.00018000	6.11045	6.05000	.06045
.00019000	6.10883	6.05000	.05883
.00020000	6.10734	6.05000	.05734
.00022000	6.10468	6.05000	.05468
.00024000	6.10235	6.05000	.05235
.00026000	6.10029	6.05000	.05029
.00027540	6.09887	6.05000	.04887
.00027550	6.09886	6.05000	.04886
.00030000	6.09682	6.05000	.04682
.00033000	6.09464	6.05000	.04464
.00036000	6.09274	6.05000	.04274
.00040000	6.09055	6.05000	.04055
.00043000	6.08911	6.05000	.03911

.00045400	6.08806	6.05000	.03806
.00045410	8.954	8.580	0.374
.00050000	8.954	8.580	0.374
.00055000	8.954	8.580	0.374
.00060000	8.954	8.580	0.374
.00065000	8.954	8.580	0.374
.00070000	8.954	8.580	0.374
.00074850	8.954	8.580	0.374
.00074860	9.755	8.280	1.475
.00080000	9.755	8.280	1.475
.00090000	9.755	8.280	1.475
.00100000	9.755	8.280	1.475
.00110000	9.755	8.280	1.475
.00120000	9.755	8.280	1.475
.00123400	9.755	8.280	1.475
.00123410	34.251071	31.410048	2.841023
.001300	33.269825	30.593000	2.676825
.001400	32.282267	29.773224	2.509043
.001500	31.395278	29.032993	2.362285
.001600	30.592877	28.360079	2.232798
.001700	29.862434	27.744757	2.117677
.001800	29.193803	27.179166	2.014637
.001900	28.578739	26.656881	1.921858
.002000	28.010455	26.172338	1.838117
.002200	26.992584	25.299999	1.692585
.002400	26.104928	24.534800	1.570128
.002600	25.321923	23.856286	1.465637
.002800	24.624519	23.249102	1.375417
.003000	23.998193	22.701468	1.296725
.003200	23.431651	22.204375	1.227276
.003400	22.915960	21.750361	1.165599
.003700	22.222463	21.137274	1.085189
.004000	21.608699	20.592203	1.016496
.004300	21.060497	20.103353	.957144
.004600	20.566973	19.661611	.905362
.005000	19.979553	19.133657	.845896
.005500	19.337681	18.553935	.783746
.006000	18.778066	18.046225	.731841
.006500	18.284554	17.596676	.687878
.007000	17.845107	17.194910	.650197
.007500	17.450544	16.832975	.617569
.008000	17.093730	16.504689	.589041
.008500	16.769024	16.205111	.563913
.009000	16.471892	15.930247	.541645
.010000	15.946278	15.442280	.503998
.011000	15.494452	15.020977	.473475
.012000	15.100674	14.652360	.448314
.013000	14.753531	14.326221	.427310
.014000	14.444522	14.034965	.409557
.015000	14.167167	13.772769	.394398
.016000	13.916426	13.535083	.381343
.017000	13.688317	13.318298	.370019
.018000	13.479642	13.119509	.360133
.019000	13.287803	12.936347	.351456
.020000	13.110661	12.766877	.343784
.022000	12.793649	12.462724	.330925
.024000	12.517499	12.196808	.320691
.026000	12.274167	11.961714	.312453

.028000	12.057657	11.751896	.305761			
.030000	11.863400	11.563114	.300286			
.032000	11.687847	11.392078	.295769			
.034000	11.528190	11.236158	.292032			
.037000	11.304651	11.026105	.278546			
.040000	11.106613	10.839837	.266776			
.043000	10.929484	10.673169	.256315			
.046000	10.771349	10.522881	.248468			
.050000	10.580388	10.343689	.236699			
.055000	10.372419	10.147490	.224929			
.060000	10.191862	9.976087	.215775			
.065000	10.031273	9.824652	.206621			
.070000	9.885737	9.689578	.196159			
.075000	9.759040	9.568112	.190928			
.080000	9.641198	9.458116	.183082			
.085000	9.535737	9.357886	.177851			
.090000	9.438672	9.266052	.172620			
.100000	9.266781	8.958430	.163466	.144884		
.200000	8.329148	7.556491	.111157	.661498		
.300000	7.913079	6.792387	.089579	1.031111		
.400000	7.664156	6.273794	.076502	1.313859		
.500000	7.494403	5.904831	.068001	1.521570		
.600000	7.369983	5.618464	.062771	1.688746		
.700000	7.272938	5.441359	.058455	1.773123		
.800000	7.195910	5.300340	.056232	1.839337		
.900000	7.132339	5.197007	.054663	1.880668		
1.000000	7.078158	5.119993	.052963	1.905201		
1.100000	7.025000	5.055132	.051786	1.918080		
1.200000	7.018000	4.997832	.051001	1.969165		
1.300000	7.010000	4.904450	.050478	2.055071		
1.400000	7.006000	4.838338	.049432	2.118229		
1.500000	7.007000	4.771540	.047862	2.187597		
1.600000	7.009000	4.736856	.046424	2.225718		
1.700000	7.015000	4.651077	.044855	2.319067		
1.800000	7.025000	4.590713	.043678	2.390607		
1.900000	7.045000	4.549208	.042370	2.453421		
2.000000	7.070000	4.520306	.041062	2.508631		
2.200000	7.110000	4.550224	.037662	2.522112	0.000000	0.000000
2.400000	7.110000	4.544840	.034916	2.530243	0.000000	0.000000
2.600000	7.040000	4.487891	.032301	2.519807	0.000000	0.000000
2.800000	6.930000	4.400357	.029947	2.499695	0.000000	0.000000
3.000000	6.840000	4.319217	.028116	2.492666	0.000000	0.000000
3.200000	6.740000	4.230403	.026416	2.483180	0.000000	0.000000
3.400000	6.680000	4.162776	.024977	2.492245	0.000000	0.000000
3.600000	6.560000	4.056787	.023669	2.479542	0.000000	0.000000
3.800000	6.440000	3.949027	.022493	2.468479	0.000000	0.000000
4.000000	6.300000	3.829151	.021316	2.449532	0.000000	0.000000
4.200000	6.190000	3.727573	.020400	2.442026	0.000000	0.000000
4.400000	6.050000	3.609369	.019511	2.421119	0.000000	0.000000
4.600000	5.950000	3.515773	.018700	2.415526	0.000000	0.000000
4.800000	5.850000	3.424656	.017968	2.407375	0.000000	0.000000
5.000000	5.780000	3.351228	.017262	2.411509	0.000000	0.000000
5.200000	5.610000	3.221893	.016621	2.371485	0.000000	0.000000
5.400000	5.550000	3.157033	.016006	2.376960	0.000000	0.000000
5.600000	5.540000	3.123175	.015444	2.401380	0.000000	0.000000
5.800000	5.490000	3.066772	.014973	2.408253	0.000000	0.000000
6.000000	5.430000	3.007134	.014502	2.408363	0.000000	0.000000
6.200000	5.370000	2.950278	.014058	2.405663	0.	0.

6.400000	5.310000	2.893419	.013626	2.402954	0.	0.
6.600000	5.230000	2.826292	.013221	2.390486	0.	0.
6.800000	5.170000	2.770603	.012828	2.386568	0.	0.
7.000000	5.160000	2.742024	.012449	2.405526	0.	0.
7.200000	5.130000	2.707101	.012096	2.410802	0.	0.
7.400000	5.060000	2.651946	.011795	2.396258	0.	0.
7.600000	4.990000	2.597295	.011508	2.381197	0.	0.
7.800000	5.020000	2.594838	.011233	2.411909	0.	.002019
8.000000	5.100000	2.617830	.010971	2.407905	0.	.063292
8.200000	5.040000	2.574936	.010710	2.275230	0.	.179123
8.400000	5.010000	2.548086	.010461	2.128274	0.	.323177
8.600000	5.040000	2.551752	.010226	1.993317	0.	.484704
8.800000	5.050000	2.545200	.010004	1.848013	0.	.646782
9.000000	5.090000	2.553653	.009794	1.716056	0.	.810495
9.200000	5.120000	2.565120	.009585	1.583707	0.	.961586
9.400000	5.060000	2.531012	.009389	1.441702	.000100	1.077795
9.600000	5.180000	2.586892	.009193	1.351433	.000117	1.232364
9.800000	5.130000	2.557818	.009010	1.238628	.000140	1.324403
10.000000	5.130000	2.553714	.008840	1.147722	.000170	1.419552
10.200000	5.200000	2.591160	.008683	1.075191	.000205	1.524760
10.400000	5.260000	2.623688	.008526	1.009714	.000245	1.617825
10.600000	5.240000	2.616332	.008369	.944535	.000295	1.670468
10.800000	5.240000	2.618952	.008225	.890120	.000350	1.722351
11.000000	5.240000	2.621048	.008081	.843304	.000420	1.767145
11.200000	5.250000	2.632875	.007937	.803057	.000500	1.805629
11.400000	5.250000	2.639700	.007807	.767965	.000600	1.833927
11.600000	5.250000	2.646525	.007676	.737918	.000720	1.857160
11.800000	5.250000	2.653350	.007545	.712210	.000860	1.876033
12.000000	5.240000	2.655108	.007427	.689910	.001030	1.886524
12.200000	5.240000	2.663492	.007323	.671077	.001250	1.896857
12.400000	5.230000	2.666777	.007218	.654765	.001500	1.899739
12.600000	5.210000	2.664915	.007114	.640670	.001800	1.895500
12.800000	5.170000	2.652727	.007009	.628350	.002150	1.879763
13.000000	5.150000	2.650190	.006904	.618236	.002530	1.872138
13.200000	5.180000	2.674434	.006800	.610239	.002950	1.885576
13.400000	5.240000	2.714320	.006695	.603678	.003500	1.911805
13.600000	5.310000	2.759607	.006604	.598077	.004100	1.941611
13.800000	5.350000	2.789490	.006512	.592964	.004800	1.956233
14.000000	5.360000	2.804352	.006420	.588339	.005500	1.955388
14.200000	5.370000	2.819250	.006342	.584375	.006300	1.953732
14.400000	5.370000	2.828916	.006264	.580925	.007200	1.946694
14.600000	5.360000	2.833296	.006185	.577930	.008200	1.934388
14.800000	5.380000	2.853552	.006107	.575484	.009100	1.935756
15.000000	5.460000	2.904720	.006028	.573581	.010000	1.965670

HF-179 CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N
1.000E-09	311.4258	6.0500	305.3758			
1.100E-09	297.2144	6.0500	291.1644			
1.200E-09	284.8187	6.0500	278.7687			
1.300E-09	273.8823	6.0500	267.8323			
1.400E-09	264.1397	6.0500	258.0897			
1.500E-09	255.3883	6.0500	249.3383			
1.600E-09	247.4708	6.0500	241.4208			
1.700E-09	240.2626	6.0500	234.2126			
1.800E-09	233.6637	6.0500	227.6137			
1.900E-09	227.5929	6.0500	221.5429			
2.000E-09	221.9833	6.0500	215.9333			
2.200E-09	211.9344	6.0500	205.8844			

2.400E-09	203.1693	6.0500	197.1193
2.600E-09	195.4361	6.0500	189.3861
2.800E-09	188.5470	6.0500	182.4970
3.000E-09	182.3588	6.0500	176.3088
3.200E-09	176.7603	6.0500	170.7103
3.400E-09	171.6633	6.0500	165.6133
3.700E-09	164.8073	6.0500	158.7573
4.000E-09	158.7379	6.0500	152.6879
4.300E-09	153.3153	6.0500	147.2653
4.600E-09	148.4322	6.0500	142.3822
5.000E-09	142.6182	6.0500	136.5682
5.500E-09	136.2627	6.0500	130.2127
6.000E-09	130.7192	6.0500	124.6692
6.500E-09	125.8283	6.0500	119.7783
7.000E-09	121.4712	6.0500	115.4212
7.500E-09	117.5575	6.0500	111.5075
8.000E-09	114.0167	6.0500	107.9667
8.500E-09	110.7930	6.0500	104.7430
9.000E-09	107.8419	6.0500	101.7919
9.500E-09	105.1270	6.0500	99.0770
1.000E-08	102.6183	6.0500	96.5683
1.100E-08	98.1243	6.0500	92.0743
1.200E-08	94.2044	6.0500	88.1544
1.300E-08	90.7460	6.0500	84.6960
1.400E-08	87.6651	6.0500	81.6151
1.500E-08	84.8977	6.0500	78.8477
1.600E-08	82.3940	6.0500	76.3440
1.700E-08	80.1145	6.0500	74.0645
1.800E-08	78.0278	6.0500	71.9778
1.900E-08	76.1080	6.0500	70.0580
2.000E-08	74.3341	6.0500	68.2841
2.200E-08	71.1563	6.0500	65.1063
2.400E-08	68.3846	6.0500	62.3346
2.600E-08	65.9391	6.0500	59.8891
2.800E-08	63.7606	6.0500	57.7106
3.000E-08	61.8037	6.0500	55.7537
3.200E-08	60.0333	6.0500	53.9833
3.400E-08	58.4215	6.0500	52.3715
3.700E-08	56.2535	6.0500	50.2035
4.000E-08	54.3342	6.0500	48.2842
4.300E-08	52.6194	6.0500	46.5694
4.600E-08	51.0752	6.0500	45.0252
5.000E-08	49.2367	6.0500	43.1867
5.500E-08	47.2269	6.0500	41.1769
6.000E-08	45.4739	6.0500	39.4239
6.500E-08	43.9272	6.0500	37.8772
7.000E-08	42.5494	6.0500	36.4994
7.500E-08	41.3118	6.0500	35.2618
8.000E-08	40.1921	6.0500	34.1421
8.500E-08	39.1727	6.0500	33.1227
9.000E-08	38.2394	6.0500	32.1894
1.000E-07	36.5876	6.0500	30.5376
1.100E-07	35.1664	6.0500	29.1164
1.200E-07	33.9269	6.0500	27.8769
1.300E-07	32.8332	6.0500	26.7832
1.400E-07	31.8590	6.0500	25.8090
1.500E-07	30.9838	6.0500	24.9338
.00000016	30.19208	6.05000	24.14208

.00000017	29.47126	6.05000	23.42126
.00000018	28.81137	6.05000	22.76137
.00000019	28.20429	6.05000	22.15429
.00000020	27.64333	6.05000	21.59333
.00000022	26.63844	6.05000	20.58844
.00000024	25.76193	6.05000	19.71193
.00000026	24.98861	6.05000	18.93861
.00000028	24.29970	6.05000	18.24970
.00000030	23.68088	6.05000	17.63088
.00000033	22.86039	6.05000	16.81039
.00000036	22.14472	6.05000	16.09472
.00000040	21.31879	6.05000	15.26879
.00000043	20.77653	6.05000	14.72653
.00000046	20.28822	6.05000	14.23822
.00000050	19.70682	6.05000	13.65682
.00000055	19.07127	6.05000	13.02127
.00000060	18.51691	6.05000	12.46691
.00000065	18.02782	6.05000	11.97782
.00000070	17.59212	6.05000	11.54212
.00000075	17.20075	6.05000	11.15075
.00000080	16.84666	6.05000	10.79666
.00000085	16.52430	6.05000	10.47430
.00000090	16.22919	6.05000	10.17919
.00000100	15.70683	6.05000	9.65683
.00000110	15.25743	6.05000	9.20743
.00000120	14.86544	6.05000	8.81544
.00000130	14.51960	6.05000	8.46960
.00000140	14.21151	6.05000	8.16151
.00000150	13.93477	6.05000	7.88477
.00000160	13.68439	6.05000	7.63439
.00000170	13.45645	6.05000	7.40645
.00000180	13.24777	6.05000	7.19777
.00000190	13.05580	6.05000	7.00580
.00000200	12.87841	6.05000	6.82841
.00000220	12.56063	6.05000	6.51063
.00000240	12.28345	6.05000	6.23345
.00000260	12.03891	6.05000	5.98891
.00000280	11.82106	6.05000	5.77106
.00000300	11.62537	6.05000	5.57537
.00000330	11.36591	6.05000	5.31591
.00000360	11.13959	6.05000	5.08959
.00000400	10.87841	6.05000	4.82841
.00000430	10.70693	6.05000	4.65693
.00000460	10.55252	6.05000	4.50252
.00000500	10.36866	6.05000	4.31866
.00000550	10.16768	6.05000	4.11768
.00000600	9.99238	6.05000	3.94238
.00000650	9.83772	6.05000	3.78772
.00000700	9.69994	6.05000	3.64994
.00000750	9.57617	6.05000	3.52617
.00000800	9.46420	6.05000	3.41420
.00000850	9.36226	6.05000	3.31226
.00000900	9.26894	6.05000	3.21894
.00001000	9.10375	6.05000	3.05375
.00001100	8.96164	6.05000	2.91164
.00001200	8.83768	6.05000	2.78768
.00001300	8.72832	6.05000	2.67832
.00001400	8.63089	6.05000	2.58089

.00001500	8.54338	6.05000	2.49338
.00001600	8.46420	6.05000	2.41420
.00001700	8.39212	6.05000	2.34212
.00001800	8.32613	6.05000	2.27613
.00001900	8.26542	6.05000	2.21542
.00002000	8.20933	6.05000	2.15933
.00002200	8.10884	6.05000	2.05884
.00002400	8.02119	6.05000	1.97119
.00002600	7.94386	6.05000	1.89386
.00002800	7.87497	6.05000	1.82497
.00003000	7.81308	6.05000	1.76308
.00003300	7.73103	6.05000	1.68103
.00003600	7.65947	6.05000	1.60947
.00004000	7.57687	6.05000	1.52687
.00004300	7.52265	6.05000	1.47265
.00004600	7.47382	6.05000	1.42382
.00005000	7.41568	6.05000	1.36568
.00005500	7.35212	6.05000	1.30212
.00006000	7.29669	6.05000	1.24669
.00006500	7.24778	6.05000	1.19778
.00007000	7.20421	6.05000	1.15421
.00007500	7.16507	6.05000	1.11507
.00008000	7.12966	6.05000	1.07966
.00008500	7.09743	6.05000	1.04743
.00009000	7.06791	6.05000	1.01791
.00010000	7.01568	6.05000	.96568
.00010130	7.00946	6.05000	.95946
.00010140	7.00899	6.05000	.95899
.00011000	6.97074	6.05000	.92074
.00012000	6.93154	6.05000	.88154
.00013010	6.89663	6.05000	.84663
.00013020	6.89630	6.05000	.84630
.00014000	6.86615	6.05000	.81615
.00015000	6.83847	6.05000	.78847
.00016000	6.81343	6.05000	.76343
.00016700	6.79726	6.05000	.74726
.00016710	6.79704	6.05000	.74704
.00017000	6.79064	6.05000	.74064
.00018000	6.76977	6.05000	.71977
.00019000	6.75058	6.05000	.70058
.00020000	6.73284	6.05000	.68284
.00022000	6.70106	6.05000	.65106
.00024000	6.67334	6.05000	.62334
.00026000	6.64889	6.05000	.59889
.00027540	6.63190	6.05000	.58190
.00027550	14.430	6.050	8.380
.00030000	14.430	6.050	8.380
.00033000	14.430	6.050	8.380
.00036000	14.430	6.050	8.380
.00040000	14.430	6.050	8.380
.00043000	14.430	6.050	8.380
.00045400	14.430	6.050	8.380
.00045410	13.410	6.050	7.360
.00050000	13.410	6.050	7.360
.00055000	13.410	6.050	7.360
.00060000	13.410	6.050	7.360
.00065000	13.410	6.050	7.360
.00070000	13.410	6.050	7.360

.00074850	13.410	6.050	7.360
.00074860	20.770	12.670	8.100
.00080000	20.770	12.670	8.100
.00090000	20.770	12.670	8.100
.00100000	20.770	12.670	8.100
.00110000	20.770	12.670	8.100
.00120000	20.770	12.670	8.100
.00123400	20.770	12.670	8.100
.00123410	30.541775	22.190031	8.351744
.001300	29.688991	21.773297	7.915694
.001400	28.831693	21.356362	7.475331
.001500	28.061705	20.976203	7.085502
.001600	27.365157	20.627450	6.737707
.001700	26.731087	20.305801	6.425286
.001800	26.150681	20.007743	6.142938
.001900	25.616780	19.727727	5.889053
.002000	25.123497	19.465112	5.658385
.002200	24.239976	18.988248	5.251728
.002400	23.469507	18.565255	4.904252
.002600	22.789892	18.186303	4.603589
.002800	22.184594	17.843950	4.340644
.003000	21.641003	17.530776	4.110227
.003200	21.149309	17.242462	3.906847
.003400	20.701763	16.977279	3.724484
.003700	20.099929	16.616356	3.483573
.004000	19.567312	16.292624	3.274688
.004300	19.091607	15.999895	3.091712
.004600	18.663369	15.733356	2.930013
.005000	18.153680	15.410834	2.742846
.005500	17.596778	15.053524	2.543254
.006000	17.111279	14.737648	2.373631
.006500	16.683158	14.455553	2.227605
.007000	16.301962	14.201454	2.100508
.007500	15.959725	13.970390	1.989335
.008000	15.650251	13.758754	1.891497
.008500	15.368643	13.564491	1.804152
.009000	15.110966	13.385286	1.725680
.010000	14.655190	13.064779	1.590411
.011000	14.263450	12.785534	1.477916
.012000	13.922078	12.538915	1.383163
.013000	13.621172	12.318803	1.302369
.014000	13.353354	12.120970	1.232384
.015000	13.112997	11.941818	1.171179
.016000	12.895731	11.778526	1.117205
.017000	12.698098	11.628837	1.069261
.018000	12.517323	11.490927	1.026396
.019000	12.351150	11.363203	.987947
.020000	12.197724	11.244488	.953236
.022000	11.923197	11.030237	.892960
.024000	11.684106	10.841650	.842456
.026000	11.473469	10.673905	.799564
.028000	11.286084	10.523368	.762716
.030000	11.117990	10.387045	.730945
.032000	10.966108	10.262774	.703334
.034000	10.828000	10.149028	.678972
.037000	10.642718	9.995096	.647622
.040000	10.478170	9.857913	.620257
.043000	10.330542	9.734608	.595934

.046000	10.200652	9.622961	.577691			
.050000	10.039541	9.489215	.550326			
.055000	9.865000	9.342038	.522962			
.060000	9.714496	9.212817	.501679			
.065000	9.578532	9.098137	.480395			
.070000	9.451507	8.995435	.456072			
.075000	9.346620	8.902710	.443910			
.080000	9.244083	8.818416	.425667			
.085000	9.154876	8.741371	.413505			
.090000	9.071927	8.670584	.401343			
.100000	8.924739	8.544678	.380060	0.000000		
.150000	8.414827	8.111691	.303135	0.000000		
.200000	8.107331	7.504255	.258440	.344635		
.250000	7.896921	6.863241	.229556	.804123		
.300000	7.740507	6.468214	.208272	1.064020		
.350000	7.618086	6.177466	.191550	1.249069		
.400000	7.518755	5.957765	.177868	1.383121		
.450000	7.436859	5.788977	.167226	1.480654		
.500000	7.367232	5.651464	.158104	1.557663		
.550000	7.308933	5.333351	.152024	1.823557		
.600000	7.257179	5.196481	.145943	1.914754		
.650000	7.210704	5.040131	.139862	2.030710		
.700000	7.170688	4.942327	.135909	2.092451		
.750000	7.136106	4.868661	.133781	2.133663		
.800000	7.103653	4.785754	.130740	2.187158		
.850000	7.074705	4.728004	.128612	2.218088		
.900000	7.048596	4.674070	.127092	2.247433		
.950000	7.023814	4.630271	.124963	2.268580		
1.000000	7.001031	4.593751	.123139	2.284140		
1.100000	6.955000	4.493840	.120403	2.340756		
1.200000	6.940000	4.434673	.118578	2.386748		
1.300000	6.945000	4.407735	.116754	2.420511		
1.400000	6.950000	4.380796	.114930	2.454273		
1.500000	6.960000	4.289675	.111434	2.558891		
1.600000	6.970000	4.198554	.107937	2.663508		
1.700000	6.990000	4.211081	.104745	2.674174		
1.800000	7.010000	4.223607	.101552	2.684840		
1.900000	7.040000	4.181787	.098511	2.759701		
2.000000	7.070000	4.139966	.095471	2.834562		
2.200000	7.110000	4.140280	.087565	2.882153	0.000000	0.000000
2.400000	7.110000	4.106254	.081180	2.922564	0.000000	0.000000
2.600000	7.040000	4.024057	.075099	2.940842	0.000000	0.000000
2.800000	6.930000	3.914372	.069627	2.946000	0.000000	0.000000
3.000000	6.840000	3.813375	.065370	2.961254	0.000000	0.000000
3.200000	6.740000	3.705099	.061417	2.973483	0.000000	0.000000
3.400000	6.680000	3.619068	.058073	3.002858	0.000000	0.000000
3.600000	6.560000	3.502288	.055032	3.002679	0.000000	0.000000
3.800000	6.440000	3.387951	.052296	2.999752	0.000000	0.000000
4.000000	6.300000	3.264323	.049559	2.986116	0.000000	0.000000
4.200000	6.190000	3.161063	.047431	2.981504	0.000000	0.000000
4.400000	6.050000	3.045398	.045363	2.959238	0.000000	0.000000
4.600000	5.950000	2.954657	.043478	2.951864	0.000000	0.000000
4.800000	5.850000	2.867025	.041776	2.941198	0.000000	0.000000
5.000000	5.780000	2.800472	.040134	2.939393	0.000000	0.000000
5.200000	5.610000	2.687591	.038644	2.883764	0.000000	0.000000
5.400000	5.550000	2.639257	.037215	2.873527	0.000000	0.000000
5.600000	5.540000	2.617120	.035908	2.886971	0.000000	0.000000
5.800000	5.490000	2.581588	.034813	2.873598	0.000000	0.000000

6.000000	5.430000	2.545584	.033718	2.850697	0.000000	0.000000
6.200000	5.370000	2.521215	.032685	2.789679	0.	.026420
6.400000	5.310000	2.496762	.031681	2.610494	0.	.171061
6.600000	5.230000	2.462807	.030739	2.357809	0.	.378644
6.800000	5.170000	2.436104	.029827	2.096692	0.	.607376
7.000000	5.160000	2.436552	.028945	1.855488	0.	.839014
7.200000	5.130000	2.435724	.028124	1.617269	0.	1.048882
7.400000	5.060000	2.415644	.027425	1.392099	0.	1.224831
7.600000	4.990000	2.395200	.026756	1.195523	0.	1.372520
7.800000	5.020000	2.422652	.026117	1.045366	0.	1.525863
8.000000	5.100000	2.475540	.025509	.922316	0.	1.676633
8.200000	5.040000	2.462040	.024901	.795572	0.	1.757486
8.400000	5.010000	2.462916	.024323	.692522	0.	1.830238
8.600000	5.040000	2.493288	.023776	.611542	0.	1.911393
8.800000	5.050000	2.513890	.023259	.541168	0.	1.971681
9.000000	5.090000	2.550599	.022773	.483695	0.	2.032932
9.200000	5.120000	2.581504	.022286	.434577	0.	2.081631
9.400000	5.060000	2.566938	.021830	.388903	0.	2.082327
9.600000	5.180000	2.643872	.021374	.358170	0.	2.156583
9.800000	5.130000	2.634255	.020948	.326086	0.	2.148709
10.000000	5.130000	2.649132	.020553	.300934	.000115	2.159264
10.200000	5.200000	2.700360	.020188	.281512	.000134	2.197805
10.400000	5.260000	2.746772	.019823	.264806	.000160	2.228437
10.600000	5.240000	2.751524	.019459	.249327	.000190	2.219499
10.800000	5.240000	2.766720	.019124	.236691	.000225	2.217238
11.000000	5.240000	2.781392	.018790	.226118	.000270	2.213429
11.200000	5.250000	2.800875	.018455	.217365	.000323	2.212980
11.400000	5.250000	2.815050	.018151	.209924	.000380	2.206494
11.600000	5.250000	2.828175	.017847	.203693	.000450	2.199834
11.800000	5.250000	2.842350	.017543	.198443	.000540	2.191122
12.000000	5.240000	2.851084	.017269	.193980	.000650	2.177015
12.200000	5.240000	2.863136	.017026	.190295	.000770	2.168772
12.400000	5.230000	2.869701	.016783	.187155	.000910	2.155450
12.600000	5.210000	2.870710	.016540	.184481	.001080	2.137188
12.800000	5.170000	2.860561	.016296	.182183	.001280	2.109678
13.000000	5.150000	2.860825	.016053	.180304	.001480	2.091336
13.200000	5.180000	2.886296	.015810	.178825	.001700	2.097368
13.400000	5.240000	2.928636	.015567	.177611	.002000	2.116185
13.600000	5.310000	2.976786	.015354	.176582	.002250	2.139027
13.800000	5.350000	3.008305	.015141	.175662	.002530	2.148361
14.000000	5.360000	3.024112	.014928	.174842	.002800	2.143316
14.200000	5.370000	3.036198	.014746	.174151	.003050	2.141854
14.400000	5.370000	3.042642	.014563	.173555	.003300	2.135938
14.600000	5.360000	3.042872	.014381	.173041	.003550	2.126155
14.800000	5.380000	3.060144	.014199	.172620	.003750	2.129286
15.000000	5.460000	3.112200	.014016	.172285	.004000	2.157498

HF-180 CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N
1.000E-09	54.3471	6.0500	48.2971			
1.100E-09	52.0995	6.0500	46.0495			
1.200E-09	50.1390	6.0500	44.0890			
1.300E-09	48.4093	6.0500	42.3593			
1.400E-09	46.8685	6.0500	40.8185			
1.500E-09	45.4844	6.0500	39.4344			
1.600E-09	44.2322	6.0500	38.1822			
1.700E-09	43.0922	6.0500	37.0422			
1.800E-09	42.0485	6.0500	35.9985			
1.900E-09	41.0884	6.0500	35.0384			

2.000E-09	40.2012	6.0500	34.1512
2.200E-09	38.6119	6.0500	32.5619
2.400E-09	37.2256	6.0500	31.1756
2.600E-09	36.0026	6.0500	29.9526
2.800E-09	34.9130	6.0500	28.8630
3.000E-09	33.9343	6.0500	27.8843
3.200E-09	33.0489	6.0500	26.9989
3.400E-09	32.2428	6.0500	26.1928
3.700E-09	31.1585	6.0500	25.1085
4.000E-09	30.1985	6.0500	24.1485
4.300E-09	29.3409	6.0500	23.2909
4.600E-09	28.5686	6.0500	22.5186
5.000E-09	27.6491	6.0500	21.5991
5.500E-09	26.6439	6.0500	20.5939
6.000E-09	25.7672	6.0500	19.7172
6.500E-09	24.9937	6.0500	18.9437
7.000E-09	24.3046	6.0500	18.2546
7.500E-09	23.6856	6.0500	17.6356
8.000E-09	23.1256	6.0500	17.0756
8.500E-09	22.6158	6.0500	16.5658
9.000E-09	22.1490	6.0500	16.0990
9.500E-09	21.7196	6.0500	15.6696
1.000E-08	21.3229	6.0500	15.2729
1.100E-08	20.6121	6.0500	14.5621
1.200E-08	19.9922	6.0500	13.9422
1.300E-08	19.4452	6.0500	13.3952
1.400E-08	18.9579	6.0500	12.9079
1.500E-08	18.5203	6.0500	12.4703
1.600E-08	18.1243	6.0500	12.0743
1.700E-08	17.7638	6.0500	11.7138
1.800E-08	17.4337	6.0500	11.3837
1.900E-08	17.1301	6.0500	11.0801
2.000E-08	16.8496	6.0500	10.7996
2.200E-08	16.3470	6.0500	10.2970
2.400E-08	15.9086	6.0500	9.8586
2.600E-08	15.5218	6.0500	9.4718
2.800E-08	15.1773	6.0500	9.1273
3.000E-08	14.8678	6.0500	8.8178
3.200E-08	14.5878	6.0500	8.5378
3.400E-08	14.3329	6.0500	8.2829
3.700E-08	13.9900	6.0500	7.9400
4.000E-08	13.6864	6.0500	7.6364
4.300E-08	13.4152	6.0500	7.3652
4.600E-08	13.1710	6.0500	7.1210
5.000E-08	12.8802	6.0500	6.8302
5.500E-08	12.5624	6.0500	6.5124
6.000E-08	12.2851	6.0500	6.2351
6.500E-08	12.0405	6.0500	5.9905
7.000E-08	11.8226	6.0500	5.7726
7.500E-08	11.6269	6.0500	5.5769
8.000E-08	11.4498	6.0500	5.3998
8.500E-08	11.2886	6.0500	5.2386
9.000E-08	11.1410	6.0500	5.0910
1.000E-07	10.8797	6.0500	4.8297
1.100E-07	10.6549	6.0500	4.6049
1.200E-07	10.4589	6.0500	4.4089
1.300E-07	10.2859	6.0500	4.2359
1.400E-07	10.1318	6.0500	4.0818

1.500E-07	9.9934	6.0500	3.9434
.00000016	9.86822	6.05000	3.81822
.00000017	9.75422	6.05000	3.70422
.00000018	9.64986	6.05000	3.59986
.00000019	9.55384	6.05000	3.50384
.00000020	9.46512	6.05000	3.41512
.00000022	9.30619	6.05000	3.25619
.00000024	9.16757	6.05000	3.11757
.00000026	9.04526	6.05000	2.99526
.00000028	8.93630	6.05000	2.88630
.00000030	8.83844	6.05000	2.78844
.00000033	8.70867	6.05000	2.65867
.00000036	8.59548	6.05000	2.54548
.00000040	8.46485	6.05000	2.41485
.00000043	8.37909	6.05000	2.32909
.00000046	8.30186	6.05000	2.25186
.00000050	8.20991	6.05000	2.15991
.00000055	8.10939	6.05000	2.05939
.00000060	8.02172	6.05000	1.97172
.00000065	7.94437	6.05000	1.89437
.00000070	7.87546	6.05000	1.82546
.00000075	7.81356	6.05000	1.76356
.00000080	7.75756	6.05000	1.70756
.00000085	7.70658	6.05000	1.65658
.00000090	7.65990	6.05000	1.60990
.00000100	7.57729	6.05000	1.52729
.00000110	7.50621	6.05000	1.45621
.00000120	7.44422	6.05000	1.39422
.00000130	7.38952	6.05000	1.33952
.00000140	7.34079	6.05000	1.29079
.00000150	7.29702	6.05000	1.24702
.00000160	7.25742	6.05000	1.20742
.00000170	7.22137	6.05000	1.17137
.00000180	7.18837	6.05000	1.13837
.00000190	7.15801	6.05000	1.10801
.00000200	7.12995	6.05000	1.07995
.00000220	7.07969	6.05000	1.02969
.00000240	7.03586	6.05000	.98586
.00000260	6.99718	6.05000	.94718
.00000280	6.96273	6.05000	.91273
.00000300	6.93178	6.05000	.88178
.00000330	6.89074	6.05000	.84074
.00000360	6.85495	6.05000	.80495
.00000400	6.81364	6.05000	.76364
.00000430	6.78652	6.05000	.73652
.00000460	6.76210	6.05000	.71210
.00000500	6.73302	6.05000	.68302
.00000550	6.70123	6.05000	.65123
.00000600	6.67351	6.05000	.62351
.00000650	6.64905	6.05000	.59905
.00000700	6.62726	6.05000	.57726
.00000750	6.60768	6.05000	.55768
.00000800	6.58997	6.05000	.53997
.00000850	6.57385	6.05000	.52385
.00000900	6.55909	6.05000	.50909
.00001000	6.53297	6.05000	.48297
.00001100	6.51049	6.05000	.46049
.00001200	6.49089	6.05000	.44089

.00001300	6.47359	6.05000	.42359
.00001400	6.45818	6.05000	.40818
.00001500	6.44434	6.05000	.39434
.00001600	6.43182	6.05000	.38182
.00001700	6.42042	6.05000	.37042
.00001800	6.40998	6.05000	.35998
.00001900	6.40038	6.05000	.35038
.00002000	6.39151	6.05000	.34151
.00002200	6.37561	6.05000	.32561
.00002400	6.36175	6.05000	.31175
.00002600	6.34952	6.05000	.29952
.00002800	6.33863	6.05000	.28863
.00003000	6.32884	6.05000	.27884
.00003300	6.31586	6.05000	.26586
.00003600	6.30454	6.05000	.25454
.00004000	6.29148	6.05000	.24148
.00004300	6.28290	6.05000	.23290
.00004600	6.27518	6.05000	.22518
.00005000	6.26599	6.05000	.21599
.00005500	6.25593	6.05000	.20593
.00006000	6.24717	6.05000	.19717
.00006500	6.23943	6.05000	.18943
.00007000	6.23254	6.05000	.18254
.00007500	6.22635	6.05000	.17635
.00008000	6.22075	6.05000	.17075
.00008500	6.21565	6.05000	.16565
.00009000	6.21099	6.05000	.16099
.00010000	6.20272	6.05000	.15272
.00010130	6.20174	6.05000	.15174
.00010140	6.20167	6.05000	.15167
.00011000	6.19562	6.05000	.14562
.00012000	6.18942	6.05000	.13942
.00013010	6.18390	6.05000	.13390
.00013020	6.18384	6.05000	.13384
.00014000	6.17907	6.05000	.12907
.00015000	6.17470	6.05000	.12470
.00016000	6.17074	6.05000	.12074
.00016700	6.16818	6.05000	.11818
.00016710	6.16814	6.05000	.11814
.00017000	6.16713	6.05000	.11713
.00018000	6.16383	6.05000	.11383
.00019000	6.16080	6.05000	.11080
.00020000	6.15799	6.05000	.10799
.00022000	6.15296	6.05000	.10296
.00024000	6.14858	6.05000	.09858
.00026000	6.14471	6.05000	.09471
.00027540	6.14203	6.05000	.09203
.00027550	6.14201	6.05000	.09201
.00030000	6.13817	6.05000	.08817
.00033000	6.13407	6.05000	.08407
.00036000	6.13049	6.05000	.08049
.00040000	6.12636	6.05000	.07636
.00043000	6.12365	6.05000	.07365
.00045400	6.12167	6.05000	.07167
.00045410	6.12167	6.05000	.07167
.00050000	6.11830	6.05000	.06830
.00055000	6.11512	6.05000	.06512
.00060000	6.11235	6.05000	.06235

.00065000	6.10990	6.05000	.05990
.00070000	6.10772	6.05000	.05772
.00074850	6.10582	6.05000	.05582
.00074860	6.164	6.050	0.114
.00080000	6.164	6.050	0.114
.00090000	6.164	6.050	0.114
.00100000	6.164	6.050	0.114
.00110000	6.164	6.050	0.114
.00120000	6.164	6.050	0.114
.00123400	6.164	6.050	0.114
.00123410	14.286445	13.020033	1.266412
.001300	14.013964	12.818125	1.195839
.001400	13.726857	12.602116	1.124741
.001500	13.469047	12.406447	1.062600
.001600	13.235880	12.228130	1.007750
.001700	13.023673	12.064752	.958921
.001800	12.829469	11.914302	.915167
.001900	12.650865	11.775131	.875734
.002000	12.485885	11.645874	.840011
.002200	12.190487	11.412708	.777779
.002400	11.932999	11.207187	.725812
.002600	11.705974	11.024338	.681636
.002800	11.503863	10.860383	.643480
.003000	11.322435	10.712235	.610200
.003200	11.158399	10.577474	.580925
.003400	11.009157	10.454174	.554983
.003700	10.808572	10.287364	.521208
.004000	10.631171	10.138744	.492427
.004300	10.472827	10.005222	.467605
.004600	10.330375	9.884378	.445997
.005000	10.160953	9.739730	.421223
.005500	9.976012	9.580638	.395373
.006000	9.814951	9.440957	.373994
.006500	9.673073	9.317021	.356051
.007000	9.546875	9.206086	.340789
.007500	9.433691	9.106007	.327684
.008000	9.331446	9.015107	.316339
.008500	9.238501	8.932052	.306448
.009000	9.153539	8.855765	.297773
.010000	9.003480	8.720215	.283264
.011000	8.874754	8.602964	.271790
.012000	8.762795	8.500205	.262590
.013000	8.664294	8.409159	.255134
.014000	8.576786	8.327744	.249042
.015000	8.498395	8.254337	.244058
.016000	8.427661	8.187709	.239952
.017000	8.363433	8.126881	.236552
.018000	8.304786	8.071052	.233733
.019000	8.250967	8.019569	.231397
.020000	8.201361	7.971893	.229467
.022000	8.112814	7.886232	.226581
.024000	8.035942	7.811253	.224689
.026000	7.968427	7.744892	.223534
.028000	7.908541	7.685606	.222935
.030000	7.854974	7.632214	.222759
.032000	7.806705	7.583797	.222908
.034000	7.762929	7.539623	.223306
.037000	7.693059	7.480059	.213000

.040000	7.631187	7.427187	.204000			
.043000	7.575840	7.379840	.196000			
.046000	7.527113	7.337113	.190000			
.050000	7.467130	7.286130	.181000			
.055000	7.402258	7.230258	.172000			
.060000	7.346407	7.181407	.165000			
.065000	7.296216	7.138216	.158000			
.070000	7.249664	7.099664	.150000			
.075000	7.210972	7.064972	.146000			
.080000	7.173536	7.033536	.140000			
.085000	7.140874	7.004874	.136000			
.090000	7.110599	6.978599	.132000			
.100000	7.057015	6.821703	.125000	.110311		
.200000	6.762872	6.139511	.085000	.538360		
.300000	6.632733	5.697450	.068500	.866782		
.400000	6.554669	5.369164	.058500	1.127004		
.500000	6.501580	5.125702	.052000	1.323877		
.600000	6.463114	4.929836	.048000	1.485277		
.700000	6.432984	4.815430	.044700	1.572853		
.800000	6.409629	4.723506	.043000	1.643122		
.900000	6.390472	4.658636	.041800	1.690035		
1.000000	6.373968	4.612685	.040500	1.720782		
1.100000	6.365000	4.582194	.039600	1.743205		
1.200000	6.380000	4.545292	.039000	1.795707		
1.300000	6.440000	4.507246	.038600	1.894153		
1.400000	6.530000	4.511039	.037800	1.981159		
1.500000	6.620000	4.509204	.036600	2.074195		
1.600000	6.720000	4.542608	.035500	2.141891		
1.700000	6.835000	4.532462	.034300	2.268237		
1.800000	6.930000	4.529079	.033400	2.367520		
1.900000	7.015000	4.530036	.032400	2.452563		
2.000000	7.070000	4.520306	.031400	2.518293		
2.200000	7.110000	4.550224	.028800	2.530975	0.000000	0.000000
2.400000	7.110000	4.544840	.026700	2.538459	0.000000	0.000000
2.600000	7.040000	4.487891	.024700	2.527408	0.000000	0.000000
2.800000	6.930000	4.400357	.022900	2.506742	0.000000	0.000000
3.000000	6.840000	4.319217	.021500	2.499282	0.000000	0.000000
3.200000	6.740000	4.230403	.020200	2.489396	0.000000	0.000000
3.400000	6.680000	4.162776	.019100	2.498123	0.000000	0.000000
3.600000	6.560000	4.056787	.018100	2.485112	0.000000	0.000000
3.800000	6.440000	3.949027	.017200	2.473772	0.000000	0.000000
4.000000	6.300000	3.829151	.016300	2.454548	0.000000	0.000000
4.200000	6.190000	3.727573	.015600	2.446826	0.000000	0.000000
4.400000	6.050000	3.609369	.014920	2.425710	0.000000	0.000000
4.600000	5.950000	3.515773	.014300	2.419926	0.000000	0.000000
4.800000	5.850000	3.424656	.013740	2.411603	0.000000	0.000000
5.000000	5.780000	3.351228	.013200	2.415571	0.000000	0.000000
5.200000	5.610000	3.221893	.012710	2.375396	0.000000	0.000000
5.400000	5.550000	3.157033	.012240	2.380726	0.000000	0.000000
5.600000	5.540000	3.123175	.011810	2.405015	0.000000	0.000000
5.800000	5.490000	3.066772	.011450	2.411777	0.000000	0.000000
6.000000	5.430000	3.007134	.011090	2.411776	0.000000	0.000000
6.200000	5.370000	2.950278	.010750	2.408972	0.	0.
6.400000	5.310000	2.893419	.010420	2.406161	0.	0.
6.600000	5.230000	2.826292	.010110	2.393598	0.	0.
6.800000	5.170000	2.770603	.009810	2.389587	0.	0.
7.000000	5.160000	2.742024	.009520	2.408456	0.	0.
7.200000	5.130000	2.707101	.009250	2.413649	0.	0.

7.400000	5.060000	2.651946	.009020	2.399034	0.	0.
7.600000	4.990000	2.597295	.008800	2.383905	0.	0.
7.800000	5.020000	2.594838	.008590	2.410511	0.	.006060
8.000000	5.100000	2.617830	.008390	2.395239	0.	.078540
8.200000	5.040000	2.574936	.008190	2.256392	0.	.200481
8.400000	5.010000	2.548086	.008000	2.106331	0.	.347582
8.600000	5.040000	2.551752	.007820	1.969957	0.	.510470
8.800000	5.050000	2.545200	.007650	1.824689	0.	.672460
9.000000	5.090000	2.553653	.007490	1.693419	0.	.835437
9.200000	5.120000	2.565120	.007330	1.562422	0.	.985127
9.400000	5.060000	2.531012	.007180	1.422538	0.	1.099269
9.600000	5.180000	2.586892	.007030	1.333530	0.	1.252547
9.800000	5.130000	2.557818	.006890	1.222790	0.	1.342501
10.000000	5.130000	2.553714	.006760	1.133635	0.	1.435890
10.200000	5.200000	2.591160	.006640	1.062549	0.	1.539650
10.400000	5.260000	2.623688	.006520	.998456	0.	1.631335
10.600000	5.240000	2.616332	.006400	.934747	0.	1.682520
10.800000	5.240000	2.618952	.006290	.881594	0.	1.733163
11.000000	5.240000	2.621048	.006180	.835879	.000100	1.776792
11.200000	5.250000	2.632875	.006070	.796614	.000115	1.814325
11.400000	5.250000	2.639700	.005970	.762399	.000138	1.841792
11.600000	5.250000	2.646525	.005870	.733114	.000165	1.864325
11.800000	5.250000	2.653350	.005770	.708070	.000199	1.882610
12.000000	5.240000	2.655108	.005680	.686354	.000235	1.892622
12.200000	5.240000	2.663492	.005600	.668023	.000280	1.902604
12.400000	5.230000	2.666777	.005520	.652150	.000335	1.905218
12.600000	5.210000	2.664915	.005440	.638439	.000400	1.900805
12.800000	5.170000	2.652727	.005360	.626459	.000470	1.884983
13.000000	5.150000	2.650190	.005280	.616624	.000570	1.877335
13.200000	5.180000	2.674434	.005200	.608847	.000670	1.890848
13.400000	5.240000	2.714320	.005120	.602470	.000820	1.917269
13.600000	5.310000	2.759607	.005050	.597027	.000970	1.947345
13.800000	5.350000	2.789490	.004980	.592058	.001150	1.962321
14.000000	5.360000	2.804352	.004910	.587563	.001390	1.961784
14.200000	5.370000	2.819250	.004850	.583711	.001630	1.960558
14.400000	5.370000	2.828916	.004790	.580360	.001900	1.954033
14.600000	5.360000	2.833296	.004730	.577450	.002230	1.942293
14.800000	5.380000	2.853552	.004670	.575073	.002600	1.944104
15.000000	5.460000	2.904720	.004610	.573220	.003100	1.974349

NAT HF CROSS SECTIONS (BARNS VS MEV)

E(MEV)	TOTAL	ELASTIC	N-GAMMA	INELASTIC	N-P	N-2N
1.000E-09	83.8954	6.0500	77.8454			
1.100E-09	80.2727	6.0500	74.2227			
1.200E-09	77.1128	6.0500	71.0628			
1.300E-09	74.3249	6.0500	68.2749			
1.400E-09	71.8414	6.0500	65.7914			
1.500E-09	69.6105	6.0500	63.5605			
1.600E-09	67.5922	6.0500	61.5422			
1.700E-09	65.7547	6.0500	59.7047			
1.800E-09	64.0725	6.0500	58.0225			
1.900E-09	62.5250	6.0500	56.4750			
2.000E-09	61.0950	6.0500	55.0450			
2.200E-09	58.5334	6.0500	52.4834			
2.400E-09	56.2990	6.0500	50.2490			
2.600E-09	54.3277	6.0500	48.2777			
2.800E-09	52.5715	6.0500	46.5215			
3.000E-09	50.9941	6.0500	44.9441			
3.200E-09	49.5669	6.0500	43.5169			

3.400E-09	48.2676	6.0500	42.2176
3.700E-09	46.5199	6.0500	40.4699
4.000E-09	44.9727	6.0500	38.9227
4.300E-09	43.5904	6.0500	37.5404
4.600E-09	42.3456	6.0500	36.2956
5.000E-09	40.8635	6.0500	34.8135
5.500E-09	39.2434	6.0500	33.1934
6.000E-09	37.8303	6.0500	31.7803
6.500E-09	36.5835	6.0500	30.5335
7.000E-09	35.4728	6.0500	29.4228
7.500E-09	34.4751	6.0500	28.4251
8.000E-09	33.5725	6.0500	27.5225
8.500E-09	32.7508	6.0500	26.7008
9.000E-09	31.9985	6.0500	25.9485
9.500E-09	31.3064	6.0500	25.2564
1.000E-08	30.6669	6.0500	24.6169
1.100E-08	29.5213	6.0500	23.4713
1.200E-08	28.5220	6.0500	22.4720
1.300E-08	27.6404	6.0500	21.5904
1.400E-08	26.8551	6.0500	20.8051
1.500E-08	26.1496	6.0500	20.0996
1.600E-08	25.5114	6.0500	19.4614
1.700E-08	24.9303	6.0500	18.8803
1.800E-08	24.3983	6.0500	18.3483
1.900E-08	23.9090	6.0500	17.8590
2.000E-08	23.4568	6.0500	17.4068
2.200E-08	22.6467	6.0500	16.5967
2.400E-08	21.9401	6.0500	15.8901
2.600E-08	21.3167	6.0500	15.2667
2.800E-08	20.7614	6.0500	14.7114
3.000E-08	20.2626	6.0500	14.2126
3.200E-08	19.8113	6.0500	13.7613
3.400E-08	19.4004	6.0500	13.3504
3.700E-08	18.8477	6.0500	12.7977
4.000E-08	18.3584	6.0500	12.3084
4.300E-08	17.9213	6.0500	11.8713
4.600E-08	17.5277	6.0500	11.4777
5.000E-08	17.0590	6.0500	11.0090
5.500E-08	16.5467	6.0500	10.4967
6.000E-08	16.0998	6.0500	10.0498
6.500E-08	15.7055	6.0500	9.6555
7.000E-08	15.3543	6.0500	9.3043
7.500E-08	15.0388	6.0500	8.9888
8.000E-08	14.7534	6.0500	8.7034
8.500E-08	14.4935	6.0500	8.4435
9.000E-08	14.2556	6.0500	8.2056
1.000E-07	13.8345	6.0500	7.7845
1.100E-07	13.4723	6.0500	7.4223
1.200E-07	13.1563	6.0500	7.1063
1.300E-07	12.8775	6.0500	6.8275
1.400E-07	12.6291	6.0500	6.5791
1.500E-07	12.4061	6.0500	6.3561
.00000016	12.20422	6.05000	6.15422
.00000017	12.02047	6.05000	5.97047
.00000018	11.85226	6.05000	5.80226
.00000019	11.69750	6.05000	5.64750
.00000020	11.55450	6.05000	5.50450
.00000022	11.29834	6.05000	5.24834

.00000024	11.07490	6.05000	5.02490
.00000026	10.87777	6.05000	4.82777
.00000028	10.70215	6.05000	4.65215
.00000030	10.54441	6.05000	4.49441
.00000033	10.33525	6.05000	4.28525
.00000036	10.15281	6.05000	4.10281
.00000040	9.94227	6.05000	3.89227
.00000043	9.80404	6.05000	3.75404
.00000046	9.67956	6.05000	3.62956
.00000050	9.53135	6.05000	3.48135
.00000055	9.36934	6.05000	3.31934
.00000060	9.22802	6.05000	3.17802
.00000065	9.10334	6.05000	3.05334
.00000070	8.99228	6.05000	2.94228
.00000075	8.89251	6.05000	2.84251
.00000080	8.80225	6.05000	2.75225
.00000085	8.72007	6.05000	2.67007
.00000090	8.64484	6.05000	2.59484
.00000100	8.51168	6.05000	2.46168
.00000110	8.39712	6.05000	2.34712
.00000120	8.29720	6.05000	2.24720
.00000130	8.20904	6.05000	2.15904
.00000140	8.13050	6.05000	2.08050
.00000150	8.05995	6.05000	2.00995
.00000160	7.99613	6.05000	1.94613
.00000170	7.93802	6.05000	1.88802
.00000180	7.88483	6.05000	1.83483
.00000190	7.83589	6.05000	1.78589
.00000200	7.79067	6.05000	1.74067
.00000220	7.70966	6.05000	1.65966
.00000240	7.63901	6.05000	1.58901
.00000260	7.57667	6.05000	1.52667
.00000280	7.52114	6.05000	1.47114
.00000300	7.47125	6.05000	1.42125
.00000330	7.40511	6.05000	1.35511
.00000360	7.34741	6.05000	1.29741
.00000400	7.28084	6.05000	1.23084
.00000430	7.23712	6.05000	1.18712
.00000460	7.19776	6.05000	1.14776
.00000500	7.15089	6.05000	1.10089
.00000550	7.09966	6.05000	1.04966
.00000600	7.05497	6.05000	1.00497
.00000650	7.01555	6.05000	.96555
.00000700	6.98042	6.05000	.93042
.00000750	6.94887	6.05000	.89887
.00000800	6.92033	6.05000	.87033
.00000850	6.89434	6.05000	.84434
.00000900	6.87055	6.05000	.82055
.00001000	6.82845	6.05000	.77845
.00001100	6.79222	6.05000	.74222
.00001200	6.76062	6.05000	.71062
.00001300	6.73274	6.05000	.68274
.00001400	6.70791	6.05000	.65791
.00001500	6.68560	6.05000	.63560
.00001600	6.66541	6.05000	.61541
.00001700	6.64704	6.05000	.59704
.00001800	6.63022	6.05000	.58022
.00001900	6.61474	6.05000	.56474

.00002000	6.60044	6.05000	.55044
.00002200	6.57482	6.05000	.52482
.00002400	6.55248	6.05000	.50248
.00002600	6.53277	6.05000	.48277
.00002800	6.51521	6.05000	.46521
.00003000	6.49943	6.05000	.44943
.00003300	6.47851	6.05000	.42851
.00003600	6.46027	6.05000	.41027
.00004000	6.43922	6.05000	.38922
.00004300	6.42539	6.05000	.37539
.00004600	6.41295	6.05000	.36295
.00005000	6.39813	6.05000	.34813
.00005500	6.38192	6.05000	.33192
.00006000	6.36779	6.05000	.31779
.00006500	6.35532	6.05000	.30532
.00007000	6.34422	6.05000	.29422
.00007500	6.33424	6.05000	.28424
.00008000	6.32521	6.05000	.27521
.00008500	6.31700	6.05000	.26700
.00009000	6.30948	6.05000	.25948
.00010000	6.29616	6.05000	.24616
.00010130	6.29458	6.05000	.24458
.00010140	13.78574	9.84250	3.94324
.00011000	13.77677	9.84250	3.93427
.00012000	13.76758	9.84250	3.92509
.00013010	13.75940	9.84250	3.91691
.00013020	10.70497	7.47820	3.22677
.00014000	10.69791	7.47820	3.21971
.00015000	10.69143	7.47820	3.21323
.00016000	10.68556	7.47820	3.20736
.00016700	10.68177	7.47820	3.20357
.00016710	10.44079	6.26546	4.17533
.00017000	10.43937	6.26546	4.17390
.00018000	10.43472	6.26546	4.16926
.00019000	10.43045	6.26546	4.16499
.00020000	10.42650	6.26546	4.16103
.00022000	10.41942	6.26546	4.15396
.00024000	10.41325	6.26546	4.14779
.00026000	10.40781	6.26546	4.14234
.00027540	10.40403	6.26546	4.13857
.00027550	9.40864	6.12763	3.28100
.00030000	9.40657	6.12763	3.27894
.00033000	9.40436	6.12763	3.27673
.00036000	9.40244	6.12763	3.27480
.00040000	9.40021	6.12763	3.27258
.00043000	9.39875	6.12763	3.27112
.00045400	9.39769	6.12763	3.27006
.00045410	12.93838	8.84264	4.09574
.00050000	12.93720	8.84264	4.09456
.00055000	12.93608	8.84264	4.09344
.00060000	12.93510	8.84264	4.09246
.00065000	12.93424	8.84264	4.09160
.00070000	12.93347	8.84264	4.09083
.00074850	12.93280	8.84264	4.09016
.00074860	15.85081	11.38468	4.46612
.00080000	15.85081	11.38468	4.46612
.00090000	15.85081	11.38468	4.46612
.00100000	15.85081	11.38468	4.46612

.00110000	15.85081	11.38468	4.46612
.00120000	15.85081	11.38468	4.46612
.00123400	15.85081	11.38468	4.46612
.00123410	27.77628	22.63244	5.14384
.001300	27.023468	22.156192	4.867276
.001400	26.263127	21.669696	4.593431
.001500	25.580236	21.228631	4.351604
.001600	24.962487	20.826203	4.136284
.001700	24.400153	20.456956	3.943197
.001800	23.885420	20.116448	3.768972
.001900	23.411939	19.800671	3.611267
.002000	22.974481	19.506783	3.467697
.002200	22.190971	18.974964	3.216008
.002400	21.507734	18.505683	3.002050
.002600	20.905082	18.087653	2.817428
.002800	20.368344	17.712030	2.656313
.003000	19.886337	17.371717	2.514620
.003200	19.450362	17.061409	2.388954
.003400	19.053544	16.776405	2.277138
.003700	18.519941	16.389795	2.130145
.004000	18.047728	16.044699	2.003028
.004300	17.625989	15.734055	1.891934
.004600	17.246351	15.452381	1.793969
.005000	16.794523	15.114315	1.680207
.005500	16.300873	14.740914	1.559958
.006000	15.870544	14.412168	1.458376
.006500	15.491099	14.119944	1.371154
.007000	15.153266	13.857852	1.295413
.007500	14.849978	13.620896	1.229082
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.008500	14.326217	13.207695	1.118521
.009000	14.097910	13.025934	1.071976
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.014000	12.541103	11.759118	.781984
.015000	12.328289	11.581680	.746608
.016000	12.135940	11.420397	.715543
.017000	11.960992	11.272932	.688060
.018000	11.800985	11.137395	.663588
.019000	11.653917	11.012229	.641687
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.024000	11.063739	10.503823	.559915
.026000	10.877439	10.341224	.536214
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.032000	10.428853	9.945166	.483687
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.043000	9.853854	9.440814	.413040
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.050000	9.589423	9.207993	.381429
.055000	9.431216	9.068753	.362463
.060000	9.294470	8.946758	.347712
.065000	9.171685	8.838724	.332960

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.800000	6.967743	4.980046	.090615	1.897080		
.900000	6.918723	4.884678	.088086	1.945957		
1.000000	6.876582	4.815195	.085347	1.976038		
1.100000	6.839026	4.749417	.083450	2.006156		
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1.400000	6.859471	4.598434	.079657	2.181378		
1.500000	6.886955	4.541936	.077194	2.267823		
1.600000	6.918546	4.508440	.074810	2.335294		
1.700000	6.961538	4.477561	.072479	2.411496		
1.800000	6.998082	4.456954	.070385	2.470740		
1.900000	7.037862	4.426722	.068277	2.542860		
2.000000	7.070000	4.397646	.066170	2.606182		
2.200000	7.110000	4.418017	.060691	2.631290	0.000000	0.000000
2.400000	7.110000	4.403396	.056266	2.650337	0.000000	0.000000
2.600000	7.040000	4.338304	.052051	2.649643	0.000000	0.000000
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3.000000	6.840000	4.156082	.045308	2.638608	0.000000	0.000000
3.200000	6.740000	4.060992	.042568	2.636438	0.000000	0.000000
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3.600000	6.560000	3.877961	.038143	2.643895	0.000000	0.000000
3.800000	6.440000	3.768080	.036246	2.635673	0.000000	0.000000
4.000000	6.300000	3.646994	.034349	2.618655	0.000000	0.000000
4.200000	6.190000	3.544873	.032874	2.612251	0.000000	0.000000
4.400000	6.050000	3.427488	.031441	2.591069	0.000000	0.000000
4.600000	5.950000	3.334813	.030135	2.585051	0.000000	0.000000
4.800000	5.850000	3.244820	.028954	2.576224	0.000000	0.000000
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5.600000	5.540000	2.959972	.024887	2.555139	0.000000	0.000000
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7.000000	5.160000	2.643509	.020061	2.297049	0.000000	.199378
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8.800000	5.050000	2.535102	.016121	1.412652	.000065	1.086057
9.000000	5.090000	2.552667	.015784	1.303717	.000078	1.217750
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9.800000	5.130000	2.582468	.014519	.931976	.000195	1.600838
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