ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439

PALLADIUM: FAST-NEUTRON TOTAL
AND SCATTERING CROSS SECTIONS

by

A. B. Smith, P. Lambropoulos,
P. T. Guenther, and J. F. Whalen

Applied Physics Division

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PALLADIUM: FAST-NEUTRON TOTAL AND SCATTERING CROSS SECTIONS

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ABSTRACT

The neutron total and scattering cross sections of elemental palladium were experimentally studied. Total cross sections were measured from 0.1 to 1.5 MeV with resolutions of ~ 2 keV, and elastic- and inelastic-scattering cross sections were determined from incident neutron energies of 0.3-1.5 MeV. The inelastic neutron excitation of states at 320 ± 50 , 390 ± 20 , 440 ± 20 , 500 ± 30 , 570 ± 20 , 830 ± 20 , and 940 ± 25 keV was prominently observed. In addition, the excitation of states at 650 ± 25 , 720 ± 25 , 760 ± 25 , and 1010 ± 50 keV was qualitatively and/or tentatively observed. An optical potential deduced from detailed comparisons of calculated and measured fast-neutron cross sections was descriptive of the present experimental results, of previously reported high-energy cross sections, and of the minimum in the $\ell = 0$ strength function in the region of $A \sim 105$.

I. INTRODUCTORY REMARK

Elemental palladium consists primarily of the isotopes $A = 104$, 105, 106, 108, and 110 and thus is in a region of interest from the point of view of the neutron-nucleus interaction and its implication in the applied use of such neighboring nuclei as zirconium, molybdenum, and cadmium. Moreover, the exceptionally large hydrogen permeability of palladium makes this element of interest in nuclear applications, such as controlled thermonuclear reactors, where tritium containment and separation are important. Understanding of the neutron-nucleus interaction in this region is usually based upon the concept of the nuclear optical model.¹ The predictions of this model are unambiguously comparable with the observed total-neutron cross section over a wide energy range and, in the low-energy limit, with the average resonance properties usually expressed as strength functions.² The choice of model parameters is particularly sensitive in the region of palladium, $A \sim 105$, where the observed fast-neutron properties must be reconciled in the low-energy limit with the minimum in the $\ell = 0$

strength function.³⁻⁵ Thus it is odd that the experimental basis (elemental or isotopic) in this sensitive region is not particularly definitive. Fast-neutron total and partial cross sections of palladium are not known in detail over a wide energy range, and the strength functions have not received the experimental attention warranted by their sensitive position near the minimum of the systematic distribution in mass.

Theoretical and experimental studies at this Laboratory over a number of years have illuminated some of these uncertainties in this region of the periodic table.^{4,6,7} The study of the fast-neutron properties of palladium reported here is a part of this work. The results of detailed experimental studies of fast-neutron total and scattering cross sections of palladium are set forth and are related to the optical model of the neutron-nucleus interaction in the region of $A \sim 105$.

II. EXPERIMENTAL PROCEDURES

Total neutron cross sections were deduced from the measured neutron transmissions of a palladium sample.⁸ The neutron source was the ${}^7\text{Li}(p,n){}^7\text{Be}$ reaction⁹ arranged to provide neutrons of known average energy and with an incident energy spread of ~ 2 keV at the transmission sample. The samples were fabricated of high-chemical-purity natural metal in thicknesses providing neutron transmissions of $\approx 50\%$ throughout the energy range of the measurements. At energies of $\lesssim 600$ keV, neutrons were detected with a BF_3 proportional-counter system. Above ~ 600 keV, a proton-recoil scintillation detector was used, biased to reject the second neutron-source group from the ${}^7\text{Li}(p,n){}^7\text{Be}^*$ reaction. In addition, pulse-shape-discrimination techniques were employed to suppress the gamma-ray sensitivity of the scintillation detector. Corrections were made for background and "in-scattering" perturbations, though these were small due to careful attention to shielding, collimation, and geometry. The entire apparatus and experimental procedure were controlled in an automated manner with an on-line computer system.¹⁰ The fidelity of the apparatus and technique was verified by the determination of the well-known total neutron cross sections of carbon.¹¹

Elastic- and inelastic-neutron scattering cross sections were measured using pulsed-beam time-of-flight techniques.¹² Neutrons of known average energy were produced in bursts of ~ 1 -nsec duration using the ${}^7\text{Li}(p,n){}^7\text{Be}$ reaction and were incident on the palladium scattering samples. The samples were natural-metal right cylinders 2.0 cm in diameter and 2.0 cm long. Eight collimated proton-recoil detectors were arranged about the sample at flight paths of ~ 200 cm and at scattering angles in the range 25 - 155° . Incident-neutron energy resolutions were ~ 20 keV and scattered-neutron velocity resolutions ~ 1.5 nsec/M. The entire detection system was connected to an on-line computer for data acquisition and

preliminary processing. The relative detector sensitivities were determined from ~0.3 to 1.5 MeV by observing neutrons scattered from a similar carbon sample, and all scattering cross sections were determined relative to the known differential elastic scattering cross sections of carbon.¹³ The results were corrected for multiple scattering, neutron attenuation, and angular resolution perturbations using Monte-Carlo procedures.¹⁴

The specific apparatus and methods employed in both the total- and scattering-cross-section measurements are described in detail elsewhere.^{10,12}

III. EXPERIMENTAL RESULTS

A. Total Neutron Cross Sections

The total neutron cross sections of palladium were determined from 0.1 to 1.5 MeV at intervals of ≤ 2 keV with resolutions of ~ 2 keV. The statistical accuracy of the individual measurements was $\sim 1\%$, and the consistency was also of that order. The results are summarized in Fig. 1 and tabulated in the appendix. The observed total cross sections were generally a smooth function of energy with some structure of small amplitude in the few-hundred-keV region. At low energies (few hundred keV), the present results are in good agreement with those reported in BNL-325¹⁵ and with the total-neutron-scattering cross sections reported by Langsdorf *et al.*¹³ However, the present values are a few percent higher than those given in Ref. 16. At energies near 1.5 MeV, the total-cross-section results of Refs. 13 and 15 tend to be 5-8% smaller than those obtained in the present work. The source of this discrepancy is uncertain. The total scattering cross sections deduced from these experiments (see below) indicated that the present measured total cross sections were, if anything, somewhat low. Furthermore, the present results extrapolate smoothly to the higher-energy total cross sections reported by Foster and Glasgow¹⁷ (see Fig. 2), and the

Fig. 1. Total and Elastic-scattering Cross Sections of Elemental Palladium. Data points represent the present experimental results, and the solid curve the total scattering cross sections deduced from the present measurements. The "selected" curves were obtained using the potential proposed in the text.

"Cal. A" uses the potential of Ref. 3, and "Cal. B" that of Ref. 4. ANL Neg. No. 116-915.

Fig. 2. Comparison of Calculated and Measured Total Cross Sections of Palladium from 0.1 to 10.0 MeV. The crosses indicate the experimental results of the present work, and the boxes the values given in Ref. 17. The solid curve indicates the result of calculation using the "selected" potential. ANL Neg. No. 116-913.

identical total-cross-section apparatus used in the present work has proven to be reliable in the precision determination of standard total cross sections.¹¹

B. Elastic-neutron Scattering Cross Sections

Differential-elastic scattering cross sections were determined from incident energies of 0.3 to 1.5 MeV at intervals of ≈ 20 keV and at eight laboratory scattering angles distributed between 25 and 155°. The angles varied somewhat from measurement to measurement, but were typically 27, 39, 54, 70, 85, 115, 130, and 155°. The instrumental resolution was sufficient to separate the elastically scattered component from all known inelastic contributions. The measured values were least-squares fitted with the expression

$$\frac{d\sigma}{d\Omega} = \frac{\sigma}{4\pi} \left(1 + \sum_{i=1}^5 \omega_i P_i \right), \quad (1)$$

where P_i are Legendre polynomials expressed in the laboratory system, and σ (angle-integrated elastic cross section) and ω_i are coefficients deduced from the fitting procedure. The expression of Eq. 1 derived from the fitting was well behaved, descriptive of measurement, and reasonably extrapolated the measured values throughout the angular range 0-180°. Further, Eq. 1 gave a reasonable estimate of the angle-integrated cross section and made possible, quantitative comparison of values measured at somewhat different incident energies and scattering angles.

Representative measured angular distributions are shown in Fig. 3. The deduced angle-integrated elastic cross sections are shown in Fig. 1. The measured elastic scattering results, in the format of Eq. 1, are graphically summarized in Fig. 4 and tabulated in the appendix. The uncertainties in the individual measured differential values were estimated to be $< 10\%$, inclusive of systematic errors, statistical uncertainties, and uncertainties associated with the carbon reference standard. The uncertainty in the

Fig. 3. Measured and Calculated Differential-elastic Scattering Cross Sections of Palladium. Measured values are indicated by individual data points. The curves indicate results obtained with various optical potentials as follows:

- "Selected" potential with corrections for fluctuation and correlation effects, $Q = 0.0$.
- As above, but with $Q = 1.0$.
- — — — As above, but with no corrections for fluctuation or correlation effects.
- — — — Calculated with potential of Ref. 4.
- — — — Calculated with potential of Ref. 3.
- - - - "Selected" potential inclusive of collective deformation and vibrational excitations.

Fig. 4

Differential-elastic Scattering Cross Sections of Palladium, Summarized in the Format of Eq. 1. Individual data points indicate the results deduced from the measured values. The curves indicate the results of calculations using the "selected" potential of the text, where --- denotes values obtained with $Q = 0$ and — with $Q = 1$. ANL Neg. No. 116-914.

angle-integrated elastic cross section was estimated to be $\leq 8\%$. These estimates were conservative in the context of the consistency of the data. This is noteworthy as the measurements spanned a five-year period and were made with apparatus differing in detail.

No previously reported elastic scattering cross sections of palladium in the present energy range were found in the literature. Langsdorf *et al.* have measured the total scattering cross section at five angles.¹³ Their results are qualitatively consistent with those of the present work when corrected for the appreciable contributions from inelastic neutron scattering. As noted above, the total scattering cross section derived from the present elastic and inelastic scattering results is in reasonable agreement with the measured total cross section as shown in Fig. 1.

C. Inelastic-neutron Scattering Cross Sections

The differential cross sections for the excitation of "states" in the isotopes of palladium were determined concurrently with the measurement of the elastic-scattering cross section. The excited structure of the element is complex, with contributions from a number of isotopes as outlined in Fig. 5.¹⁸ The experimental resolution was not sufficient to completely resolve the various neutron groups resulting from this structure, and the observed excited "states" often consisted of contributions from a number of true levels. Thus the corresponding measured inelastic excitation cross sections are actually neutron-production cross sections corresponding to

the specified reaction Q-value and include contributions from all levels within the specified resolution increment.

Fig. 5. Observed Inelastic Excitations, Compared with the Reported Structures of the Isotopes of Palladium.¹⁸ The shaded boxes indicate the energy definition of the experimental results. Dashed lines and brackets associate the measured values with the various structures in the individual isotopes. ANL Neg. No. 116-917.

Neutron cross sections for the excitation of "states" at 320 ± 50 , 390 ± 20 , 440 ± 20 , 500 ± 30 , 570 ± 20 , 830 ± 20 , and 840 ± 25 keV were quantitatively measured. Further, cross sections for the excitation of "states" at 650 ± 25 , 720 ± 25 , 760 ± 25 , and 1010 ± 50 keV were qualitatively and/or tentatively determined. The latter cross sections were usually small (few mb/sr). The energies of the observed "states" were determined from the time calibration of the experimental apparatus and verified by the observation of the inelastic neutron excitation of known states in other nuclei. Generally, the observed energies were consistent with the known structure of the prominent isotopes of palladium, as indicated in Fig. 5. The observed differential inelastic cross sections were isotropic to within the experimental uncertainty, and therefore the angle-integrated inelastic excitation cross sections were determined from a simple average of the differential values. In the formulation of the averages, emphasis was given to results obtained from particularly careful measurements. Inelastic neutrons were observed to within 150 keV of threshold. However, detector sensitivity calibrations at these low energies were judged unreliable, and the cross sections were accepted only when corresponding to neutron energies of 250 keV and above. The second neutron group from the ${}^7\text{Li}(p,n){}^7\text{Be}^*$ source reaction masked inelastic neutron groups corresponding to excitation energies of about 500 keV. Corrections were applied where appropriate, but they did lead to increased uncertainties in this excitation region.

The experimental inelastic scattering cross sections are graphically summarized in Fig. 6 and tabulated in the appendix. The indicated errors

were based upon subjective estimates and were inclusive of systematic and statistical effects. A search of the literature did not reveal any information on inelastic neutron scattering suitable for comparison with the present results. However, as noted above, the total-neutron-scattering cross sections deduced from the present measurements were reasonably consistent with the directly measured total neutron cross sections determined in an entirely different manner.

IV. INTERPRETATION AND DISCUSSION

The objective of this interpretation was a model descriptive of the fast-neutron cross sections of palladium measured here and suitable for extrapolation of the experimental values to higher and lower incident neutron energies. The low-energy limit is of particular physical interest, as the $l = 0$ strength function of palladium is near the minimum of the strength-function distribution in mass, and its calculation is sensitive to model choice. The basis of the interpretation was the optical model.¹ In the present experimental context, this model can be directly related to measured total neutron cross sections, and the elastic scattering cross sections are largely optical-shape scattering with minor compound-nucleus contributions. Inelastic neutron cross sections are predominantly compound-nucleus in origin with possible minor contributions from direct-reaction processes.^{19,20} Thus the derivation of a suitable optical potential emphasized comparisons of measured and calculated total neutron cross sections with further adjustment of the potential to optimize the agreement with measured differential elastic cross sections while retaining a good description of the

Fig. 6

Measured and Calculated Inelastic-neutron Excitation Cross Sections of Palladium. Individual data points denote measured values. The curves indicate results calculated using the "selected" potential, where — is without correction factors, and with corrections — — — $Q = 0$ and — · — $Q = 1$, as described in the text. ANL Neg. No. 116-916 Rev. 1.

experimental total cross sections. Inelastic cross sections were not used in the selection of the potential as they were relatively uncertain experimentally and their interpretation was complicated by ill-defined structure in the contributing isotopes of palladium.

The optical potential was assumed to have the form

$$V = Vf(r) + Wg(r) + V_g h(r) \underline{L} \cdot \underline{g}, \quad (2)$$

where the shape factors were

$$\left. \begin{aligned} f(r) &= \left[1 + \exp\left(\frac{r - R_1}{a}\right) \right]^{-1} \\ \text{and} \\ g(r) &= 4 \exp\left(\frac{r - R_2}{b}\right) \left[1 + \exp\left(\frac{r - R_2}{b}\right) \right]^{-2} \end{aligned} \right\} \quad (3)$$

with $R_i = R_i A^{1/3}$ and $h(r)$ the Thomas form of $f(r)$.¹ The parameters V , W , R_1 , R_2 , a , and b were assumed to be variables and were given initial values found suitable for the molybdenum isotopes.⁷ The parameters were then varied to obtain a good description of, primarily, the measured total neutron cross sections and, secondly, the elastic scattering angular distributions. The contribution of compound-nucleus elastic scattering was calculated from the Bohr statistical model using the Hauser-Feshbach formula modified to include resonance-width fluctuation and correlation effects in the manner of Moldauer.¹⁹⁻²² Throughout the statistical calculations, the reported excited structure of the palladium isotopes shown in Fig. 5 was assumed. Generally, the omission of fluctuation and correlation corrections resulted in calculated elastic distributions with minima appreciably below the experimental values as illustrated in Figs. 3B and 3E. The agreement between calculated and measured elastic scattering cross sections was improved by use of the correction factors (see Figs. 3A and 3E), with a correlation parameter value of $Q \sim 0$ preferred. Based upon subjective judgement of the overall quality of the agreement between calculation and experiment, the following parameter set was "selected":

$$\left. \begin{aligned} V &= 51.0 \text{ MeV}, & W &= 6.0 \text{ MeV}, & R_1 &= 1.22 \text{ F}, \\ R_2 &= 1.28 \text{ F}, & a &= 0.60 \text{ F}, & b &= 0.55 \text{ F}, \end{aligned} \right\} \quad (4)$$

where V_g was constant at 7.0 MeV. These parameters did not differ greatly from the initial estimate and center the absorption effects at the surface slightly outside the mean real potential radius in the manner suggested by Moldauer.⁴

The total neutron cross section calculated with the above "selected" potential agreed to within $\sim 2\%$ with the average of the experimental values throughout the measured energy interval, as illustrated in Fig. 1. Calculated elastic scattering distributions inclusive of correction factors were reasonably descriptive of experiment throughout the measured interval, as indicated in Figs. 3 and 4. Discrepancies between elastic calculation and experiment were appreciable only near the minima of the angular distributions where the calculated values were as much as 10-20% lower than the measured quantities. These differences were only slightly larger than experimental error in many instances and were more acute for other trial parameter sets, as illustrated in Figs. 3C and 3D.

The even isotopes of palladium are dominant in the element, with low-energy $2+$ states strongly excited by inelastic neutron scattering¹⁸ in a manner characteristic of collective-vibrational interactions. Therefore the calculations were extended to include channel-coupling assuming a deformation parameter $\beta = 0.2$.²³ With some minor adjustment of the potential, agreement with the measured total cross sections was retained and the calculated elastic angular distributions were similar to those obtained with the "selected" spherical potential. The elastic scattering calculated with the collective model is illustrated in Figs. 3C and 3D. It is not inclusive of fluctuation and correlation corrections, which would tend to improve the agreement with experiment near the minima of the distribution and degrade it at back-scattering angles.

As noted in Sec. III, the experimental inelastic excitation cross sections were generally composites of contributions from states in several isotopes of palladium. Thus the calculations were based upon the reported structures of the contributing isotopes grouped as judged consistent with the respective experimental resolutions. This correlation between reported structure and measurement is indicated in Fig. 5. Using these relations, the inelastic excitation cross sections were calculated from the statistical theory with and without the corrections for resonance fluctuations and correlations. The results are compared with the corresponding experimental values in Fig. 6. The calculated inelastic cross sections obtained with the Hauser-Feshbach formula alone were in reasonable agreement with the observed excitations of the 330- and 440-keV states and a little lower than the observed cross sections for the excitation of the 390-keV state. All calculations of the excitation of the 500-keV state were lower than the experimental values, but, as noted above, these experimental values may be systematically in error. Comparison of calculated and measured cross sections for the excitation of higher-energy states is of marginal merit as the experimental values and/or the structures used in the calculations were uncertain. The latter is particularly true of the excitation of states in the vicinity of 1.0 MeV, where a number of possibly unreported additional states may be contributing factors.

Inelastic cross sections calculated, including resonance fluctuations and correlation corrections, tended to be appreciably smaller than the corresponding experimental values, regardless of the choice of correlation parameter, Q . This discrepancy may be partially due to systematically large experimental values, as the total scattering cross section deduced from the measurements is slightly larger than the directly observed total neutron cross section as shown in Fig. 1. However, the latter difference can be largely attributed to the excitation of the 500-keV state, where the measured cross sections are uncertain due to corrections for the second neutron group from the source reaction. A possible source of uncertainty was a systematic error in the calculations and/or their physical basis. Particularly doubtful was the assumption that the correlation correction (i.e., Q) is identical for all reaction channels. Direct excitation of states in both a collective-vibration and -rotational context was examined and found to be small. The apparent tendency for the "corrected" statistical calculations to result in inelastic cross sections lower than experimental values is not unusual in this mass region.⁷ Generally, the complexity and uncertainties of the contributing structure of the experimental measurements precluded any quantitative conclusions about the specific structure of the individual palladium isotopes and made any adjustment of the model potential based upon the inelastic experimental results unrewarding.

The calculations based upon the "selected" potential were extended to higher energies. In doing so, the parameters were made energy-dependent and a small volume absorption was introduced at higher energies in the manner suggested by Engelbrecht and Fiedeldey.²⁴ The resulting calculated total neutron cross sections were in good agreement with reported experimental values to 10.0 MeV, as illustrated in Fig. 2.¹⁷ At no energy in the interval 0.1-10.0 MeV were the measured and calculated results discrepant by more than ~5%.

In the low-energy limit, the optical model directly determines the strength function (herein noted as S_0 and S_1 for $l = 0$ and 1, respectively). A number of potentials have been proposed, largely or in part based on strength-function distributions.^{3-5,25} The present "selected" potential, founded upon fast-neutron processes, was extrapolated to low energies to obtain the S_0 and S_1 values given in Table I. Comparable experimental strength functions are not well known. Experimental estimates of the S_0 and of palladium are $\sim 0.5 \times 10^{-4}$, and S_1 is reported to be $2.5 (+4.5, -1.0) \times 10^{-4}$.^{26,27} Systematic behavior of S_0 indicates that the value is near a minimum at $A \sim 105$, with a magnitude in the range $0.3 \times 10^{-4} - 0.7 \times 10^{-4}$,²⁸ and that S_1 values are approximately an order of magnitude larger.²⁷ It is noteworthy that the S_0 and S_1 values obtained with the present potential, based entirely upon fast-neutron cross sections, are within 20-50% of these estimated values. The differences between calculation and experiment are of the same order as the uncertainties in the experimental estimates in the region. Potentials entirely or largely based upon strength functions are often

no more suitable in this region. For comparison, the results obtained with two such potentials are given in Table I. The calculated S_0 values of Buck and Perey³ are about two times larger and those of Moldauer⁴ about three times smaller than those calculated with the present potential. The results calculated with the potentials of Refs. 3 and 4 tend to give less satisfactory agreement with experimental estimate or strength-function systematics than that obtained with the present "selected" potential. Interestingly, the unusual characteristic of the Moldauer potential, a surface absorption centered somewhat outside the mean radius of the real potential, is a property of the present "selected" potential. Buck and Perey suggest that the potential may be dependent on angular momentum. This suggestion is not particularly supported by the present results. The "selected" potential does not differ appreciably from that found suitable for description of the fast-neutron cross sections of the neighboring molybdenum isotopes, and in those cases qualitative agreement with the known strength functions was also obtained.⁷ The introduction of collective effects, in either a vibrational or a rotational context, leads to slightly higher S_0 and appreciably smaller S_1 values, as noted in Table I. These collective effects certainly are appreciable in the rare-earth region, and the splitting of the S_1 peak in the region of $A = 100$ has been attributed to these collective effects.³ This is apparent in the present calculations, where the S_1 value obtained with the deformed potential is approximately half of that deduced from the spherical potential.

TABLE I. Comparison of Calculated Strength Functions of Palladium

Isotope	$S_0 \times 10^4$		
	"Selected" Potential	Potential of Ref. 3	Potential of Ref. 4
104	0.670	1.05	0.21
105	0.690	1.07	0.20
106	0.697	1.09	0.19
108	0.739	1.13	0.18
110	0.786	1.18	0.19
Ave $S_0 \times 10^4 =$	0.71	1.10	0.19
$S_1 \times 10^4 =$	6.40	5.08	5.23
Ave with $\beta = 0.2$			
$S_0 \times 10^4 =$	0.83		
$S_1 \times 10^4 =$	3.70		

It should be emphasized that potentials giving quite different strength functions do not necessarily lead to widely different calculated fast-neutron cross sections. This is illustrated in Fig. 1, where the total cross sections calculated with the potentials of Buck and Perey and of Moldauer are compared with the present experimental and calculated results. The former

two potentials lead to systematically low total cross sections as compared to the present work, but the discrepancies are not large. Similar qualitative agreements are found in the elastic angular distributions as illustrated in Figs. 3A, 3C, and 3D. Neither the calculations based upon the potentials of Buck and Perey nor that of Moldauer included the fluctuation and correlation corrections, which would tend to improve the agreement with measured elastic cross sections. The use of fast-neutron cross sections for the determination of potentials suitable for extrapolation, particularly to low energies, must be highly quantitative. Indeed, the differences noted above between various calculations and the experimental values are smaller than the discrepancies often existing between the results of various total-cross-section measurements. An accurate experimental basis inclusive of total and partial cross sections over a relatively large energy range is mandatory if an optical potential is to be reliably defined. Furthermore, differences of the same order as those noted above have been observed between various numerical calculations using identical potentials for the description of the same physical phenomena. Thus increased attention should be given to the validity of the calculational procedures used if the deduced potentials are to be quantitatively meaningful.

V. SUMMARY CONTENT

The present experiments define the total cross sections of palladium from 0.1 to 1.5 MeV and the differential elastic scattering cross sections from 0.3 to 1.5 MeV and provide neutron-production cross sections associated with states in the isotopes of palladium to excitation energies of ~1.1 MeV. An optical potential was deduced from this experimental foundation and shown suitable for extrapolation to higher and lower neutron energies. Calculations based upon the "selected" potential directly and quantitatively described the measured total neutron cross sections. The selection of the potential was sensitive to the elastic angular distributions, though the comparison of calculated and experimental elastic values required the additional concepts of a compound nucleus and statistical interactions. The latter processes are reasonably calculable in this energy region of good experimental definition and, as a consequence, may be preferred to potential selection based upon higher-energy comparisons of calculated and measured elastic scattering, where the relation to the optical potential is more direct but the experimental basis often more uncertain due to poorly resolved inelastic contributions to the observed elastic processes. Concurrent with the quantitative description of the fast-neutron processes, the "selected" potential provided reasonable estimates of strength functions in a region where S_0 values are at or near a minimum. Thus average S_0 values were reasonably extrapolated from the available fast-neutron base in this experimentally difficult resonance region, free from energy-local perturbations, and with results equivalent to or better than that obtained

with potentials often more directly based upon experimental strength-function values. It is emphasized that the deduction of a reliable optical potential from fast-neutron data requires precise experimental information including total and partial cross sections over an appreciable energy range. Such information is not widely available. Furthermore, attention must be given to the validity of the computational procedures used if the results are to be meaningful.

APPENDIX

Numerical Tabulation of Experimental Results

NATURAL PD DATA BLOCK
 ANL--- 7869--TO BE PUBLISHED
 AUTHORS-- A. SMITH AND J. WHALEN

ELASTIC SCATTERING
FORM

$$(DXSEC/DOMEGA)=(XSEC/4*PI)*(1+SUM(WI*P))$$

I=1---6 OR LESS

MEASURED ANGLES 25-155 DEG, 8 POINTS PER DISTRIBUTION

ALL ANGLES IN THE LAB SYSTEM

FORMAT(6X,2I4,6(I5,I4))

ENERGY IN KEV

XSEC IN BARNS*100

(OMEGA AND ERROR OMEGA)*1000 FOR OMEGA 1 TO 6

CORRECTED FOR MULTIPLE SCATTERING

REFERENCED TO CARBON ELASTIC CROSS SECTION OF ANL-5537 REV.
 INCIDENT NEUTRON RESOLUTION=20 KEV

300	848	743	14	227	18	-56	30	-24	32	PD-NAT
300	825	924	85	464	126	147	154	14	11	PD-NAT
330	748	810	75	375	112	-47	136	-5	187	PD-NAT
340	782	848	159	253	132	-60	177	-134	80	PD-NAT
350	796	884	49	355	62	-56	100	15	107	PD-NAT
350	758	821	27	542	40	169	49	-100	68	PD-NAT
380	758	988	98	384	85	66	102	144	140	PD-NAT
390	742	988	17	578	26	100	32	22	44	PD-NAT
400	724	957	27	407	39	-32	47	-131	65	PD-NAT
400	722	940	13	364	16	-51	27	19	29	PD-NAT
410	721	943	23	474	35	61	43	-44	57	PD-NAT
410	683	998	25	613	37	201	45	121	62	PD-NAT
420	698	967	27	426	40	-46	48	-83	66	PD-NAT
430	742	1031	57	596	85	144	104	72	142	PD-NAT
450	698	1001	45	558	68	28	82	-119	113	PD-NAT
460	680	979	18	472	26	30	31	9	43	PD-NAT
470	703	1033	46	545	68	61	83	-68	114	PD-NAT
480	697	1021	21	486	31	35	37	-169	51	PD-NAT
490	701	1041	23	614	35	114	42	3	58	PD-NAT
500	667	1077	22	515	32	30	39	-106	53	PD-NAT
510	687	1036	18	581	26	126	32	6	44	PD-NAT
518	669	1076	20	587	30	103	38	56	50	PD-NAT
520	676	1088	27	645	39	132	47	55	64	PD-NAT
530	679	1088	29	700	43	215	53	103	72	PD-NAT
540	664	1116	31	707	46	200	56	74	78	PD-NAT
550	675	1149	29	597	37	135	61	26	65	PD-NAT
560	672	1026	14	518	21	105	25	-56	35	PD-NAT
580	648	1162	17	690	25	162	30	50	42	PD-NAT
580	603	1179	11	773	17	206	21	-23	29	PD-NAT
600	670	1160	19	722	28	178	33	34	46	PD-NAT
600	642	1137	18	727	28	186	34	-5	46	PD-NAT
620	614	1181	21	735	31	151	37	8	52	PD-NAT
620	601	1198	17	783	26	216	32	9	44	PD-NAT
640	618	1167	17	669	26	111	31	-46	42	PD-NAT
640	602	1181	20	747	30	153	36	-15	50	PD-NAT
650	607	1157	14	679	21	152	27	70	35	PD-NAT
650	652	1199	15	683	19	75	31	-16	34	PD-NAT
660	619	1206	33	790	49	282	59	150	82	PD-NAT
660	626	1206	13	722	20	169	24	5	33	PD-NAT
680	609	1228	34	692	49	121	59	-45	81	PD-NAT
680	616	1243	20	872	30	300	37	58	51	PD-NAT
700	593	1252	28	853	42	285	51	87	70	PD-NAT
705	595	1216	21	769	31	183	39	33	52	PD-NAT
720	591	1238	15	743	22	168	26	-41	37	PD-NAT
720	619	1267	47	902	70	250	85	30	117	PD-NAT
740	595	1286	10	868	15	233	18	-33	25	PD-NAT

740	573	1277	13	925	19	319	23	121	31
760	605	1233	30	828	44	140	53	44	73
760	590	1250	32	882	47	214	57	42	74
780	588	1288	3	850	4	203	5	4	7
780	609	1229	18	906	26	257	32	115	44
800	562	1335	18	975	26	317	32	133	43
800	532	1275	40	976	59	282	73	94	97
800	557	1287	26	952	39	367	47	207	65
805	593	1273	17	805	26	159	32	22	43
820	564	1266	21	802	26	142	40	-27	43
840	583	1352	55	870	81	110	97	-110	133
840	540	1289	17	890	26	284	32	101	43
840	585	1246	61	948	91	334	110	143	151
850	573	1350	20	856	26	181	42	34	45
860	589	1290	54	1003	81	388	98	221	135
880	560	1250	56	963	83	328	102	255	139
900	555	1253	33	957	49	397	59	309	82
900	562	1356	9	972	14	251	17	81	23
920	536	1268	40	1038	60	341	73	168	100
940	557	1256	17	949	25	383	30	196	42
960	541	1263	54	970	80	219	97	-9	134
1000	478	1207	13	947	20	274	24	92	33
1000	523	1277	36	1115	54	363	66	167	91
1020	559	1231	19	1061	29	335	35	203	49
1020	543	1314	24	1151	35	428	43	179	60
1040	565	1250	25	1041	37	338	46	207	63
1040	499	1332	107	1141	160	385	194	37	266
1060	472	1304	27	1090	40	407	49	117	67
1060	542	1212	18	1074	26	319	32	128	45
1080	544	1277	32	1150	47	329	58	194	79
1100	538	1260	25	1146	37	453	46	366	63
1120	513	1214	49	1062	72	279	88	121	121
1120	510	1336	26	1263	38	545	47	260	64
1140	532	1203	21	1119	31	385	38	257	52
1140	494	1333	33	1210	49	495	60	200	82
1150	565	1211	26	1067	39	269	46	217	58
1151	570	1304	30	1164	46	445	54	313	69
1160	528	1227	12	1140	19	359	23	268	32
1160	496	1317	60	1181	90	448	109	217	150
1180	505	1310	11	1236	16	431	20	216	27
1200	516	1306	17	1263	26	567	31	350	41
1200	513	1420	23	1201	35	456	41	230	52
1200	480	1411	46	1366	69	695	84	347	115
1220	492	1309	40	1249	60	497	72	241	94
1240	482	1284	15	1212	23	406	27	192	36
1240	457	1343	14	1212	21	422	25	199	35
1250	511	1395	97	1146	144	357	179	211	239
1260	514	1304	20	1267	30	527	36	289	48
1280	495	1381	135	1333	201	590	245	383	136
1290	488	1402	67	1309	99	541	12		

[illegible]

PD-NAT
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PD NATURAL--INELASTIC CROSS SECTIONS

FÖRMÅT (7E10, 4)

- ```

1. INCIDENT ENERGY IN MEV
2. TOTAL SPREAD IN INCIDENT ENERGY IN MEV
3. REACTION Q IN MEV
4. +- ERROR IN Q IN MEV
 Q IS MEAN OBSERVED ENERGY AND ERROR IS UNCERTAINTY IN
 THAT MEAN. RESPECTIVE CROSS SECTIONS INTEGRATE OVER
 LARGER INTERVAL IN Q AS NOTED IN BASIC REF. (SEE ABOVE)
5. INEL X-SEC IN BARNS
6. + X-SEC ERROR IN BARNS
7. - X-SEC ERROR IN BARNS
CORRECTED FOR MULTIPLE SCATTERING
REFERENCED TO CARBON ELASTIC CROSS SECTION OF ANL-5567 REV.

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היטל סטנדרט

| PD-NAT    | Q*         | -.320000  |           |           |           |           |  | PD-NAT |
|-----------|------------|-----------|-----------|-----------|-----------|-----------|--|--------|
| .6000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3703E 00 | .5000E-01 | .5000E-01 |  | PD-NAT |
| .6200E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .4730E 00 | .7090E-01 | .7090E-01 |  | PD-NAT |
| .6500E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3788E 00 | .8000E-01 | .8000E-01 |  | PD-NAT |
| .6600E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .4050E 00 | .6080E-01 | .6080E-01 |  | PD-NAT |
| .6800E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3270E 00 | .4900E-01 | .4900E-01 |  | PD-NAT |
| .7000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3120E 00 | .4680E-01 | .4680E-01 |  | PD-NAT |
| .7200E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3000E 00 | .4500E-01 | .4500E-01 |  | PD-NAT |
| .7400E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2640E 00 | .3970E-01 | .3970E-01 |  | PD-NAT |
| .7400E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2226E 00 | .2671E-01 | .2671E-01 |  | PD-NAT |
| .7500E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2689E 00 | .5000E-01 | .5000E-01 |  | PD-NAT |
| .7800E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2990E 00 | .4490E-01 | .4490E-01 |  | PD-NAT |
| .8000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2230E 00 | .3350E-01 | .3350E-01 |  | PD-NAT |
| .8000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2370E 00 | .4000E-01 | .4000E-01 |  | PD-NAT |
| .8000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3451E 00 | .4142E-01 | .4142E-01 |  | PD-NAT |
| .8050E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2356E 00 | .2827E-01 | .2827E-01 |  | PD-NAT |
| .8200E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2260E 00 | .3380E-01 | .3380E-01 |  | PD-NAT |
| .8400E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2020E 00 | .2424E-01 | .2424E-01 |  | PD-NAT |
| .8400E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2400E 00 | .3600E-01 | .3600E-01 |  | PD-NAT |
| .8500E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .1838E 00 | .4000E-01 | .4000E-01 |  | PD-NAT |
| .8600E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .3140E 00 | .4710E-01 | .4710E-01 |  | PD-NAT |
| .8800E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2890E 00 | .4340E-01 | .4340E-01 |  | PD-NAT |
| .8800E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2164E 00 | .3246E-01 | .3246E-01 |  | PD-NAT |
| .9000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .1420E 00 | .3000E-01 | .3000E-01 |  | PD-NAT |
| .9000E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2000E 00 | .3000E-01 | .3000E-01 |  | PD-NAT |
| .9200E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2218E 00 | .3327E-01 | .3327E-01 |  | PD-NAT |
| .9200E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .1410E 00 | .2110E-01 | .2110E-01 |  | PD-NAT |
| .9400E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .2130E 00 | .3200E-01 | .3200E-01 |  | PD-NAT |
| .9500E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .1720E 00 | .4000E-01 | .4000E-01 |  | PD-NAT |
| .9600E-00 | .2000E-01- | .3200E 00 | .5000E-01 | .1900E 00 | .2850E-01 | .2850E-01 |  | PD-NAT |
| .1000E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1252E 00 | .3000E-01 | .3000E-01 |  | PD-NAT |
| .1000E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1870E 00 | .2810E-01 | .2810E-01 |  | PD-NAT |
| .1020E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .2170E 00 | .3250E-01 | .3250E-01 |  | PD-NAT |
| .1040E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1680E 00 | .2530E-01 | .2530E-01 |  | PD-NAT |
| .1050E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1367E 00 | .3000E-01 | .3000E-01 |  | PD-NAT |
| .1080E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1460E 00 | .2190E-01 | .2190E-01 |  | PD-NAT |
| .1100E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1622E 00 | .3000E-01 | .3000E-01 |  | PD-NAT |
| .1140E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1340E 00 | .2010E-01 | .2010E-01 |  | PD-NAT |
| .1150E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1392E 00 | .1670E-01 | .1670E-01 |  | PD-NAT |
| .1150E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1328E 00 | .3000E-01 | .3000E-01 |  | PD-NAT |
| .1151E-01 | .2000E-01- | .3200E 00 | .5000E-01 | .1192E 00 | .1431E-01 | .1431E-01 |  | PD-NAT |

|           |           |           |           |           |           |           |        |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--------|
| .1200E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1580E 00 | .3000E-01 | .3000E-01 | PD-NAT |
| .1200E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1050E 00 | .1580E-01 | .1580E-01 | PD-NAT |
| .1220E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1490E 00 | .2230E-01 | .2230E-01 | PD-NAT |
| .1250E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1525E 00 | .2287E-01 | .2287E-01 | PD-NAT |
| .1260E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .2040E 00 | .3060E-01 | .3060E-01 | PD-NAT |
| .1270E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .2106E 00 | .3159E-01 | .3159E-01 | PD-NAT |
| .1300E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .2150E 00 | .3230E-01 | .3230E-01 | PD-NAT |
| .1300E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1216E 00 | .1459E-01 | .1459E-01 | PD-NAT |
| .1320E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1510E 00 | .2250E-01 | .2250E-01 | PD-NAT |
| .1350E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1910E 00 | .2865E-01 | .2865E-01 | PD-NAT |
| .1340E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1020E 00 | .1530E-01 | .1530E-01 | PD-NAT |
| .1460E 01 | .2000E-01 | .3200E 00 | .5000E-01 | .1070E 00 | .1610E-01 | .1610E-01 | PD-NAT |
| PD-NAT    |           |           |           |           |           |           |        |
| .6600E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1620E 00 | .4430E-01 | .4430E-01 | PD-NAT |
| .7000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2790E 00 | .4190E-01 | .4190E-01 | PD-NAT |
| .7000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2030E 00 | .3000E-01 | .3000E-01 | PD-NAT |
| .7000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .3070E 00 | .4000E-01 | .4000E-01 | PD-NAT |
| .7050E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2434E 00 | .3920E-01 | .3920E-01 | PD-NAT |
| .7200E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1730E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .7400E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2560E 00 | .3850E-01 | .3850E-01 | PD-NAT |
| .7400E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1350E 00 | .3600E-01 | .3600E-01 | PD-NAT |
| .7500E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1637E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .7600E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2110E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .8000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2037E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .8000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1781E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .8000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2400E 00 | .3600E-01 | .3600E-01 | PD-NAT |
| .8050E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2101E 00 | .3521E-01 | .3521E-01 | PD-NAT |
| .8200E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2080E 00 | .3510E-01 | .3510E-01 | PD-NAT |
| .8400E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2120E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .8500E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1539E 00 | .3800E-01 | .3800E-01 | PD-NAT |
| .8500E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1958E 00 | .5000E-01 | .5000E-01 | PD-NAT |
| .8800E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2183E 00 | .3275E-01 | .3275E-01 | PD-NAT |
| .9000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1900E 00 | .3800E-01 | .3800E-01 | PD-NAT |
| .9000E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1690E 00 | .3800E-01 | .3800E-01 | PD-NAT |
| .9200E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .2047E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .9400E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1880E 00 | .3800E-01 | .3800E-01 | PD-NAT |
| .9500E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1560E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .9600E 00 | .2000E-01 | .3900E 00 | .2000E-01 | .1534E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1000E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .2160E 00 | .3240E-01 | .3240E-01 | PD-NAT |
| .1000E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1870E 00 | .3800E-01 | .3800E-01 | PD-NAT |
| .1040E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1275E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1050E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1416E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1080E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1720E 00 | .3600E-01 | .3600E-01 | PD-NAT |
| .1100E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1193E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1120E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .2650E 00 | .4500E-01 | .4500E-01 | PD-NAT |
| .1140E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1630E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1150E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1386E 00 | .3600E-01 | .3600E-01 | PD-NAT |
| .1150E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1345E 00 | .3000E-01 | .3000E-01 | PD-NAT |
| .1151E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1239E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1180E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .2210E 00 | .3310E-01 | .3310E-01 | PD-NAT |
| .1200E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1240E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1200E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .1343E 00 | .3500E-01 | .3500E-01 | PD-NAT |
| .1240E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .2630E 00 | .3950E-01 | .3950E-01 | PD-NAT |
| .1280E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .2000E 00 | .4500E-01 | .4500E-01 | PD-NAT |
| .1500E 01 | .2000E-01 | .3900E 00 | .2000E-01 | .2277E 00 | .3732E-01 | .3732E-01 | PD-NAT |
| PD-NAT    |           |           |           |           |           |           |        |
| .7000E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .4720E 00 | .4500E-01 | .4500E-01 | PD-NAT |
| .7600E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .5320E 00 | .7990E-01 | .7990E-01 | PD-NAT |
| .7800E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .4790E 00 | .7190E-01 | .7190E-01 | PD-NAT |
| .8000E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .4440E 00 | .6650E-01 | .6650E-01 | PD-NAT |
| .8000E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .3902E 00 | .7000E-01 | .7000E-01 | PD-NAT |
| .8000E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .3553E 00 | .2824E-01 | .2824E-01 | PD-NAT |
| .8050E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .4236E 00 | .5083E-01 | .5083E-01 | PD-NAT |
| .8200E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .4350E 00 | .6520E-01 | .6520E-01 | PD-NAT |
| .8400E 00 | .2000E-01 | .4400E 00 | .2000E-01 | .3995E 00 | .4794E-01 | .4794E-01 | PD-NAT |

|           |                     |           |           |           |           |        |
|-----------|---------------------|-----------|-----------|-----------|-----------|--------|
| .8400E 00 | .2000E-01-.4400E 00 | .2000E-01 | .3730E 00 | .5590E-01 | .5590E-01 | PD-NAT |
| .8500E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4007E 00 | .4000E-01 | .4000E-01 | PD-NAT |
| .8600E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4050E 00 | .6080E-01 | .6080E-01 | PD-NAT |
| .8800E 00 | .2000E-01-.4400E 00 | .2000E-01 | .5040E 00 | .7570E-01 | .7570E-01 | PD-NAT |
| .8800E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4472E 00 | .6709E-01 | .6709E-01 | PD-NAT |
| .9000E 00 | .2000E-01-.4400E 00 | .2000E-01 | .3750E 00 | .4000E-01 | .4000E-01 | PD-NAT |
| .9000E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4220E 00 | .6330E-01 | .6330E-01 | PD-NAT |
| .9200E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4290E 00 | .6430E-01 | .6430E-01 | PD-NAT |
| .9200E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4304E 00 | .6456E-01 | .6456E-01 | PD-NAT |
| .9400E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4120E 00 | .6180E-01 | .6180E-01 | PD-NAT |
| .9500E 00 | .2000E-01-.4400E 00 | .2000E-01 | .3413E 00 | .6000E-01 | .6000E-01 | PD-NAT |
| .9600E 00 | .2000E-01-.4400E 00 | .2000E-01 | .3270E 00 | .4910E-01 | .4910E-01 | PD-NAT |
| .9800E 00 | .2000E-01-.4400E 00 | .2000E-01 | .4420E 00 | .6630E-01 | .6630E-01 | PD-NAT |
| .1000E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3750E 00 | .5630E-01 | .5630E-01 | PD-NAT |
| .1000E 01 | .2000E-01-.4400E 00 | .2000E-01 | .4720E 00 | .7080E-01 | .7080E-01 | PD-NAT |
| .1000E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3223E 00 | .6000E-01 | .6000E-01 | PD-NAT |
| .1040E 01 | .2000E-01-.4400E 00 | .2000E-01 | .4770E 00 | .7150E-01 | .7150E-01 | PD-NAT |
| .1040E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3940E 00 | .5920E-01 | .5920E-01 | PD-NAT |
| .1060E 01 | .2000E-01-.4400E 00 | .2000E-01 | .4890E 00 | .7330E-01 | .7330E-01 | PD-NAT |
| .1080E 01 | .2000E-01-.4400E 00 | .2000E-01 | .4850E 00 | .7270E-01 | .7270E-01 | PD-NAT |
| .1100E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2880E 00 | .3000E-01 | .3000E-01 | PD-NAT |
| .1100E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3800E 00 | .5700E-01 | .5700E-01 | PD-NAT |
| .1120E 01 | .2000E-01-.4400E 00 | .2000E-01 | .4060E 00 | .6090E-01 | .6090E-01 | PD-NAT |
| .1140E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3310E 00 | .4960E-01 | .4960E-01 | PD-NAT |
| .1150E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3699E 00 | .6000E-01 | .6000E-01 | PD-NAT |
| .1150E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3108E 00 | .3730E-01 | .3730E-01 | PD-NAT |
| .1151E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2827E 00 | .3393E-01 | .3393E-01 | PD-NAT |
| .1160E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3570E 00 | .5360E-01 | .5360E-01 | PD-NAT |
| .1180E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3030E 00 | .4550E-01 | .4550E-01 | PD-NAT |
| .1200E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3080E 00 | .4620E-01 | .4620E-01 | PD-NAT |
| .1200E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2896E 00 | .5000E-01 | .5000E-01 | PD-NAT |
| .1220E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2680E 00 | .4010E-01 | .4010E-01 | PD-NAT |
| .1240E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2760E 00 | .4140E-01 | .4140E-01 | PD-NAT |
| .1260E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3140E 00 | .4700E-01 | .4700E-01 | PD-NAT |
| .1270E 01 | .2000E-01-.4400E 00 | .2000E-01 | .3478E 00 | .5217E-01 | .5217E-01 | PD-NAT |
| .1280E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2550E 00 | .3830E-01 | .3830E-01 | PD-NAT |
| .1300E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2720E 00 | .4090E-01 | .4090E-01 | PD-NAT |
| .1320E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2420E 00 | .3640E-01 | .3640E-01 | PD-NAT |
| .1330E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2532E 00 | .3798E-01 | .3798E-01 | PD-NAT |
| .1460E 01 | .2000E-01-.4400E 00 | .2000E-01 | .2300E 00 | .3450E-01 | .3450E-01 | PD-NAT |

| PD-NAT    | Q=                  | -.500000  |           |           |           | PD-NAT |
|-----------|---------------------|-----------|-----------|-----------|-----------|--------|
| .8400E 00 | .1000E-01-.5000E 00 | .3000E-01 | .4193E 00 | .6837E-01 | .6837E-01 | PD-NAT |
| .8400E 00 | .1000E-01-.5000E 00 | .3000E-01 | .6945E 00 | .1270E 00 | .1270E 00 | PD-NAT |
| .8600E 00 | .1000E-01-.5000E 00 | .3000E-01 | .4476E 00 | .9150E-01 | .9150E-01 | PD-NAT |
| .8800E 00 | .1000E-01-.5000E 00 | .3000E-01 | .5121E 00 | .9610E-01 | .9610E-01 | PD-NAT |
| .9000E 00 | .1000E-01-.5000E 00 | .3000E-01 | .3693E 00 | .8350E-01 | .8350E-01 | PD-NAT |
| .9200E 00 | .1000E-01-.5000E 00 | .3000E-01 | .4580E 00 | .9480E-01 | .9480E-01 | PD-NAT |
| .9400E 00 | .1000E-01-.5000E 00 | .3000E-01 | .4612E 00 | .9460E-01 | .9460E-01 | PD-NAT |
| .9600E 00 | .1000E-01-.5000E 00 | .3000E-01 | .3367E 00 | .9590E-01 | .9590E-01 | PD-NAT |
| .9800E 00 | .1000E-01-.5000E 00 | .3000E-01 | .5944E 00 | .1150E 00 | .1150E 00 | PD-NAT |
| .1000E 01 | .1000E-01-.5000E 00 | .3000E-01 | .4433E 00 | .9150E-01 | .9150E-01 | PD-NAT |
| .1040E 01 | .1000E-01-.5000E 00 | .3000E-01 | .4994E 00 | .9650E-01 | .9650E-01 | PD-NAT |
| .1060E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5727E 00 | .1090E 00 | .1090E 00 | PD-NAT |
| .1080E 01 | .1000E-01-.5000E 00 | .3000E-01 | .4532E 00 | .9370E-01 | .9370E-01 | PD-NAT |
| .1100E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5940E 00 | .1120E 00 | .1120E 00 | PD-NAT |
| .1120E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5336E 00 | .1030E 00 | .1030E 00 | PD-NAT |
| .1140E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5946E 00 | .1120E 00 | .1120E 00 | PD-NAT |
| .1150E 01 | .1000E-01-.5000E 00 | .3000E-01 | .4171E 00 | .9834E-01 | .9834E-01 | PD-NAT |
| .1160E 01 | .1000E-01-.5000E 00 | .3000E-01 | .6563E 00 | .1270E 00 | .1270E 00 | PD-NAT |
| .1180E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5367E 00 | .1070E 00 | .1070E 00 | PD-NAT |
| .1200E 01 | .1000E-01-.5000E 00 | .3000E-01 | .6583E 00 | .1260E 00 | .1260E 00 | PD-NAT |
| .1220E 01 | .1000E-01-.5000E 00 | .3000E-01 | .3842E 00 | .1000E 00 | .1000E 00 | PD-NAT |
| .1240E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5607E 00 | .1100E 00 | .1100E 00 | PD-NAT |
| .1260E 01 | .1000E-01-.5000E 00 | .3000E-01 | .9285E 00 | .1110E 00 | .1110E 00 | PD-NAT |
| .1280E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5813E 00 | .1150E 00 | .1150E 00 | PD-NAT |
| .1300E 01 | .1000E-01-.5000E 00 | .3000E-01 | .9210E 00 | .8410E-01 | .8410E-01 | PD-NAT |
| .1320E 01 | .1000E-01-.5000E 00 | .3000E-01 | .5511E 00 | .1130E 00 | .1130E 00 | PD-NAT |

|                     |    |           |         |    |           |           |           |           |           |        |
|---------------------|----|-----------|---------|----|-----------|-----------|-----------|-----------|-----------|--------|
| .1350E              | 01 | .1000E-01 | -.5000E | 00 | .3000E-01 | .4402E    | 00        | .9774E-01 | .9774E-01 | PD-NAT |
| .1400E              | 01 | .1000E-01 | -.5000E | 00 | .3000E-01 | .3493E    | 00        | .9591E-01 | .9591E-01 | PD-NAT |
| .1450E              | 01 | .1000E-01 | -.5000E | 00 | .3000E-01 | .5299E    | 00        | .9021E-01 | .9021E-01 | PD-NAT |
| .1460E              | 01 | .1000E-01 | -.5000E | 00 | .3000E-01 | .3931E    | 00        | .9330E-01 | .9330E-01 | PD-NAT |
| PD-NAT Q= -.570000  |    |           |         |    |           |           |           |           |           |        |
| .8400E              | 00 | .2000E-01 | -.5700E | 00 | .2000E-01 | .1626E    | 00        | .5951E-01 | .5951E-01 | PD-NAT |
| .8050E              | 00 | .2000E-01 | -.5700E | 00 | .2000E-01 | .2305E    | 00        | .5765E-01 | .5765E-01 | PD-NAT |
| .1150E              | 01 | .2000E-01 | -.5700E | 00 | .2000E-01 | .1772E    | 00        | .5126E-01 | .5126E-01 | PD-NAT |
| .1151E              | 01 | .2000E-01 | -.5700E | 00 | .2000E-01 | .2047E    | 00        | .5456E-01 | .5456E-01 | PD-NAT |
| PD-NAT Q= -.650000  |    |           |         |    |           |           |           |           |           |        |
| .1150E              | 01 | .2000E-01 | -.6500E | 00 | .2500E-01 | .4371E-01 | .2245E-01 | .2245E-01 | .2245E-01 | PD-NAT |
| .1151E              | 01 | .2000E-01 | -.6500E | 00 | .2500E-01 | .2965E-01 | .2557E-01 | .2557E-01 | .2557E-01 | PD-NAT |
| .1300E              | 01 | .2000E-01 | -.6500E | 00 | .2500E-01 | .6034E-01 | .2240E-01 | .2240E-01 | .2240E-01 | PD-NAT |
| PD-NAT Q= -.720000  |    |           |         |    |           |           |           |           |           |        |
| .1150E              | 01 | .2000E-01 | -.7200E | 00 | .2500E-01 | .2155E-01 | .1585E-01 | .1585E-01 | .1585E-01 | PD-NAT |
| .1151E              | 01 | .2000E-01 | -.7200E | 00 | .2500E-01 | .1104E-01 | .1325E-01 | .1325E-01 | .1325E-01 | PD-NAT |
| PD-NAT Q= -.760000  |    |           |         |    |           |           |           |           |           |        |
| .1150E              | 01 | .2000E-01 | -.7600E | 00 | .2500E-01 | .2496E-01 | .1995E-01 | .1995E-01 | .1995E-01 | PD-NAT |
| PD-NAT Q= -.830000  |    |           |         |    |           |           |           |           |           |        |
| .1300E              | 01 | .2000E-01 | -.8300E | 00 | .2000E-01 | .9880E-01 | .7186E-01 | .7186E-01 | .7186E-01 | PD-NAT |
| .1350E              | 01 | .2000E-01 | -.8300E | 00 | .2000E-01 | .2577E    | 00        | .8204E-01 | .8204E-01 | PD-NAT |
| .1400E              | 01 | .2000E-01 | -.8300E | 00 | .2000E-01 | .2084E    | 00        | .8549E-01 | .8549E-01 | PD-NAT |
| .1450E              | 01 | .2000E-01 | -.8300E | 00 | .2000E-01 | .2713E    | 00        | .8931E-01 | .8931E-01 | PD-NAT |
| PD-NAT Q= -.940000  |    |           |         |    |           |           |           |           |           |        |
| .1400E              | 01 | .2000E-01 | -.9400E | 00 | .2500E-01 | .5488E    | 00        | .1000E    | .1000E    | PD-NAT |
| .1450E              | 01 | .2000E-01 | -.9400E | 00 | .2500E-01 | .5299E    | 00        | .1000E    | .1000E    | PD-NAT |
| PD-NAT Q= -1.010000 |    |           |         |    |           |           |           |           |           |        |
| .1300E              | 01 | .2000E-01 | -.1010E | 01 | .5000E-01 | .1905E    | 00        | .5287E-01 | .5287E-01 | PD-NAT |

END OF INELASTIC BLOCK

PD TOTAL CROSS SECTIONS  
FORMAT(JE12.8)  
1. ENERGY IN KEV  
2. X-SEC IN BARNs  
3. ERROR IN X-SEC IN BARNs  
RESOLUTION ABOUT 2 KEV

|          |    |          |    |             |        |        |
|----------|----|----------|----|-------------|--------|--------|
| .100011E | 03 | .758337E | 01 | .828750E-01 | PD-NAT |        |
| .102067E | 03 | .759097E | 01 | .817850E-01 | PD-NAT |        |
| .104104E | 03 | .777973E | 01 | .801960E-01 | PD-NAT |        |
| .106132E | 03 | .759642E | 01 | .811680E-01 | PD-NAT |        |
| .108156E | 03 | .747383E | 01 | .804640E-01 | PD-NAT |        |
| .110176E | 03 | .741465E | 01 | .798660E-01 | PD-NAT |        |
| .112194E | 03 | .762284E | 01 | .794410E-01 | PD-NAT |        |
| .114210E | 03 | .779805E | 01 | .794490E-01 | PD-NAT |        |
| .116225E | 03 | .786343E | 01 | .791160E-01 | PD-NAT |        |
| .118238E | 03 | .778573E | 01 | .797230E-01 | PD-NAT |        |
| .120251E | 03 | .787985E | 01 | .793880E-01 | PD-NAT |        |
| .122263E | 03 | .782702E | 01 | .790130E-01 | PD-NAT |        |
| .124274E | 03 | .787654E | 01 | .793730E-01 | PD-NAT |        |
| .126284E | 03 | .794822E | 01 | .788880E-01 | PD-NAT |        |
| .128294E | 03 | .784839E | 01 | .789480E-01 | PD-NAT |        |
| .130303E | 03 | .784985E | 01 | .785660E-01 | PD-NAT |        |
| .132312E | 03 | .784217E | 01 | .784000E-01 | PD-NAT |        |
| .134321E | 03 | .789509E | 01 | .780490E-01 | PD-NAT |        |
| .136329E | 03 | .763334E | 01 | .780060E-01 | PD-NAT |        |
| .138337E | 03 | .727865E | 01 | .786430E-01 | PD-NAT |        |
| .140344E | 03 | .781015E | 01 | .783130E-01 | PD-NAT |        |
| .142351E | 03 | .764387E | 01 | .778710E-01 | PD-NAT |        |
| .144359E | 03 | .754576E | 01 | .110919E    | 00     | PD-NAT |

|             |             |             |        |
|-------------|-------------|-------------|--------|
| .146365E 03 | .767543E 01 | .779800E-01 | PD-NAT |
| .148372E 03 | .774540E 01 | .777490E-01 | PD-NAT |
| .150378E 03 | .798056E 01 | .776400E-01 | PD-NAT |
| .152385E 03 | .775677E 01 | .777620E-01 | PD-NAT |
| .156397E 03 | .754021E 01 | .772420E-01 | PD-NAT |
| .158402E 03 | .775630E 01 | .775790E-01 | PD-NAT |
| .160408E 03 | .754896E 01 | .773810E-01 | PD-NAT |
| .162414E 03 | .753722E 01 | .774590E-01 | PD-NAT |
| .164419E 03 | .759427E 01 | .773910E-01 | PD-NAT |
| .166424E 03 | .764959E 01 | .769960E-01 | PD-NAT |
| .168429E 03 | .749102E 01 | .772030E-01 | PD-NAT |
| .170434E 03 | .773476E 01 | .770120E-01 | PD-NAT |
| .174444E 03 | .766981E 01 | .767420E-01 | PD-NAT |
| .176449E 03 | .780001E 01 | .769460E-01 | PD-NAT |
| .178453E 03 | .776325E 01 | .771560E-01 | PD-NAT |
| .180458E 03 | .794318E 01 | .769730E-01 | PD-NAT |
| .182462E 03 | .782092E 01 | .766590E-01 | PD-NAT |
| .184467E 03 | .788200E 01 | .767680E-01 | PD-NAT |
| .186471E 03 | .789169E 01 | .765990E-01 | PD-NAT |
| .188475E 03 | .776517E 01 | .768880E-01 | PD-NAT |
| .190479E 03 | .783539E 01 | .767510E-01 | PD-NAT |
| .192484E 03 | .788419E 01 | .765480E-01 | PD-NAT |
| .194488E 03 | .785015E 01 | .768010E-01 | PD-NAT |
| .196492E 03 | .768344E 01 | .767710E-01 | PD-NAT |
| .198495E 03 | .780591E 01 | .765100E-01 | PD-NAT |
| .200499E 03 | .791690E 01 | .765600E-01 | PD-NAT |
| .202503E 03 | .792075E 01 | .766140E-01 | PD-NAT |
| .204507E 03 | .795699E 01 | .766630E-01 | PD-NAT |
| .206511E 03 | .781503E 01 | .763230E-01 | PD-NAT |
| .208514E 03 | .786640E 01 | .761540E-01 | PD-NAT |
| .210518E 03 | .779290E 01 | .762930E-01 | PD-NAT |
| .212521E 03 | .798946E 01 | .763220E-01 | PD-NAT |
| .214525E 03 | .791016E 01 | .762790E-01 | PD-NAT |
| .216528E 03 | .799392E 01 | .762920E-01 | PD-NAT |
| .218532E 03 | .769603E 01 | .761410E-01 | PD-NAT |
| .220535E 03 | .788604E 01 | .763480E-01 | PD-NAT |
| .222538E 03 | .803269E 01 | .761240E-01 | PD-NAT |
| .224542E 03 | .797691E 01 | .762140E-01 | PD-NAT |
| .226545E 03 | .778411E 01 | .761650E-01 | PD-NAT |
| .228548E 03 | .793679E 01 | .761890E-01 | PD-NAT |
| .230551E 03 | .798273E 01 | .760540E-01 | PD-NAT |
| .232554E 03 | .802113E 01 | .758050E-01 | PD-NAT |
| .234557E 03 | .793399E 01 | .759790E-01 | PD-NAT |
| .236561E 03 | .795712E 01 | .760640E-01 | PD-NAT |
| .238564E 03 | .798418E 01 | .760470E-01 | PD-NAT |
| .240567E 03 | .771775E 01 | .758470E-01 | PD-NAT |
| .242570E 03 | .778315E 01 | .760550E-01 | PD-NAT |
| .244572E 03 | .769171E 01 | .757490E-01 | PD-NAT |
| .246575E 03 | .782341E 01 | .758260E-01 | PD-NAT |
| .248578E 03 | .782988E 01 | .758510E-01 | PD-NAT |
| .250581E 03 | .765771E 01 | .756340E-01 | PD-NAT |
| .252584E 03 | .787972E 01 | .757410E-01 | PD-NAT |
| .254587E 03 | .790471E 01 | .756620E-01 | PD-NAT |
| .256589E 03 | .789215E 01 | .756390E-01 | PD-NAT |
| .258592E 03 | .791658E 01 | .756100E-01 | PD-NAT |
| .260595E 03 | .819554E 01 | .755160E-01 | PD-NAT |
| .264600E 03 | .793914E 01 | .756420E-01 | PD-NAT |
| .266603E 03 | .788416E 01 | .756220E-01 | PD-NAT |
| .270608E 03 | .788169E 01 | .755650E-01 | PD-NAT |
| .272611E 03 | .768621E 01 | .106758E 00 | PD-NAT |
| .274613E 03 | .769162E 01 | .752910E-01 | PD-NAT |
| .276616E 03 | .762942E 01 | .752840E-01 | PD-NAT |
| .278618E 03 | .769496E 01 | .753980E-01 | PD-NAT |
| .280621E 03 | .782124E 01 | .752670E-01 | PD-NAT |
| .282623E 03 | .787728E 01 | .752190E-01 | PD-NAT |
| .284626E 03 | .813928E 01 | .753920E-01 | PD-NAT |
| .288631E 03 | .805573E 01 | .752440E-01 | PD-NAT |
| .290633E 03 | .792166E 01 | .752240E-01 | PD-NAT |



|          |    |          |    |             |        |
|----------|----|----------|----|-------------|--------|
| .298640E | 03 | .758194E | 01 | .752170E-01 | PD-NAT |
| .298642E | 03 | .803357E | 01 | .752870E-01 | PD-NAT |
| .300645E | 03 | .790626E | 01 | .753120E-01 | PD-NAT |
| .302647E | 03 | .777947E | 01 | .753020E-01 | PD-NAT |
| .304649E | 03 | .770650E | 01 | .751040E-01 | PD-NAT |
| .306651E | 03 | .773088E | 01 | .750600E-01 | PD-NAT |
| .308654E | 03 | .779809E | 01 | .750200E-01 | PD-NAT |
| .310656E | 03 | .773901E | 01 | .750750E-01 | PD-NAT |
| .312658E | 03 | .767638E | 01 | .750240E-01 | PD-NAT |
| .314660E | 03 | .774070E | 01 | .751040E-01 | PD-NAT |
| .316662E | 03 | .781354E | 01 | .751040E-01 | PD-NAT |
| .318665E | 03 | .784199E | 01 | .750230E-01 | PD-NAT |
| .330677E | 03 | .783553E | 01 | .751410E-01 | PD-NAT |
| .332679E | 03 | .767071E | 01 | .750740E-01 | PD-NAT |
| .334681E | 03 | .785935E | 01 | .750460E-01 | PD-NAT |
| .336683E | 03 | .759803E | 01 | .749470E-01 | PD-NAT |
| .338685E | 03 | .772498E | 01 | .751260E-01 | PD-NAT |
| .340687E | 03 | .783719E | 01 | .751160E-01 | PD-NAT |
| .342689E | 03 | .781893E | 01 | .750030E-01 | PD-NAT |
| .344691E | 03 | .779587E | 01 | .749920E-01 | PD-NAT |
| .346693E | 03 | .763905E | 01 | .750650E-01 | PD-NAT |
| .348695E | 03 | .752850E | 01 | .750410E-01 | PD-NAT |
| .350697E | 03 | .777355E | 01 | .752790E-01 | PD-NAT |
| .352701E | 03 | .758036E | 01 | .750900E-01 | PD-NAT |
| .354703E | 03 | .776499E | 01 | .751080E-01 | PD-NAT |
| .356705E | 03 | .776698E | 01 | .752070E-01 | PD-NAT |
| .358707E | 03 | .787822E | 01 | .751240E-01 | PD-NAT |
| .360709E | 03 | .785500E | 01 | .752390E-01 | PD-NAT |
| .362711E | 03 | .782039E | 01 | .750500E-01 | PD-NAT |
| .364713E | 03 | .776641E | 01 | .751400E-01 | PD-NAT |
| .366715E | 03 | .774522E | 01 | .751400E-01 | PD-NAT |
| .368717E | 03 | .784977E | 01 | .613110E-01 | PD-NAT |
| .370719E | 03 | .761028E | 01 | .613280E-01 | PD-NAT |
| .372721E | 03 | .764368E | 01 | .613880E-01 | PD-NAT |
| .374723E | 03 | .777794E | 01 | .614660E-01 | PD-NAT |
| .376725E | 03 | .806975E | 01 | .614320E-01 | PD-NAT |
| .378727E | 03 | .793831E | 01 | .613150E-01 | PD-NAT |
| .380729E | 03 | .750572E | 01 | .613650E-01 | PD-NAT |
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| .384733E | 03 | .776448E | 01 | .614080E-01 | PD-NAT |
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