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ECSIL, A SYSTEM FOR STORAGE, RETRIEVAL, AND DISPLAY OF EXPERIMENTAL NEUTRON DATA

D. E. Cullen, K. L. Hill, R. J. Howerton,

and S. T. Perkins

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MASTER

Foreword

The UCRL-50400 series describes an integrated and computer-oriented system for the production and application of neutronics and photonics calculational constants.

The system must supply reliable up-to-date data, select specific types of data on request, provide output in a variety of forms – ultimately in the form of input to other computer codes, and function rapidly and efficiently. The system has now been developed to a point where these goals are being realized.

The UCRL-50400 series, An Integrated System for Production of Neutronics and Photonics Calculational Constants, comprises the following volumes:

- Vol. 1, ECSIL, A System for Storage, Retrieval and Display of Experimental Neutron Data, March 1974.
- Vol. 2, A Bibliography of the Experimental Data of Neutron-Induced Interactions, March 1974.
- Vol. 3, An Index of the Experimental Data of Neutron-Induced Interactions, March 1974.
- Vol. 4, Evaluated Nuclear Cross-Section Library, April 1971.
- Vol. 5, CLYDE: A Nuclear Data-Processing Computer Program for Producing Calculational Constants, May 1971.
- Vol. 6, Photon Cross sections 1 keV to 100 MeV, October 1968.
- Vol. 7, Graphical Experimental Data for Major Neutron-Induced Interactions, April 1974.
- Vol. 8, Graphical Experimental Data for Supplemental Neutron-Induced Interactions, to be published.
- Vol. 9, Thresholds of Nuclear Reactions Induced by Neutrons, Photons, Deuterons, Tritons, and Alpha Particles, September 1970.
- Vol. 10, Tabulated Experimental Data for Neutron-Induced Interactions, May 1974.
- Vol. 11, Experimental Data, Indexes and Techniques of Obtaining a Selected Set of Neutron Resonance Parameters, May 1972.
- Vol. 12, An Atlas of Resolved Neutron Resonance Parameters, July 1972.
- Vol. 13, An Atlas of Unresolved Neutron Resonance Parameters, September 1972.
- Vol. 14, TARTNP: A Coupled Neutron-Photon Monte Carlo Transport Code, June 1974.

Contents

Relationship to Other Volumes

This volume, describing the ECSIL system, is closely related to other volumes of the UCRL-50400 series. It defines ECSIL conventions and explains how to use ECSIL's supporting programs.

Volume 2 contains bibliographic indexes that can be used to determine whether a given reference is included in the ESCIL system, and which experimental data are associated with the reference.

Volume 3 lists data indexes that may be used to determine the data in the library for a given isotope or reaction.

Volume 7 is a graphical presentation of all total, elastic, capture, and fission integral cross sections. It also supplies data on $\bar{\nu}$ (neutrons/fission), α (capture/fission ratio) and η (neutrons/nonelastic event).

Volume 8 is a graphical presentation of all other integrated (as opposed to angular distribution) cross sections, including (n, n'), (n, α), etc.

Volume 10 contains the integrated cross sections tabulated on microfiche.

Volume 11 lists indexes and tabulated resonance parameters contained in ECSIL.

Volume 12 lists tabulated selected resolved resonance parameters.

Volume 13 lists tabulated selected unresolved resonance parameters.

Acknowledgments

We gratefully acknowledge the cooperation we have received from the National Neutron Cross Section Center at Brookhaven National Laboratory, the ENEA Center for collection of neutron data at Saclay, the IAEA nuclear data section at Vienna, and the Nuclear Data Section a OBNINSK. The National Neutron Cross Section Center has routinely supplied us with experimental data collected at the four centers.

Many experimenters have furnished us with their data in advance of publication. To them, especially, we offer our grateful thanks. Finally, we would like to express our sincere gratitude to Mrs. Violet Gamble for her effort in maintaining the bibliographic file.

ECSIL, A SYSTEM FOR STORAGE, RETRIEVAL, AND DISPLAY OF EXPERIMENTAL NEUTRON DATA

Abstract

A description of the experimental cross section information library (ECSIL) as of March 1, 1974 is presented, together with its associated formats, conventions, and supporting programs. The forms (i.e., plots and listings) and the order in which data and bibliographic information may be obtained are also given.

Introduction

In 1958, a computerized system for the storage and retrieval of experimental neutron-interaction data was installed at Lawrence Livermore Laboratory. The system has developed gradually and it is still being improved.

The present system is made up of two separate files: A numeric data file and a bibliographic information file. The two files are linked through the use of a four digit number which is uniquely assigned to each reference.

In 1959 and 1960, tabulations of integrated and differential neutron cross sections below 15 MeV were published. Since that time the number of entries in the system has increased by more than an order of magnitude. Consequently, there is too much data in the current library (almost one million data points) to publish tabulations of this information; the resulting volumes would be prohibitively expensive and bulky. However, by presenting the data in graphs[1, 2] and on microfiche,[3] we can significantly reduce the expense and the bulk. Moreover, the reduction in bulk means that indexes[4] and bibliographies[5] can be added to help in the manipulation of the data.

The ECSIL System

This volume describes

- The conventions used in ECSIL to classify experimental neutron-induced cross sections and related information.
- The two formats used to handle the numeric data. The numeric data file is large, encompassing 985,158 points expressed in 7,100,000 computer words. This is stored in a binary format for rapid computer

readout and interpretation. There is also a card image format, used to prepare new numeric data for inclusion in or retrieval from the data library.

- The single format used throughout the bibliographic information system. The bibliographic information file is relatively small; its 3371 references are stored for simplicity as 13,000 card images. The same card image format is used to prepare new bibliographic information for inclusion in or retrieval from the library.
- The system of programs used not only to maintain the current numeric data file and bibliographic information file, but also to prepare indexes, listings, and plots of the data. These indexes, listings, and plots are routinely prepared after every update and published periodically.[1-5]
- An extension of the ECSIL conventions and numeric data formats to allow the system to handle cross sections for any incident particle (e.g., $\sigma(p, p')$), and to describe any emerging particle (e.g., angular distribution of either n or p from the reaction $\sigma(n,n'p)$). The new data conventions and formats will not affect the bibliographic system. At present this new format is implemented on an experimental basis to handle data on charged particles, photons, etc. Barring complications it will be adopted in the future as a replacement for the current ECSIL format.

ECSIL Conventions

The ECSIL Data System describes experimental neutron-induced cross sections and related information by indicating:

Target—The ZA number is used to describe the target. There are several special conventions. For example, A is set equal to zero for elemental mixtures. For compounds, the Z of the element that appears first in the molecular formula is used, and A is defined as 300 plus the molecular weight (e.g., H_2O is assigned Z = 1 and A = 318). For unstable targets, the longest-lived isomer is assigned the ZA of the target; short lived isomers are assigned the Z of the target, and A is defined as 600 plus the A of the target (e.g., ^{242g}Am is assigned Z = 95 and A = 842). See Table 1 for a complete list of compounds and special isotopes.

Table 1. Compounds and special isotopes (assigned ZA's).

Assigned ZA	Material	Assigned ZA	Material
1302	H_2(gas)	14360	SiO_2
1318	H_2O	16364	SO_2
1320	D_2O	22349	$TiH_{0.6}$
5370	B_2O_3	22350	$TiH_{1.9}$
6328	C_2H_4	26460	Fe_2O_3
6331	CH_3OH	27660	^{60m}Co
6376	C_6H_6	40391	$ZrH_{0.63}$
6384	C_6H_{12}	40392	$ZrH_{0.98}$
6386	C_6H_{14}	40393	$ZrH_{1.5}$
6392	$C_3H_8O_3$	40394	$ZrH_{1.98}$
6404	C_8H_8	40423	ZrO_2
6652	$C_{25}H_{52}$	60636	Nd_2O_3
7328	N_2(gas)	61748	^{148g}Pm
7353	NH_4Cl	82999	RADIO-Pb
7398	NH_4Br	92570	UO_2
7445	NH_4I	95842	^{242g}Am
8332	O_2(gas)	95844	^{244g}Am
12340	MgO	99854	^{254m}Es
13402	Al_2O_3		

Interaction—A numerical equivalent is used to designate the interaction: total, elastic, capture, etc. In ECSIL this numerical equivalent is referred to as the basic C number. Table 2 gives a complete list of all basic C numbers.

Interaction Property—A numerical equivalent designates the interaction properties that are measured, such as cross section, angular distribution, or energy distribution. In ECSIL this numerical equivalent is referred to as the C increment number. The total C number used to describe the interaction and its property is the sum of the C number increment and the basic C number [e.g., 11 indicates the total (n, n') cross section, whereas 311 indicates the (n, n') secondary neutron energy spectrum]. Table 3 gives a complete list of all C number

Table 2. Basic reaction designator (basic C).

Basic C	Cross section type	Basic C	Cross section type
1	Total	26	(n,p)
2	Elastic	27	(n,Xp)
3	Nonelastic	28	(n,D)
4	Neutron emission (elastic + nonelastic)	29	(n,XD)
5	Total scattering (inelastic + elastic)	30	(n,T)
6	Neutron nonelastic emission	31	(n,XT)
7	Removal	32	(n, ^{3}He)
8	—	33	(n,X ^{3}He)
9	—	34	(n,α)
10	—	35	(n,Xα)
11	(n,n')	36	Activation
12	(n,2n)	37	(n,2α)
13	(n,3n)	38	—
14	(n,n' p)	39	—
15	(n,n'D)	40	—
16	(n,n'T)	41	Bound atom
17	(n,n', ^{3}He)	42	Free atom
18	(n,n',α)	43	Coherent scattering
19	(n,4n)	44	Incoherent scattering
20	—	45	—
21	Absorption	46	$\bar{\nu}_p$, prompt neutrons per fission (average)
22	(n,fission)	47	$\bar{\nu}_d$, delayed neutrons per fission (average)
23	(n,γ)	48	η, neutrons produced per nonelastic event
24	(n,Xγ) gamma-ray production	49	α, capture-to-fission ratio
25	(n,X) charged-particle emission		

increments. Table 4 lists miscellaneous quantities which are not included in the basic C, C increment scheme.

Interaction Modifier—A numerical equivalent is used to further qualify or describe the interaction. This quantity indicates conditions such as the target temperature, the cross section for excitation of one or more levels of the residual nucleus, and the cross section for production of one or more photons. In ECSIL this numerical equivalent is referred to as the S number. Table 5 gives a complete list of all S numbers.

Table 3. Reaction designator increments (C increment).

C increment	Reaction property (units)	Definition
0	Integrated cross sections (barns), or related parameters	σ
50	Spectrum-averaged cross section (barns)	$\bar{\sigma}$
100[a]	Angular distributions (barns/steradian)	$\sigma(E,\theta)$
200	Energy distributions (barns/MeV)	$\sigma(E,E')$
250	Angular distributions integrated between fixed angular limits (barns)	$\sigma(E,\theta_{min},\theta_{max})_{lab}$
300	Differential energy distributions (barns/steradian MeV)	$\sigma(E,E',\theta)_{lab}$
350	Partial distributions integrated between fixed energy and angular limits (barns)	$\sigma(E,E'_{min},E'_{max},\theta_{min},\theta_{max})_{lab}$
400	Energy distributions integrated between fixed energy limits (barns)	$\sigma(E,E'_{min},E'_{max})$
450[a]	Legendre expansion of angular distributions — $g_\ell(E)$ (dimensionless)	$\sigma(E,\theta) = \sigma(E) \sum_{\ell=0}^{\infty} \frac{2\ell+1}{4\pi} g_\ell(E) P_\ell(\cos\theta)$
500	Resonance integrals (barns)	$R.I. = \int_{E_{min}}^{E_{max}} \sigma(E) \frac{dE}{E}$
550[a]	Polarization (dimensionless)	$P(E,\theta)$
600	Partial distributions integrated between fixed-energy limits (barns/steradian)	$\sigma(E,E'_{min},E'_{max},\theta)_{lab}$
650	Partial distributions integrated between fixed angular limits (barns/MeV)	$\sigma(E,E',\theta_{min},\theta_{max})_{lab}$
800	C/S ratios (dimensionless)	
900	Miscellaneous quantities	See: Table 4

[a]Angular distributions for all unique two-body reactions are expressed in the center-of-mass system. Multibody reactions are expressed in the laboratory frame of reference.

Table 4. Reaction designator for miscellaneous quantities.

C					
	Spectra parameters				
901	Nuclear temperature, nonelastic (excluding fission)				
902	Nuclear temperature, total nonelastic				
903	Nuclear temperature, fission				
904	Nuclear temperature, inelastic (first neutron)				
905	Nuclear temperature (second neutron)				
	Thermal parameters				
911	Thermal scattering law, $S(\alpha,\beta)$				
	Average resonance parameters				
941	$\overline{D}_{observed}$	944	$\overline{\Gamma}_n^{\ell}$		
942	$\overline{\Gamma}_\gamma$	945	$\overline{D}_\ell$		
943	$\overline{\Gamma}_f$	946	$\overline{S}_\ell$		
	Resolved resonance parameters				
951	E_o (energy only)	965	$g\Gamma_n^2$	979	$\Gamma_n\sigma_o$
952	J,π	966	$g\Gamma_n$	981	$\sigma_o\Gamma_f/\Gamma_t$
953	ℓ	967	$g\Gamma_n^o$	982	$\sigma_o\Gamma_\gamma/\Gamma_t$
954	g	968	$g\Gamma_\gamma$	983	$\sigma_o\Gamma_a/\Gamma_t$
955	σ_o	969	Γ_n/Γ_t	986	$g\Gamma_\gamma\Gamma_n/\Gamma_t$
956	Γ_t	970	Γ_a/Γ_t	987	$2g\Gamma_n^2/\Gamma_t$
957	Γ_n	971	Γ_γ/Γ_t	988	$\Gamma_t^2\sigma_o$
958	Γ_n^o	972	Γ_n/Γ_a	989	$g\Gamma_n^o\Gamma_f$
959	Γ_γ	973	Γ_f/Γ_t	990	$g\Gamma_f\Gamma_n/\Gamma_t$
960	Γ_f	974	Γ_f/Γ_a	991	$\sigma_o\Gamma_f\Gamma_t$
961	Γ_a	975	Γ_γ/Γ_f	992	$\Gamma_n^o\Gamma_f/\Gamma_t$
962	Γ_α	976	$\Gamma_t\sigma_o$	993	$g(\Gamma_n)^2$
963	Γ_p	977	$\Gamma_f\sigma_o$	994	$g\Gamma_n\Gamma_\gamma$
964	$g\Gamma_n^1$	978	$\Gamma_\gamma\sigma_o$		

Table 5. Reaction designator modifier[a] (S number).

S	Modification (units)	S	Modification (units)
1	Level excitation (MeV)	9	Material temperature (Kelvin)
2	Isomer production (seconds)	10	Unresolved photon production (MeV)
3	Isomer production (minutes)	11	Spin state (dimensionless)
4	Isomer production (hours)	12	Isotope bound in material (dimensionless)
5	Isomer production (days)	13	Oriented crystal (Miller number)
6	Isomer production (years)	14	Electron production (MeV)
7	Photon production (MeV)	20	Transmission measurement (barns/atom)
8	Unresolved level excitation (MeV)		

[a] S + 80 indicates relative distribution.

ECSIL Numeric Data Card Format

Each data point in the ECSIL numeric data card format is described by 8 required quantities and from 4 to 10 experimentally measured components. All fields in the format are numeric (as opposed to alphanumeric) and must be right adjusted. The end of a file is indicated by an end-of-file card, replacing the end-of-data sentinel (i.e., Z = 300) used in earlier versions of ECSIL.

The card format allows six of the measured components to appear on a first card and the remaining four on a second card. The second card is present only if more than six components are required to describe the data point. Therefore each data point is described by either one or two card images. Table 6 described the ECSIL numeric data card format.

Table 6. ECSIL numeric data card format.

Card	Field	Format	Columns	Definition	Relevant tables
1	1	I3	1-3	Z (atomic number of target)	1
	2	I3	4-6	A (atomic weight of target)	1
	3	I3	7-9	C (interaction numerical equivalent)	2, 3, 4
	4	I2	10-11	S (interaction modifier)	7
	5	E10.3	12-21	Measured components (4 to 10)	8
	6	E10.3	22-31	↓	
	7	E10.3	32-41	↓	
	8	E10.3	42-51	↓	
	9	E10.3	52-61	↓	
	10	E10.3	62-71	↓	
	11	I1	72	Status[b]	9
	12	I2	73-74	Year (last two digits: e.g., 1972 ⇒72)	
	13	I4	75-78	Reference number	
	14	I2	79-80	Sub-reference number	
2[a, b]			1-11	(Blank)[c]	
	15	E10.3	12-21	Measured components (continued)	8
	16	E10.3	22-31	↓	
	17	E10.3	32-41	↓	
	18	E10.3	42-51	↓	
			52-71	(Blank)	
	19	I1	72	Status[b]	
	20	I2	73-74	Year	Must be identical to corresponding columns on first card[c]
	21	I4	75-78	Reference number	
	22	I2	79-80	Sub-reference number	

Footnote on next page.

[a]Second or continuation card is present only if data point requires more than six measured components to describe it.

[b]Presence of second card is indicated by adding 5 to status (e.g., status = 1 - preliminary data, one card for data point; status = 6 - preliminary data, two cards for data point).

[c]Only the status field indicates continuation, these fields are used to check that the continuation card, if required, is indeed present.

CARD 1

1	2	3	4	5	6	7	8	9	10 (Status)	11	12	13 (Year)	14
Z	A	C	S	D_1	D_2	D_3	D_4	D_5	D_6			Ref. No.	Sub-Ref
1-3	4-6	7-9	10-11	12-21	22-31	32-41	42-51	52-61	62-71	72	73-74	75-78	79-80

Field 1, (Z) Atomic Number of the Target

For molecules, the Z of the target is defined to be the Z of the first element in the molecular formula (e.g., for H_2O, Z is defined to be 1, the Z for hydrogen). See Table 1 for the present table of compounds and special isotopes.

Field 2, (A) Atomic Weight of the Target

For naturally occurring elemental mixtures of isotopes A is defined to be zero. For monoisotopic elements the mass number of the single isotope is used (e.g., Fluorine, A = 19). For molecules A is defined to be the molecular weight of the molecule, rounded to the nearest integer, plus 300, (e.g., for H_2O, A = (molecular weight of H_2O) + 300 = 318). For isomers, the A number of the longest lived level is defined to be the mass number (e.g., ^{242m}Am, A = 242). For the shorter lived level, the A number is defined to be the mass number plus 600 (e.g., ^{242g}Am, A = 242 + 600 = 842). Radiolead is arbitrarily assigned the A value of 999. See Table 1 for a complete list of all compounds and special isotopes. General rules for A are

- A = 0 - Naturally occurring elemental mixture.
- $1 \leq A \leq 299$ - Individual isotope.
- $300 \leq A \leq 599$ - Molecule.
- $600 \leq A \leq 998$ - Short lived isomeric level.
- A = 999 - Radiolead.

} see Table 1

Table 7. Field definitions for each numerical interaction designator (C) range.

Card	1								2			
Field number	3	4	5	6	7	8	9	10	15	16	17	18
Columns (inclusive)	7-9	10-11	12-21	22-31	32-41	42-51	52-61	62-71	12-21	22-31	32-41	42-51
Reaction property	C	S[b]	Quantity contained (all fields 3-10,3)									
Integrated cross sections	1-49		E	ΔE	C,S	$\Delta C,S$	X_1[a]	X_2	X_3	X_4	X_5	X_6
Spectrum-averaged cross section	51-99		E	ΔE	C,S	$\Delta C,S$	X_1	X_2	X_3	X_4	X_5	X_6
Angular distributions	101-149		E	ΔE	$\cos\theta$	C,S	$\Delta C,S$	X_1	X_2	X_3	X_4	X_5
Energy distributions	201-249		E	ΔE	E'	$\Delta E'$	C,S	$\Delta C,S$	X_1	X_2	X_3	X_4
Angular distributions integrated between fixed angular limits	251-299		E	ΔE	$(\cos\theta)_{min}$	$(\cos\theta)_{max}$	C,S	$\Delta C,S$	X_1	X_2	X_3	X_4
Differential energy-angle distributions	301-349		E	ΔE	E'	$\cos\theta$	C,S	$\Delta C,S$	X_1	X_2	X_3	X_4
Energy-angular distributions integrated between fixed energy and angular limits	351-399		E	ΔE	E'_{min}	E'_{max}	$(\cos\theta)_{min}$	$(\cos\theta)_{max}$	C,S	$\Delta C,S$	X_1	X_2
Energy distribution integrated between fixed energy limits	401-499		E	ΔE	E'_{min}	E'_{max}	C,S	$\Delta C,S$	X_1	X_2	X_3	X_4
Legendre coefficients ($\ell \geq 1$)	451-499		ℓ	ΔE	ℓ	g_ℓ[c]	Δg_ℓ	X_1	X_2	X_3	X_4	X_5
Resonance integrals	501-549		E_{min}	E_{max}	R.I.	ΔR.I.	X_1	X_2	X_3	X_4	X_5	X_6
Polarization	551-599		E	ΔE	$\cos\theta$	P	ΔP	X_1	X_2	X_3	X_4	X_5
Energy-angular distribution integrated between fixed energy limits	601-649		E	ΔE	E'_{min}	E'_{max}	$\cos\theta$	C,S	$\Delta C,S$	X_1	X_2	X_3
Energy-angular distribution integrated between fixed angular limits	651-699		E	ΔE	E'	$(\cos\theta)_{min}$	$(\cos\theta)_{max}$	C,S	$\Delta C,S$	X_2	X_3	X_4
Cross section ratio for a specific isotope and reaction	801-849		E	ΔE	Ratio	ΔRatio	ZA_D[d]	C_D[e]	X_1	X_2	X_3	X_4
Nuclear temperature	901-904		T	ΔE	E'_{max}		T	ΔT	X_1	X_2	X_3	X_4
Thermal scattering law	911		β	$\Delta\beta$	σ	$\Delta\sigma$	S	ΔS	E	T	X_1	X_2
Average level spacings, gamma and fission widths	941-943		E_{min}	E_{max}	Param	ΔParam	X_1[f]	X_2	X_3	X_4	X_5	X_6
Average reduced neutron widths and strength functions	944-946		E_{min}	E_{max}	f	Param	ΔParam	X_1[f]	X_2	X_3	X_4	X_5
Resolved resonance parameters	951-999[g]		E	ΔE	J[h]	ΔJ[i]	X_1	X_2	X_3	X_4	X_5	X_6

[a] For activation (C = 36) this field identifies the activated isotope (ZA_2) and X_1 fields start in Field 10.

[b] X_1 fields only used for S > 0 (see Table 4 for definition of X_1 fields for each S).

[c] See Table 3 for definition of g_ℓ.

[d] ZA_D identifies isotope in denominator of ratio.

[e] C_D identifies reaction in denominator of ratio (C_D = 1 to 49).

[f] The only allowed S numbers are S = 0 or 11; if S = 0, X_1 is not used; if S = 11, X_1 = J.

[g] S ≠ C is not allowed.

[h] Only E and ΔE are used for C = 951.

[i] For C = 952 ± (i.e., parity) is defined in Field 8.

Field 3, (C) Interaction Designator

The interaction designator is the numerical sum of two numbers, the basic C and the C increment. The basic C number describes the interaction (e.g., 1 = total, 2 = elastic, etc.), as defined in Table 2. The C increment number describes the interaction property as defined in Table 3, (e.g., from Table 2, (n,n') is described by a basic C = 11; the interaction designator for the (n,n') cross section is 11, (11 + 0) whereas 311 (11 + 300) indicates an (n,n') secondary neutron energy spectrum).

A number of miscellaneous, usually derived quantities do not lend themselves to the scheme outlined above. These quantities have been assigned C numbers in the range 900 to 999 and are all defined in Table 4. Table 7 defines the contents of each field for each range of the numerical interaction designator (C).

Field 4 (S) Interaction Modifier

All interaction modifiers are defined in Table 8. Relative distributions are indicated by S + 80 (e.g., C = 22, S = 0 indicates a fission cross section (barns);

Table 8. Interaction designator modifier (S number).[a]

S	Modifier	X_i[b] field definition	Units	Allowed X_i[b,c] fields
1	Level excitation	Energy of excited level	MeV	1-6
2	Isomer production	Half-Life of isomer	Sec	1-6
3	Isomer production	Half-Life of isomer	Min	1-6
4	Isomer production	Half-Life of isomer	Hr	1-6
5	Isomer production	Half-Life of isomer	Day	1-6
6	Isomer production	Half-Life of isomer	Yr	1-6
7	Photon production	Energy of photon	MeV	1-6
8	Unresolved level excitation	Lower (X_1) and upper (X_2)	MeV	2
9	Material temperature	Energy limits of temperature levels	Kelvin	1
10	Unresolved photon excitation	Lower (X_1) and upper (X_2) energy limits of photons	MeV	2
11	Spin state	J	Dimensionless	1
12	Isotope bound in material	ZA[d] of binding material	Dimensionless	1
13	Oriented crystal	Miller number	HKL	1
14	Electron production	Energy of electron	MeV	1-6
20	Transmission measurements	Target thickness	Barn/Atom	1

[a] S + 80 indicates relative distribution.

[b] All X_i fields are non-negative (i.e., zero or positive).

[c] Multiple X_i fields must be in ascending order (i.e., $X_i < X_{i+1}$).

[d] ZA = 1000 Z + A (see Table 1 for compounds and special isotopes).

C = 22, S = 80 indicates a relative fission cross section (dimensionless)). S = 0 or 80 indicates that only the minimum number of fields are present, whereas all other S values require one or more X_i fields. See Table 7 for the position of X_i fields for each range of the interaction designator (C), and Table 8 for the number of X_i fields allowed for each S value.

Fields 5-10 (D_1-D_6) Experimentally Measured Components

Fields 5-10 of the first card (and fields 15-18 of the second card if required) contain the actual results of the measurements. Table 7 defines the physical significance of each measured component for each range of the interaction designator (C). Conventions that have been adopted within the ECSIL system for handling or interpreting the measured components are:

- The energy is left blank for energy-dependent parameters (e.g., free atom cross section).
- A standard set of units (as opposed to arbitrary author quoted units) is used. These units are: MeV, barn, steradian and Kelvin (e.g., all level widths are in MeV). An exception is that half-lives may be expressed in seconds, minutes, hours, days or years (see Table 8).
- Only the latest cross section data are contained in the library. Superseded data are deleted from the library. Renormalized data are carried only in final form. Transmission data are not included in ECSIL, only derived cross sections.
- Uncertainties (e.g., cross section error, energy resolution) are always expressed in the same units as the data with which they are associated (e.g., cross section and error both in barn, energy and error in MeV).
- For spectrum-averaged cross sections no attempt is made to distinguish between thermal (Maxwellian) and thermal-reactor spectrum-averaged cross sections. Both are designated as spectrum-averaged cross sections at 0.025 eV. Similarly, fission-spectrum-averaged cross sections are entered with an equivalent energy of 2.0 MeV. Further differentiation is left to the annotations in the bibliographic library.
- Angular information for all two-body interactions are expressed in the center of mass system. Multibody reactions are naturally in the laboratory system.
- Legendre coefficients are normalized (see Table 3), i.e., $g_0 = 1$ and thus g_0 is never input.
- All resonance integrals include the 1/v contribution.
- If for a resonance integral no upper energy limit is indicated, it is assigned a large value (e.g., 15 MeV).
- Spectrum-averaged α in the epithermal energy region is defined in the usual manner as the ratio of the capture resonance integral to that of fission. It is therefore assigned a C of 549 (α resonance integral) rather than a C of 99 (spectrum-averaged α)

- Parity (C = 952) is defined as +1.0 for +, or -1.0 for -.
- Fission widths may have either a + or - sign because they are associated with the interference term in a multilevel analysis.

Field 11 - Status Designator

The status indicates the current state or condition of a data point. The three status categories and their numerical equivalents are listed in Table 9.

Table 9. Status designators.

Designator	Status
0 (or blank), 5[a]	Data usable without restriction
1, 6[a]	Preliminary data
2, 7[a]	Data not to be released (usually at request of author)

[a]For data points that require two input cards.

(Status designator +5) is used in the card format to indicate that the data point is continued onto a second card. For example a 1 in the status designator field indicates a preliminary data point contained on one card. A 6 indicates a preliminary data point whose components are continued onto a second card. The status designator on the second card must be identical to that on the first.*

Field 12 - Year

The last two digits of the year in which the data was published, or in the case of a private communication, the last two digits of the year in which the data was received (e.g., 1973 ⇒ 73).

Field 13 - Reference Number

Serial four digit reference number assigned when the reference is entered into the system. Reference numbers are never reassigned even after the data is deleted from the library.

Field 14 - Subreference Number

Designed to differentiate between portions of the data from a given reference. Presently unused (i.e., always zero (0)).

*Regardless of which set of numbers is used, the status stored in the library will be 0, 1 or 2. This is important in planning programs to manipulate data from the ECSIL library tapes. Any such program must reconstitute the original status designator in its output.

CARD 2

	15	16	17	18		Status	19	20	Year 21	22
(Blank)	D_7	D_8	D_9	D_{10}	(Blank)				Ref.	Sub-Ref.
1 - 11	12 - 21	22 - 31	32 - 41	42 - 51	52	- 71	72	73-74	75-78	79-80

Card 2 is only present if over six experimentally measured components are required to describe a given data point. The presence of card 2, the continuation card, is indicated by a status of five or greater (see Field 11). The status, as well as year, reference, and subreference, must be identical on both first and second cards. Columns 1-11 (Z, A, C, S fields) on the second card must be blank.

Fields 15-18 - Experimentally Measured Components

See Fields 5-10 of card 1 for all conventions associated with the measured components.

Fields 19-22 - The Status, Year, Reference Number and Sub-Reference Number

These items on the continuation card must be identical to the corresponding fields of the first card. See Fields 11-14 of card 1 for all conventions associated with these fields.

ECSIL Numeric Data Library Format

LIBRARY ORGANIZATION

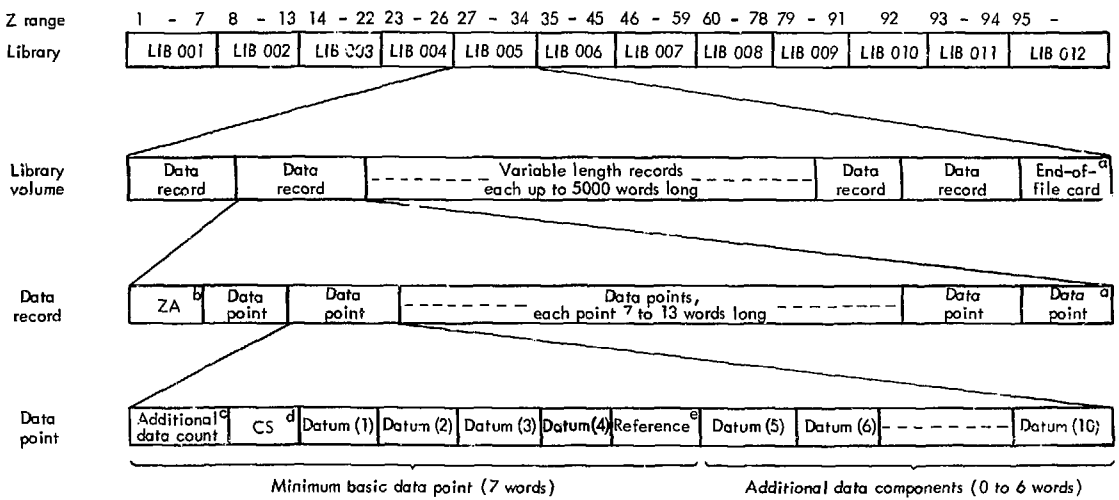
- Although the following description of the ECSIL library discusses quantities that appear to be fixed point in nature (e.g., ZA, word counts), every word within the ECSIL numeric data library is stored in floating point.
- The data points within the ECSIL numeric data library are sorted into order according to the numerical equivalents used to describe the target (Z, A), the interaction (C, S), etc. Status, year, reference or sub-reference number are not used to sort the library.
- The overall sorting order of the information in the data file is as follows: all data are sorted first by the ZA number (1000Z+A). With the exception of resolved resonance parameters ($951 \leq C \leq 999$), the next sort is on C number (see Tables 2, 3 and 4). Excluding all resonance parameters ($941 \leq C \leq 999$) this is followed by a sort on the S numbers, along with their pertinent data fields, X_i (see Table 7). Subsequent sorting criteria depend upon the interaction property measured. Table 10 describes all sort criteria after ZA.

LIBRARY FILE STRUCTURE

Figure 1 displays the organization of the ECSIL data library.

- The numeric data library is divided into 12 files, each containing a range of Z values. These files are always read from disk, as opposed to magnetic tape, and are identified as follows:

Filename	Z range
LIB001	1-7
LIB002	8-13
LIB003	14-22
LIB004	23-26
LIB005	27-34
LIB006	35-45
LIB007	46-59
LIB008	60-78
LIB009	79-91



a - End-of-file and record sentinels are no longer used.

b - ZA = 1000 Z + A - first word or each binary record - applied to all data points in record.

c - Count of additional data components (0 to 6).
(All words in ECSIL, including additional data count, are floating point numbers.)

d - CS = 100C + S.

e - Reference = (status number) $\times 10^8$ + (year) $\times 10^6$ + (reference No.) $\times 10^2$ + (sub-reference number).

Fig. 1. ECSIL data library format.

Filename	Z range
LIB010	92
LIB011	93-94
LIB012	95-

The division of the library into a number of relatively small volumes, each with a separate Z range, greatly simplifies updating and retrieval. Only those volumes affected need be present on the disks.

- Each of the 12 library volumes is composed of a number of variable length data records, each up to 5000 words long. The file is terminated by an end-of-file. This replaces the end-of-file sentinel used in earlier versions of ECSIL.

Table 10. Sort order of ECSIL data library within a given ZA.

	Sorting criteria					
C range	1	2	3	4	5	6
1-99	C	S	X_i [a]	E [b]		
101-149				E	$\cos\theta$	
201-249				E	E'	
251-299				E	$(\cos\theta)_{min}$	
301-349				E	E'	$\cos\theta$
351-399				E	E'_{min}	$(\cos\theta)_{min}$
401-449				E	E'_{min}	
451-499				E	ℓ	
501-549				E_{min}		
551-599				E	$\cos\theta$	
601-649				E	E'_{min}	$\cos\theta$
651-699				E	E'	$(\cos\theta)_{min}$
801-849				ZA_D [d]	C_D [e]	E
900-904				E	E'_{min}	
911				T	α	β
941-943		0 [c]	0	E_{min}	J [f]	
944-946		0	0	E_{min}	ℓ	J [f]
951-999	951	0	0	E	C	

[a] If S = 0, sort key defines $X_i \equiv -1.0$; i = 1,6.

[b] Activation (C = 36) is a special case. The sorting criterion is first ZA_2, the ZA of the activation product, and then E.

[c] Defined as 0 for sort key.

[d] ZA_D identifies isotope in denominator of ratio.

[e] C_D identifies reaction in denominator of ratio (C_D = 1 to 49).

[f] Defined as -1.0 for sort key if J not given (S = 0).

- A given variable length data record only applies to a single ZA. However, for a given ZA; there may be as many data records as are required to hold all of the data points associated with the ZA, each record 5000 words or less in length. The ZA only appears once in each data record, as the first word, (in floating point). The remainder of the data record is made up of a series of data points. Since the data records are of variable length, no end-of-record sentinel is used as in earlier versions of ECSIL.

- Each data point is composed of from 7 to 13 words. The first seven words contain the minimum information associated with a data point: C, S, status, year, reference number, sub-reference number, four measured compositions and a count of the extra number word (0 to 6-in. floating point). The remaining zero to six words contain additional measured compositions, as outlined in the description of the numeric data card format. The contents of the first seven words* are:

1 — Additional word count (0 to 6)*
2 — Combined CS* = 100 C+S
3 — Measured quantity (1)
4 — Measured quantity (2)
5 — Measured quantity (3)
6 — Measured quantity (4)

} See Table 7 for definition for each range of C values.

7 — Combined reference* = status $\times 10^8$ + year $\times 10^6$ + (Ref. No.) $\times 10^2$ + (sub. Ref. No.). (Status is always stored as 0, 1 or 2.)

The contents of the remaining fields are:

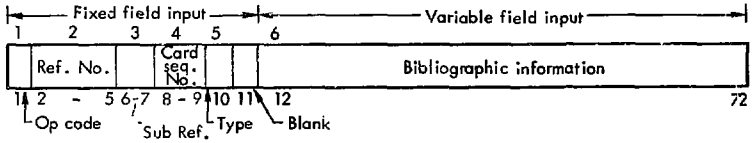
8 — Measured quantity (5)
9 — Measured quantity (6)
10 — Measured quantity (7)
11 — Measured quantity (8)
12 — Measured quantity (9)
13 — Measured quantity (10)

} See Tables 7 and 8 for definition for each value of S and range of C values.

*All words in library are floating point.

- Each data point is immediately followed by another until the end of the variable length data record is reached. The record address of the first point in the record is always the second word (immediately following ZA). If P_i is the record address of the first word of the i^{th} data point on the record and N_i is the corresponding additional word count, the record address of the first word of the $(i+1)^{th}$ data point is $P_{i+1} = P_i + 7 + N_i$ (i.e., $7 + N_i$ words from the start of the i^{th} data point).

ECSIL Bibliographic Information Format



A card image format is used throughout the ECSIL bibliographic information system: for preparation of new information, for storage, and for retrieval.

FIXED FIELD INPUT

Field 1 - Operation Code

For the vast majority of the references in the bibliography file this field is blank. The exceptions to this rule are alternate forms for the reference, usually conferences. For example there are a number of references from the conference "Nucl. React. w/Light Nucli/Nucli. Struct. Rossendorf (1967)." However references from this conference may also be listed under: "Proc. 2nd Conf. Nucl. React. w/Light N-N Struct. Rossendorf (1967)." Reference number 2917 was used to enter the later title and to indicate that in lieu of this title the user should look under the former title. Such alternate references are the only reference numbers not associated with data in the numeric data file. The operation code minus (-) is used in this case to indicate that the reference number is merely an alternate form.

The only operation codes found in the library are blank or minus (-). However this column is used during update or retrieval runs to indicate retrieval (R) or deletion (D) of the reference number that appears in field 2, col. 2-5. Therefore a complete list of operation codes is:

Blank — Normal reference
\- — Alternate form for reference
R — Retrieve reference number in field 2
D — Delete reference number in field 2

} Only fields 1 and 2 are used on cards that have these operation codes.

Field 2 - Reference Number

This field is blank on all cards but the first card of each reference number. The reference number is a unique four digit integer that must be assigned to each primary reference entered into the bibliography library.

Field 3 - Subreference Number

This field is designed to differentiate between portions of the data from a given reference. Presently unused (i.e., field is always blank).

Field 4 - Card Sequence Number

An integer, beginning with one (1) on the first card of each reference number and sequentially increasing on successive cards of the reference number. If there are over 99 cards for a given reference number the sequence may be repeated from 1 to 99 as many times as required.

Field 5 - Card Type

Each card of a reference number must be designated as type 1, 2 or 3 to indicate: (1) Reference information, (2) Commentary or (3) Cross reference information.

VARIABLE FIELD INPUT

Columns 12 through 72 of the bibliographic information cards contain reference information of which the field boundaries are determined by the punctuation rather than fixed column limits. Spaces are ignored except as noted. Information should follow in the order indicated.

The contents of a bibliographic information card depends on the card type (see field 5, above). The following section describes each of the three card types.

Type 1

Type 1 cards describe the primary reference by giving the journal or report series title, qualifying information (e.g., part, section, series, etc.), volume, page, and/or report number, followed by the year, a list of authors, and finally the institution. Any number of type 1 cards may be used. There are four distinct fields that may appear on a type 1 card: reference, date, authors, and institution. Conventions associated with these fields are:

Reference — The report or publication title must appear on the first card of any reference number and cannot be continued onto subsequent cards. The reference is considered to extend from column 12 up to the date. Acceptable abbreviations should be used whenever possible. (See the current alphabetically ordered bibliographic list.[5])

- Maximum reference length is 55 characters
- Publications are divided into three types that require different coding conventions:

1. Periodicals
   - Journal Name - Use accepted abbreviations whenever possible. (See the current alphabetically ordered bibliographic list.[5])
   - Qualifying information - Optional further description of journal name but not actually part of it (e.g., series, section, part). If present this field must begin with a comma.

- Volume - Must be numeric and end with a comma.
- Page - Must be numeric.

2. Reports
   - Report Series - Use accepted abbreviations whenever possible. (See the current alphabetically ordered bibliographic list.[5])
   - Report Number - Must be numeric and immediately preceded by a hyphen.
   - Qualifying information - Optional further description of report name but not actually part of it (e.g., series, section, part). All information between the last numeric characters of the report number and the date is considered to be qualifying information.
3. Other publications
   - Name or Title of Publication - Use accepted abbreviations whenever possible. (See the current alphabetically ordered bibliographic list.[5])
   - Qualifying Information - Optional further description of publication name but not actually part of it (e.g., series, section, part). If present this field must begin with a comma.

Date — Must follow the reference and must also be on the first card. The date must be given as a four digit integer enclosed in parenthesis in the form (19XX) or, if the document is undated (0000). The date should be the year of the publication or private communication and is always six characters long.

Authors — Names may follow the date, either immediately on the first card or on following cards.

- Maximum author's name length is 28 characters.
- Any number of authors may be listed.
- An author's name may never be continued onto a subsequent card. (i.e., must be wholly on one card).
- Any number of authors may appear on a card.
- Any number of cards may be used to list authors.

Punctuation rules that allow individual author's names to be recognized and manipulated by a computer are:

- Initials (if present) must precede the last name.
- Each initial may contain more than one letter, but each initial must be followed by a period (e.g., Yu. S. Zamyatnin).
- Commas (e.g., H. E. Montgomery, Jr.) and single blanks (e.g., T. W. De Witt are allowed.
- The end of an author's name is indicated by a comma followed by a blank if another author's name follows, (e.g., R. K. Smith, F. L. Henkel). In the case of the last author, follow with two blanks or a blank followed by a parenthesis (e.g., T. S. Green (AWRE)).
- An author's name may not contain a comma followed by a blank, two blanks, or a blank followed by a parenthesis.

Institution — If present, the institution name should follow the last author's name and be enclosed in parenthesis (e.g., T. S. Greene (AWRE)). The institution refers to the place where the

work was done, not an author's place of employment.

Type 2

Comments consisting of alphanumeric text may be input as desired in the variable field part of type 2 cards (columns 12-72). This information may be used to describe the experiment or the data. Any number of comment cards may be used, all identified as type 2.

Type 3

Cross reference information in exactly the same format as type 1 cards appear on type 3 cards. The following conventions replace those used in earlier versions of ECSIL.

- Cross references of the form "SEE ALSO REFERENCE XXXX," where XXXX may be any reference number in the library, may appear only as a comment, type 2, card.
- For statements such as "SEE ALSO" followed by a reference name, "SEE ALSO" should be on a comment, type 2, card and the reference name on the following, type 3, card.
- Each cross reference must appear on a new card.
- There is no limit to the number of cross references per reference number.

ECSIL Program System

OVERVIEW

The programs that are used to maintain and edit the ECSIL library are all written in FORTRAN-IV and are presently implemented on the Lawrence Livermore Laboratory CDC-7600 computers and IBM-1360 photostore. These programs are summarized in Table 11.

The ECSIL numeric data system includes a complete set of file maintenance programs capable of sort/merge, update, delete and retrieval operations. These programs also supply editing capabilities and prepare index listings,[4] interpreted listings,[3] and graphical displays.[1,2] There are also many programs for translating experimental data to the ECSIL format or for performing calculations and evaluation based upon data retrieved from the library. This volume, however, will describe only the file maintenance and editing programs.

The entire system of programs is optimized both from the viewpoint of the user and computer. The programs are optimized for the user by providing similar input format for all programs, by minimizing input options and output lines, and by using a common set of filenames to reference the required information. These features make program operation easy to learn and to remember.

The programs are optimized for the CDC-7600 computer by minimizing the core and execution time of the programs. In particular the small core memory (SCM) requirements of each program is in the range 20-35 K_{10}, minimum use is made of the large core memory (LCM), in no case exceeding 20 K_{10}, and extensive

Table 11. ECSIL program summary.

Program	Function	Size[a] (SCM:LCM)	Running time[b] (min)	Input			Default option	Files in	Files out	
				Card	Cols.	Description				
ECSBIB	*Retrieve from or* update bibliographic library (merge, delete, retrieve)	6 7	0.2	1	1-5 6-10	Output device (0 = HSP,[c] 1 = TTY[d]) Operation (0 = Retrieve, 1 = Update + Retrieve	0 0	BIBLIB BIBUPD	BIBLIB BIBOLD BIBRET	(BIBOLD)
ECSCEN	Check data library, report on points per ZA in library	21 4	1.8	1	1-5 6-10 11-15 16-20	Output device (0 = HSP, 1 = TTY) Data source (0, 3 = Library, 1, 2 = Cards) Operation (0 = Census, 1 = Check) Checking mode (0 = Single, 1 = Multi, 2 = All)	0 0 0 0	LIB001 . . LIB012		
ECSCHK	Check card format	13 4	0.5	1	1-5	Output device (0 = HSP, 1 = TTY)	0	UNSORT		
ECSDEL	Delete data from data library	26 6	2.0	1 2-N	1-5 6-10 1-80	Output device (0 = HSP, 1 = TTY) Original library (0 = Keep, 1 = Destroy) Deletions (2 or 4 cards per delete)	Abort	LIB001 . . LIB012	LIB001 . . LIB012	(OLD001) . . (OLD012)
ECSDEX	Create indexes to data library	29 6	2.2	1	1-5 7-7 8-10 12-15	Output device (0 = HSP, 1 = TTY) INDEXA source (0 = Exists, 1-2 = Cards, 3 = Library) Index options (0 = No, 1 = Create) Listing options (0 = No, 1 = Create)	0 3 111 1111	SORTED LIB001 . . LIB012	INDEXA INDEXB INDEXC INDEXD	LISTA LISTB LISTC LISTD
ECSMRG	Merge sorted card files	18 8	0.7	1	1-5 6-10 15-20	Output device (0 = HSP, 1 = TTY) Merge order 0 = Z, A, C, S, E (library ordered) 1 = Z, A, C, S, Ref. No., E 2 = Ref. No., Z, A, C, S, E (Reference ordered) 3 = General General field indices	0 0	SORT001 SORT002 . . .	SORTED	
ECSORT	Sort card file	26 16	1.2	1	1-5 6-10 13-20	Output device (0 = HSP, 1 = TTY) Sort order 0 = Z, A, C, S, E (Library ordered) 1 = Z, A, C, S, Ref. No., E 2 = Ref. No., Z, A, C, S, E (Reference ordered) 3 = General General field indices	0 0	UNSORT	SORT001 SORT002 SORT003 . . .	

Continued on next page.

Table 11. (continued)

Program	Function	Size[a] (SCM/LCM)	Running time[b] (min)	Input			Default option	Files in	Files out	
				Card	Cols.	Description				
ECSPLT	Plot, list and retrieve cards from data library or card file. Plots may include corresponding evaluated data	30/8	2.5	1	1-5	Output device (0 = HSP, 1 = TTY)	0	SORTED	PLT000	
					6-10	ECSIL source (1-2 = Cards, 3 = Library)	3	ENDLIN	PLT001	
					11-15	Plot option (0 = No, 1 = Plot)	1	ENDFIN	.	
					16-20	List option (0 = No, 1 = List, 2 = Ret. order)	1	LIB001	.	
								.	LISTS	
					21-25	Card option (0 = No, 1 = Cards, 2 = Ret. order)	0	.	CARDS	
								LIB012		
					26-30	Status selector (0 = No status 2, 1 = All data)	0			
					31-35	Error bars (0 = None, 1 = X, 2 = Y, 3 = Both)	0			
					36-40	Evaluated data (0 = None, 1 = ENDL, 2 = ENDF)	0			
					41-45	ECSIL-Evaluated match criteria (0 = ZA, 1 = Z (one is natural)	0			
					46-50	Plot mode (0 = 1 = default) 1 Individual scaling 2 Overlap sync on X = Y 3 Overlap-sync X=Y 4 Sync X=Y 5 Ret. No. ordered 6 Reverse chronological (latest first) 7 Overlap-sync X=Y-multiple sets 8 Sync X=Y-multiple sets	1			
				2-N	1-80	Retrievals (2 or 4 cards per retrieval)	e			
ECSPOP	Create bibliographic index files	25/9	1.5	1	1-5	Output device (0 = HSP, 1 = TTY)	0	BIBLAB	BIBSRT	BIBLST
					6-10	Search criteria (0 = Both bibliography and data index 1 = All bib, match data index 2 = All data index, match bib)	0	INDEXB	AUTSRT	AUTLST
									RETSRT	RETLST
ECSRET	Retrieve points from data library to card	28/4	2.0	1	1-5	Output device (0 = HSP, 1 = TTY)	0	LIB001	SORTED	
				2-N	1-80	Retrievals (2 or 4 cards per retrieval)	e	.		
								.		
								LIB012		
ECSUPD	Update data library from cards	24/4	2.0	1	1-5	Output device (0 = HSP, 1 = TTY)	0	SORTED	LIB001	(OLD001)
					6-10	Original library (0 = Keep, 1 = Destroy)	0	LIB001	.	.
								.	.	.
								LIB012	LIB012	(OLD012)

[a] All sizes are maximum decimal thousands dynamically minimized during execution (SCM = small core memory, LCM = large core memory).

[b] Based upon time to read entire ECSIL library and manipulate 25,000 points at a [1, 1] priority. All programs are small enough to run on standby [1, 3] during the day.

[c] HSP = high speed printer.

[d] TTY = teletype.

[e] If no requests, program will retrieve all data.

use is made of scratch disk files. This combination of features allows all of the programs to be operated in standby priority [1, S] during the day to minimize computer charges and yet still maintain good response time.

COMMON DESIGN FEATURES

There are three features of the system of programs that are common to all programs and that greatly simplify the process of learning and remembering how to operate the programs. These features are minimum input/output and common filenames.

Input Cards

All of the programs are designed to read input parameters from the INPUT file. However, if there is no INPUT file present they will execute with a standard set of default options (see Table 11). The default options are designed to facilitate operations performed during normal file maintenance and editing procedures. Therefore, the INPUT file is only required if one wishes to perform a special operation.

Even when the INPUT file is present, the number of parameters that must be supplied by the user is minimum. All programs read only one parameter card that specifies program options. Several programs then read additional cards that describe the data to be retrieved, deleted, plotted, etc.

General rules that apply to the parameter card are:

- All input is integer and in I5 format whenever possible.
- Arrays of yes/no type choices will be right adjusted into series of 5 or 10 columns (e.g., 1X, 4I1 ; 3X, 7I1).
- Yes (or do it) is always indicated by a one (1) (or > 0), and no (or don't) is always indicated by a zero (0)(or ≤ 0).
- Columns 1-5 always indicate the output listing device (0 = high speed printing (HSP), 1 = teletype (TTY)). High speed printer is always the default option, if INPUT file is not present.

General rules that apply to all cards, if any, following the parameters card are:

- All cards are in the ECSIL card image format and specify data requests (e.g., retrieve, delete, plot, list).
- Each data request is specified by one or, if cards are continued, two pairs of cards; the former of each pair giving the lower limit of each field and the latter giving the upper limit.
- Limits may be specified for any or all of the 18 fields described in the card format.
- A blank (not zero) field indicates "no limit," whereas a zero field indicates a zero (0) limit (e.g., blank A (atomic weight) field limits indicates the whole gamut, including all isotopes and compounds of the element, whereas zero field limits indicate only the elemental mixture (A = 0)).
- The end of the input cards is indicated by an end of file.
- For programs that expect data requests, the default option (no

INPUT file, or no requests on the input file) is to request everything (e.g., retrieve, plot, list everything). Delete everything has no meaning and program will simply terminate.

Output Listings

The output listing provided by every program is designed to provide enough information to properly document and simply check the operation of any program or series of programs. The information supplied by all programs includes:

- Indentification of the program, computer and date.
- Interpretation of all input parameters, or list of default options (if no input file).
- Interpretation of all data requests (always on high speed printer).
- Statistics of all data points and/or cards read and/or written by the program. These statistics are designed to monitor not only the size of the library and card files, but also program operation. They insure point and card "conservation" during any sort/merge, update, delete and/or editing operation. Each statistic can be independently obtained from at least two programs (e.g., the number of points in each library volume is defined during an update and may be verified during a data index creation).

Unless the program encounters an error condition, this is the only output listing information supplied. An update operation, for instance normally has only 14 lines of information output: identification of program, computer and date, one line of statistics for each of the 12 library volumes and finally statistics for the library as a whole. This output information is in a form that can be retained to document each version of the library.

Filenames

A feature of the ECSIL system of programs that has greatly simplified the input and made disk files easily recognizable is the use of standard filenames. All output files are left on disk to facilitate storage in the photcstore and allow as many copies as required to be made. Standard filenames are defined below.

Binary Library — The existing 12 volumes of the ECSIL binary data library are referred to by the filenames: LIB001, LIB002, ... LIB011 and LIB012 respectively. During a library update or deletion the altered volumes of the library are defined as temporary files: TMP001, TMP002, ... TMP011 and TMP012 respectively. At the conclusion of the library update or deletion the original volumes (if altered) are renamed as a backup version as: OLD001, OLD002, ... OLD011 and OLD012 respectively. The new altered volumes become: LIB001, LIB002 ... LIB011 and LIB012 respectively. Therefore following an update or deletion the current library will still be LIB001-LIB012. The replaced volumes will be OLD001-OLD012 (only those replaced), and the temporary files TMP001-TMP012 will have disappeared. In summary:

- LIB0NN (NN = 01-12) Current ECSIL binary data files.
- OLD0NN (NN = 01-12) Penultimate ECSIL binary data files.
- TMP0NN (NN = 01-12) Temporary files.

Numeric Data Cards — Data card files are considered to be either sorted or unsorted and are referred to by the filenames: SORTED or UNSORT respectively. If there is a conflict to this convention, such as a program reading and writing a sorted card file, the input file is called SORTED and the output file is called CARDS. Multiple SORTED files that are to be merged together to form a single sorted file are called SORT001, SORT002, ... SORTONN (as many as required) and the merged output file will be called SORTED. In summary:

- SORTED - sorted ECSIL numeric data card images.
- UNSORT - unsorted ECSIL numeric data card images.
- CARDS - sorted ECSIL numeric data card images (program already using filename: SORTED.)
- SORTONN (NN = 01 to 99) - individually sorted files to be merged.

Evaluated Cross Sections — The Livermore Evaluated Nuclear Data Library (ENDL) and the Evaluated Nuclear Data File/version B (ENDF/B) are read using the filenames (ENDLIN and ENDFIN respectively. In summary:

- ENDLIN - evaluated nuclear data library (ENDL)
- ENDFIN - evaluated nuclear data file (ENDF/B)

Numeric Data Listing, Plotting and Index Files — Interpreted data listing files are always named LISTS, and plotting files are a series of files called PLT001, PLT002, ... PLTONN (as many as required.) The plotting files are normally then processed through the program FROG[6] to obtain 35 mm film, microfiche, printer, etc. hardcopy. Reaction indexes are made in four sort orders: (a) Z/A/C/S/E (Library order), (b) Ref. No./Z/A/C/S/E (Reference number order), (c) C/S/Z/A/E (Interaction number order) (d) Basic C/C Increment/S/Z/A/E (Basic interaction number order) Both machine readable and interpreted listing files are made for each sort order. The machine readable files are named: INDEXA, INDEXB, INDEXC and INDEXD, while the interpreted listings are named: LISTA, LISTB, LISTC and LISTD respectively. In summary:

- LISTS - Interpreted data listing file.
- PLTONN (NN = 01 to 99) - Plotted data files (UCRL-50400, Vols. 7-8).
- INDEXN (N = A to D) - Machine readable reaction index files.
- LISTN (N = A to D) - Interpreted reaction index files (UCRL-50400, Vol. 3).

Bibliographic Card Image Files - The current bibliographic library is named BIBLIB and the penultimate version is named BIBOLD. Three additional bibliographic filenames have been defined. BIBUPD contains all new bibliographic information for inclusion in the library as well as deletion and retrieval requests. BIBRET contains bibliographic information retrieved from the library. BIBDEL contains bibliographic information deleted from the library. In summary

- BIBLIB - current bibliographic library file.
- BIBOLD - penultimate bibliographic library file.

- BIBUPD - update (new bibliographic information), deletion and retrieval request file.
- BIBRET - retrieved bibliographic card file.
- BIBDEL - deleted bibliographic card file.

Bibliographic Listing and Index Files – Three bibliographic listing and index orders are routinely prepared: (1) a reference number ordered, combined bibliographic and data index, (2) an alphabetically ordered listing of all references, (3) an alphabetically ordered listing of all author citations. For each ordering a machine readable file and an interpreted listing are made. In summary

- BIBSRT - machine readable, reference number ordered, combined bibliography and data index.
- REFSRT - machine readable, alphabetically ordered references.
- AUTSRT - machine readable, alphabetically ordered author citations.
- BIBLST - interpreted combined bibliography and data index.*
- REFLST - interpreted alphabetically ordered references.*
- AUTLST - interpreted alphabetically ordered author citations.*

Scratch Files – Scratch files, as many as are required, are named SCR1, SCR2, etc. all scratch files are destroyed at the end of the program.

PROGRAM OPERATION

The following section describes each of the ECSIL programs in turn in the order in which they are normally used to first check and enter numeric data into the library, to delete or retrieve data, to create listings, plots, and indexes of the data. Then the programs used to update the bibliography and create listings and indexes of the bibliography are described. This is followed by a summary of the program in alphabetic order.

Program Names

The programs will be discussed in the following order.

Data

- ECSCHK – Check cards in the ECSIL numeric data card image format.
- ECSORT – Sort cards into ECSIL data library, or other, order.
- ECSMRG – Merge sorted card files into ECSIL numeric data library, or other, order.
- ECSUPD – Update the ECSIL numeric binary library by merging points into library.
- ECSDEL – Delete points from ECSIL numeric binary library.
- ECSRET – Retrieve points from ECSIL numeric binary library.
- ECSCEN – Create a census (i.e., define the number of data points per ZA and Z) or check the ECSIL numeric data binary library.

*UCRL-50400, Vol. 2

Data
- ECSDEX – Create index files to the ECSIL numeric binary library or a card image file.
- ECSPLT – Create interpreted listings, cards and/or plots of data from the ECSIL numeric binary library or a card image file.

Bibliography
- ECSBIB – Merge information into, delete information from and/or retrieve information from the ECSIL bibliographic library.
- ECSPOP – Create listings and index files to the ECSIL bibliographic library.

Program Availability

All ECSIL programs have been compiled, loaded and are ready for execution. They may be obtained from the IBM-1360 photostore, where they are stored under the name of the program in the .T:ECSIL directory of user 193025 (e.g., ELF RDS .193025:ECSIL:ECSPLT / 1 1 will retrieve the ECSIL listings and plotting code ECSPLT, ready for immediate execution).

Library Availability

The current ECSIL numeric and bibliographic files are available from the IBM-1360 photostore, where they are stored under the name of the file in the .T:LIBE directory of user 394800 (e.g., ELF RDS. .394800:LIBE:BIBLST / 1 1 will retrieve the listing of the reference number ordered, combined bibliography and data indexes). The following files are always available under .T:LIBE

LIBONN (NN = 01 to 12) – Current ECSIL data library.
BIBLIB – Current ECSIL bibliographic library.
INDEXN (N = A to D) – Machine readable indexes to ECSIL data library.
LISTN (N = A to D) – Interpreted indexes to ECSIL data library (UCRL-50400, Vol. 3).
BIBLST – Interpreted, reference number ordered, combined bibliography and data indexes.
REFLST – Interpreted, alphabetically ordered references.
AUTLST – Interpreted, alphabetically ordered authors.

Purpose

ECSCHK checks the format and contents of numeric data in the ECSIL card image format.

Limitations

None.

Core

SCM - 13 K_{10}/LCM - 4 K_{10}.

Time

0.5 min/25,000 cards checked.

Files In

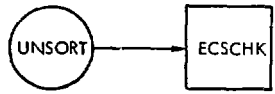
UNSORT - Numeric data in ECSIL card image format.

Files Out

(None)

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device selector (0 - HSP, 1 = TTY)



ECSCHK operation diagram.

Purpose

ECSORT sorts numeric data in the ECSIL card image format into one of three standard orders, or into a generalized sort based upon any combination of seven fields. The standard orders available are:

(1) Z/A/C/S/E — Library order.

(2) Z/A/C/S/Ref. No./E — Reaction/Reference Number order.

(3) Ref. No./Z/A/C/S/E — Reference Number order.

The sort continues according to the order outlined under ECSIL library organization for each C range.

The generalized sort is any ordering of from one to seven of the following fields:

(1) Z

(2) A

(3) C

(4) S

(5) Status

(6) Year

(7) Reference Number

The sort order is indicated by using the above indexes in the order desired. For example the three standard sorts correspond to:

(1) Z/A/C/S/E — 1234

(2) Z/A/C/S/Ref. No./E — 12347

(3) Ref. No./Z/A/C/S/E — 71234.

An example of a chronologically ordered file is:

Year/Z/A/C/S/E — 61234.

Limitations

There is no limit to the number of cards sorted by ECSIL. The program will create a series of sorted files each up to 16,000 cards in length. If there is more than one file they are not merged together, and ECSMRG must be used to merge them.

Core

SCM-28 K_{10}/LCM-16 K_{10}.

Time

1.2 min/25,000 cards sorted.

Files In

UNSORT - Numeric date to be sorted in ECSIL card image format.

Files Out

- SORT001 — Sorted card files, each file up to 16,000 cards, as many files as required.

SORT002

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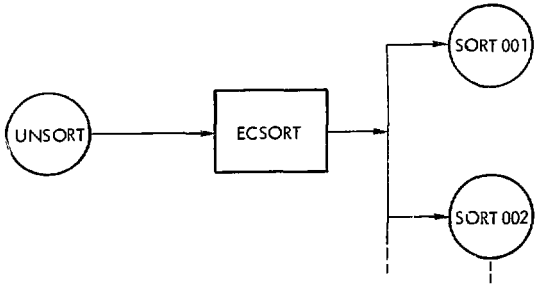
.

.

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device selector (0 = HSP, 1 = TTY)
	6-10	I5	Sort order = 0 — Z/A/C/S/E (Library) = 1 — Z/A/C/S/Ref. No./E (Reaction/Reference) = 2 — Ref. No./Z/A/C/S/E (Reference) = 3 — General
	13-20	7I1	General sort index used for general sort order only. Use any of the 7 available columns: e.g., 1234000 is considered identical to 0001234 or 1020304.



ECSORT operation diagram.

Purpose

ECSMRG merges sorted cards into one of three standard orders, or a generalized merge based upon any combination of seven fields. The merge orders are identical to those used by ECSORT, as are the input parameters (INPUT file) and names of files to be merged. See ECSORT for a description of available merge orders. The program determines which files to merge by opening them in order, SORT001, SORT002, etc., until it cannot locate a file.

Limitations

From 1 to 10 sorted files may be merged together. If only one file is present it is simply renamed from SORT001 to SORTED and execution is terminated.

Core

SCM - 18 K_{10}/LCM - 8 K_{10}.

Time

0.7 min/25,000 cards merged.

Files In

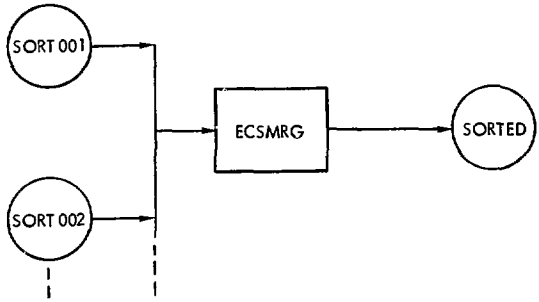
- SORT001 – Sorted card files, of any length, from 1 to 10 files.
  SORT002
  .
  .
  .
  SORT010

Files Out

- SORTED – Merged card file.

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device selector (0 = HSP, 1 = TTY).
	6-10	I5	Merge order = 0 – Z/A/C/S/E (Library) = 1 – Z/A/C/S/Ref. No./E (Reaction/Library) = 2 – Ref. No./Z/A/C/S/E (Reference) = 3 – General
	13-20	711	General merge index (used for general merge order only). Use any of the 7 available columns: e.g., *1234000* is considered identical to 0001234 or 1020304. See: ECSORT for general index definitions.



ECSMRG operation diagram.

Purpose

ECSUPD updates the ECSIL numeric data binary library by reading data points in the ECSIL card image format and merging them into the library. Deletions are not performed by the update program (see ECSDEL).

Limitations

The cards must be sorted into library order (see ECSORT and ECSMRG).

Core

SCM - 24 K_{10}/LCM - 4 K_{10}.

Time

2.0 min to read entire library and merge 25,000 points.

Files In

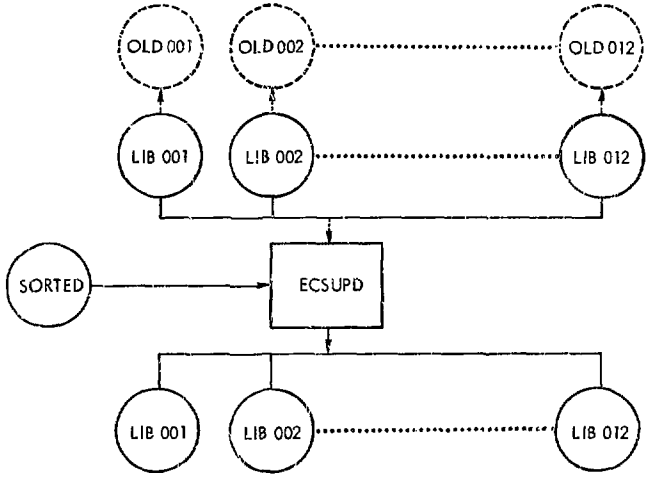
SORTED	– Data in ECSIL card image format, sorted into library order.
LIB001	– Current ECSIL binary library volumes (only those library volumes
LIB002	affected by the update need be present, e.g., to add U-235 fission
.	data to library, only LIB010 need be present). See description of
.	ECSIL library file structure to define the Z range for each library
LIB012	volume.

Files Out

OLD001	– Penultimate ECSIL binary library volumes (only those library
OLD002	volumes affected by the update). These are the original library
.	volumes before update.
.	
OLD012	
LIB001	– New current ECSIL binary library volumes (only those library
LIB002	volumes affected by the update will differ from the original library
.	volumes).
.	
LIB012	

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = TTY).
	6-10	I5	Disposition of outmoded library volumes
			= 0 – Leave on disk as OLD001, OLD002, etc.
			= 1 – Destroy (minimize disk storage requirements).



ECSUPD operation diagram.

Purpose

ECSDEL exists to delete data points from the ECSIL numeric data binary library based upon a series of deletion requests. All deleted data points are written in the SORTED file in the ECSIL card image format. Each deletion request is in the ECSIL data card format and is composed of one or, in the case of continuation cards, two pairs of cards. The first card of each pair specifies a lower limit for each of the 18 fields described in the card format. The second card specifies an upper limit for the corresponding fields. A blank field indicates no limit, whereas a zero(0) means a zero limit. For example, leaving the A (atomic weight) field blank indicates not only the elemental mixture (A = 0) but also all the element's isotopes and compounds. A zero in the A field indicates the elemental mixture (A = 0) only.

Limitations

Deletions may be in any order. There is a maximum of 100 deletion requests (i.e., 200, or 400, cards). The operation of the program can be greatly expedited by specifying a Z range for each request. This makes it possible to examine only certain volumes and data records, not the entire library.

Core

SCM - 26 K_{10} LCM - 6 K_{10}.

Time

2.0 min to read entire library and delete 25,000 points.

Files In

LIB001	–	Current ECSIL binary library volumes (only those library volumes
LIB002		affected by the deletion need be present, e.g., to delete a set of
.		U-235 fission data from the library, only LIB010 need be present).
.		See description of ECSIL library file structure to define the Z range
LIB012		for each library volume.

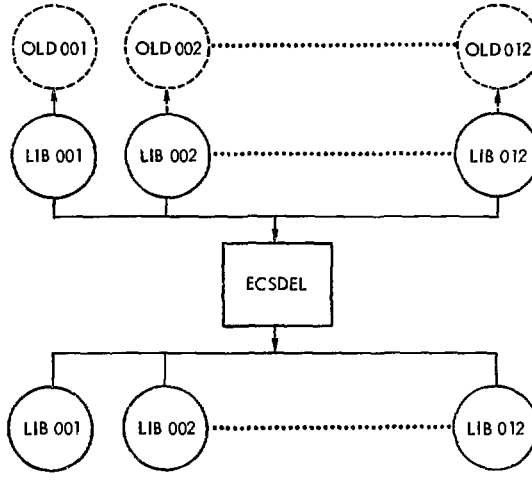
Files Out

SORTED	–	Deleted data points in the ECSIL card image format.
OLD001	–	Penultimate ECSIL binary library volumes (only those library
OLD002		volumes affected by the deletion). These are the original library
.		volumes before deletion.
.		
OLD012		

LIB001 - New current ECSIL binary library volumes (only those library
LIB002 volumes affected by the deletion will differ from the original
. library volumes).
.
LIB012

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 - TTY)
	6-10	I5	Disposition of outmoded library volumes = 0 - Leave on disk as OLD001, OLD002, etc. = 1 - Destroy (minimize disk storage requirements).
2-N	1-80		Deletions in the ECSIL data card format. Each request is composed of one or two pairs of cards, the former of each pair specifying a lower and the latter specifying an upper limit for each of the 18 fields defined in the format. A blank field indicates no limit.



ECSDEL operation diagram.

Purpose

ECSRET retrieves data points from the ECSIL numeric data binary library based upon a series of retrieval requests. All retrieved data points are written in the SORTED file in the ECSIL card image format. Each retrieval request is in the ECSIL data card format and is composed of one or, in the case of continuation cards, two pairs of cards. The first card of each pair specifies a lower limit for each of the 18 fields described in the card format. The second card specifies an upper limit for the corresponding fields. A blank field indicates no limit, whereas a zero(0) means a zero limit (e.g., the limit indicated by blank A (atomic weight) field includes the elemental mixture (A = 0), all isotopes, and all compounds. A zero field limit indicates the elemental mixture (A = 0) exclusively.

Limitations

Requests may be in any order, with up to 100 requests (i.e., 200 or 400 cards). The operation of the program can be greatly expedited by specifying a Z range for each request. This makes it possible to examine only certain volumes and data records, not the entire library. Retrieved data point are always in library order; use ECSORT and ECSMRG to obtain other orderings.

Core

SCM - 28 K_{10}/LCM - 4 K_{10}.

Time

2.0 min to read entire library and retrieve 25,000 points.

Files In

LIB001 – Current ECSIL binary library volumes (only those library volumes
LIB002 affected by the deletion need be present, e.g., to retrieve a set of
. U-235 fission data from the library, only LIB010 need be present).
. See description of ECSIL library file structure to define the Z range
LIB012 for each library volume.

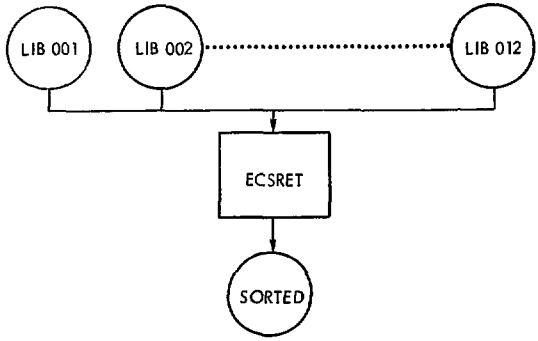
Files Out

SORTED – Retrieved data points in the ECSIL card image format.

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = [illegible])
2-N	1-80		Retrievals in the ECSIL data card format. Each request is composed of one or two pairs of cards, the

former of each pair specifying a lower and the latter specifying an upper limit for each of the 18 fields defined in the format. A blank field indicates no limit.



ECSRET operation diagram.

Purpose

ECSEN counts the data points per ZA and Z (census) or checks either the ECSIL numeric data binary library or a card image file. The census also defines total point and computer word counts for each volume and for the library as a whole. In addition to tests normally performed by ECSCHK to check the consistency of individual data points, ECSEN performs tests based upon the relative position of data points within the library (e.g., duplicate points, similar points etc.).

Limitations

None

Core

SCM - 21 K_{10}/LCM - 4 K_{10}.

Time

1.8 min to read entire library and create census of check.

Files In

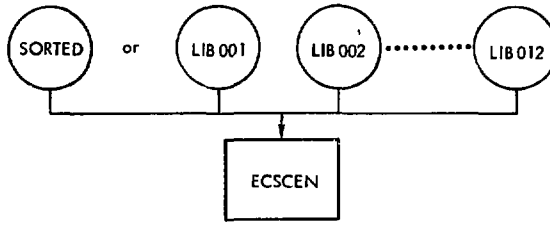
SORTED – Data in ECSIL card image format, either sorted or unsorted.
LIB001 – Current ECSIL binary library volumes (only those volumes present
LIB002 will be used, missing volumes will be skipped and will not cause
. program to abort).
.
LIB012

Files Out

(None)

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = TTY).
	6-10	I5	Source of data to check
			0 = Library
			1 = Sorted (no sort order checks)
			2 = Sorted (perform sort order checks)
			3 = Library
	11-15	I5	Operation (0 = CENSUS, 1 = CHECK)
	16-20	I5	Checking mode
			0 = One error message per Z, A, C, S, Ref.
			1 = One error message of each type per Z, A, C, S, Ref.
			2 = All error messages



ECSCEN operation diagram.

Purpose

ECSDEX creates index files to either the ECSIL numeric binary library or a card image file. Index files may be created in any or all of four sort orders: (a) Z/A/C/S/E (library order) (b) Ref. No./Z/A/C/S/E (reference number order), (c) C/S/Z/A/E (interaction number order), (d) Basic C/C Increment/S/Z/A/E (basic interaction number order). Both machine readable and interpreted listing files may be made for each sort order.

Limitations

If index files are to be made from a card image file, the card image file must be sorted in the library order (see ECSORT). The file INDEXA is used to make the files INDEXB, INDEXC and/or INDEXD. The files LISTA-D are then made from the corresponding file INDEXA. Therefore to make INDEXB-D, INDEXA must first exist or be made from cards or the library. Similarly to make LISTA-D the corresponding file INDEXA-D must exist or be made during execution.

Core

SCM - 29 K_{10}/LCM - 6 K_{10}.

Time

2.2 min to read entire library and create all index files.

Files In

INDEXA - Z/A/C/S/E ordered machine readable index (if col. 7 = 0).*

or

SORTED - Card image file (if col. 7 = 1 or 2).

or

LIB001 - Current ECSIL binary library volumes (if col. 7 = 3). (Only those
LIB002 volumes present will be used. Missing volumes will be skipped
. and will not cause program to abort.)
.
LIB012

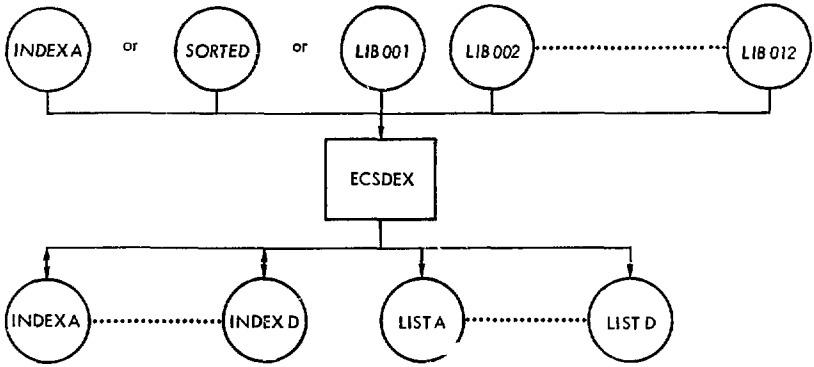
*Refers to columns of input card.

Files Out

INDEXA	– Z/A/C/S/E order (if col. 7 > 0)	Machine readable index files
INDEXB	– Ref. No./Z/A/C/S/E order (if col. 8 > 0)	
INDEXC	– C/S/Z/A/E order (if col. 9 > 0)	
INDEXD	– Basic C/C Increment/S/Z/A/E order (if col. 10 > 0)	
LISTA	– Z/A/C/S/E order (if col. 12 > 0)	Interpreted[4] index files
LISTB	– Ref. No./Z/A/C/S/E order (if col. 13 > 0)	
LISTC	– C/S/Z/A/E order (if col. 14 > 0)	
LISTD	– Basic C/C Increments/S/Z/A/E order (if col. 15 > 0)	

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = TTY).
	7	I1	Source of INDEXA (0 = it exists, 1 or 2 = cards, 3 = library)
	8	I1	INDEXB option (0 = no, 1 = create)
	9	I1	INDEXC option (0 = no, 1 = create)
	10	I1	INDEXD option (0 = no, 1 = create)
	12	I1	LISTA option (0 = no, 1 = create)
	13	I1	LISTB option (0 = no, 1 = create)
	14	I1	LISTC option (0 = no, 1 = create)
	15	I1	LISTD option (0 = no, 1 = create)



ECSDEX operation diagram.

Purpose

ECSPLT exists to create intepreted listings, cards and/or plots of data from the ECSIL numeric binary library or a card image file. Plots of the data may have evaluated data from either the evaluated nuclear data library (ENDL)[7] or the evaluated nuclear data file version B (ENDF/B)[8] overlayed on the plots. To facilitate comparison of experimental data physically comparable data sets may also be presented, either on separate plots with similar scaling or on the same plot.

Limitations

If a card image file is used it must be library ordered. Requests may be in any order. There is a maximum of 100 requests (i.e., 200 or 400 cards). The operation of the program can be greatly expedited by specifying a Z range for each request. This makes it possible to examine only certain volumes and data records, not the entire library.

Core

SCM - 30 K_{10}/LCM - 8 K_{10}.

Time

2.5 min to read entire library and plot 25,000 points (~400 plots).

Files In

SORTED - Card image file.

or

LIB001 - Current ECSIL binary library volumes (only those library volumes
LIB002 affected by the requests need be present, e.g., to plot the U-235
. fission cross sections from the library, only LIB010 need be
. present). See description of ECSIL library file structure to define
LIB012 the Z range for each library volume.

ENDLIN - Evaluated nuclear data library (ENDL) data in card image format[7] (required only if ENDL comparison requested).

ENDFIN - Evaluated nuclear data file (ENDF/B) data in card image format[8] (required only if ENDF/B comparison requested).

Files Out

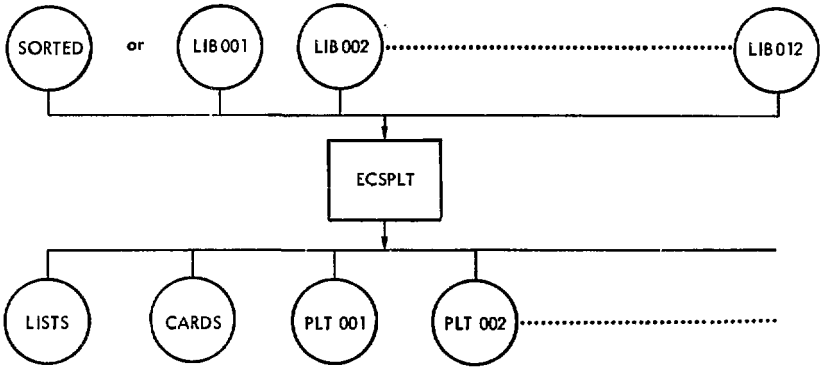
- PLT000 - Plot files (present only if plots are requested) which may be
  PLT001 processed by FROG[6] to obtain 35 mm film, microfiche, printer
  . etc. hardcopy.
  .

- LISTS – Interpreted listings of data (present only if listing is requested).
- CARDS – Data points in ECSIL card image format (present only if cards are requested).

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = TTY).
	6-10	I5	ECSIL source (1 or 2 = cards, 3 = library).
	11-15	I5	Plot option (0 = no, 1 = plots).
	16-20	I5	List option (0 = no, 1 = list library order, 2 = list ref. no. order).
	21-25	I5	Card option (0 = no, 1 = cards library order, 2 = cards ref. no. order).
	26-30	I5	Status selector (0 = no status 2, 1 = any status).
	31-35	I5	Error bars (0 = none, 1 = x, 2 = y, 3 = both x and y).
	36-40	I5	Evaluated data (0 = none, 1 = ENDL, 2 = ENDF).
	41-45	I5	ECSIL – evaluated match criteria (0 = ZA, 1 = Z if one is natural (A = 0)).*
	46-50	I5	Plot mode = 1 individual scaling = 2 overlapping same inches/X - Y range = 3 overlapping same X - Y ranges = 4 all same X - Y ranges = 5 Ref. No. order = 6 reverse chronological (latest year first) } one data set per plot = 7 overlapping same X - Y ranges = 8 all same X - Y range } multiple data sets per plot
2-N	1-80		Retrievals in the ECSIL data card format, each request is composed of one or two pairs of cards, the former of each pair specifying a lower and the later specifying an upper limit for each of the 18 fields defined in the format. A blank field indicates no limit.

*The ECSIL and evaluated data are normally considered to be physically comparable if both are for the same reaction and isotope (ZA). When ECSIL and evaluated data are not both available for a given isotope (ZA), this option may be used to compare isotopic data from one library to elemental (same Z, A = 0) data from the other library (e.g., compare an oxygen-16 evaluation to natural oxygen experimental data).



ECSPLT operation diagram.

Purpose

ECSBIB merges information into, deletes information from, and retrieves information from the ECSIL bibliographic library. Information to be merged is in the ECSIL bibliographic card image format. Information to be deleted or retrieved is indicated by using the operation code (col. 1) and reference number (col. 2-5) fields. The operation code for deletion is D, that for retrieval is R.

Limitations

The information to be merged and requests for deletion or retrieval need not be in reference number order. There is no limit to the number of bibliographic cards to be merged, deleted or retrieved. For simple retrieval (i.e. no changes to library) the operation of the program can be expedited by indicating retrieval only on the input card (e.g. col. 10 = 0).

Core

SCM - 6 K_{10}, LCM - 7 K_{10}.

Time

0.2 min to read entire bibliography and merge, delete or retrieve 300 reference numbers.

Files In

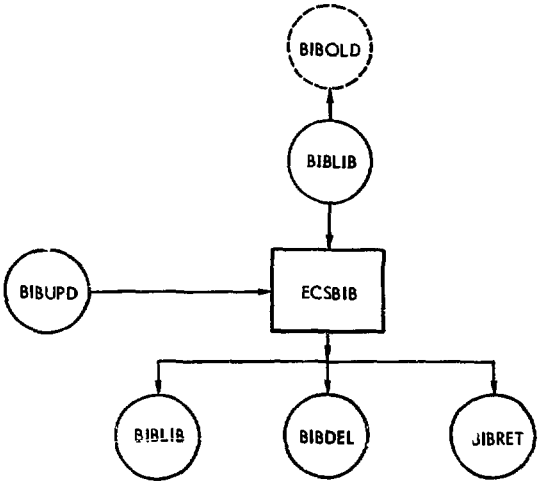
BIBLIB - Current version of the ECSIL bibliographic file.
BIBUPD - Bibliographic information to be merged, deleted or retrieved.

Files Out

BIBOLD - Penultimate version of the ECSIL bibliographic file. This was current bibliographic file before update (only used in merge delete mode of program).
BIBLIB - New current version of the ECSIL bibliographic file.
BIBDEL - Bibliographic information that was deleted from the library (only used if a deletion occurs).
BIBRET - Bibliographic information that was retrieved from the library (only used if a retrieval occurs).

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = TTY).
	6-10	I5	Operating mode (0 = retrieval, 1 = any combination of Merge, Delete and Retrieve).



ECSBIB operation diagram.

Purpose

ECSPOP creates listings and index files to the ECSIL bibliographic system. Three listings and index files are created: (1) combined complete bibliography and data index, (2) alphabetic reference index, (3) alphabetic author citation index. Each of these files is created in two forms, machine readable and interpreted listings.[5]

The listings may be based upon the entire bibliographic file and reference number order data index (see ECSDEX). Alternatively the listings may be based upon all bibliographic information, and only the corresponding data indexes (e.g., determine what was measured for any set of reference numbers), or on all data indexes, and only the corresponding bibliographic information (e.g., define the bibliographic information for any set of data indexes).

Limitations

If a minibibliographic library is used to determine the corresponding data indexes, the bibliographic information must be in ascending reference number order. If either the bibliographic file (BIBLIB), or the data index file (INDEXB) is not present on the disk the program will process the other file. If both are missing the program will abort.

Core

SCM - 25 K_{10}/LCM - 9 K_{10}.

Time

1.5 min to read all files and create all listings and index files.

Files In

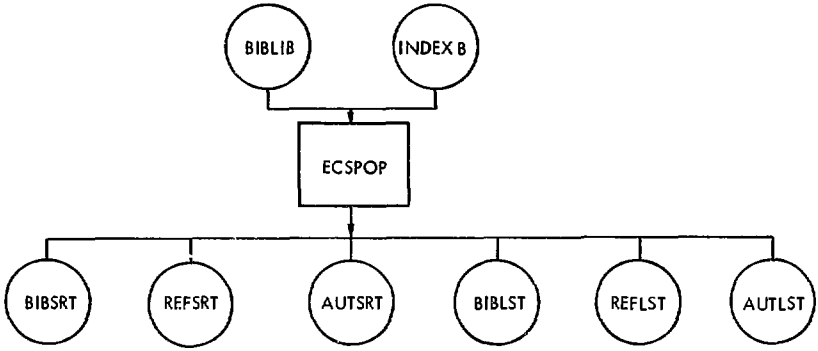
BIBLIB - current bibliographic information library.
INDEXB - Ref. No./Z/A/C/S/E ordered data index (see ECSDEX).

Files Out

BIBSRT	- combined bibliography and data index	machine readable
REFSRT	- alphabetic reference index	
AUTSRT	- alphabetic author citation index	
BIBLST	- combined bibliography and data index	interpreted listings
REFLST	- alphabetic reference index	
AUTLST	- alphabetic author citation index	

Input Parameters

Card	Cols.	Format	Description
1	1-5	I5	Output device (0 = HSP, 1 = TTY).
	6-10	I5	Search criteria
			= 0 – All bibliography and data indexes.
			= 1 – All bibliography, corresponding data indexes.
			= 2 – All data indexes, corresponding bibliography.



ECSPOP operation diagram.

Extended ECSIL Conventions

The extended ECSIL conventions still describe experimental neutron-induced cross sections by target, interaction, interaction property and interaction modifier. However the interaction and the interaction property, formerly the basic C and C increment, are now referred to simply as the C and the I and are separate fields. The data is further described by indicating the incident and outgoing particles.

Incident Particle

A numerical equivalent (referred to as Y_i) is assigned for each incident particle of interest, see Table 12. This allows the system to handle incident charged particles, photons, etc.

Outgoing Particle

A numerical equivalent (referred to as Y_o) is assigned for each outgoing particle of interest, see Table 12, to allow the system to describe angular distributions, energy distributions, etc. for charged particles, photons, etc.

Table 12. Designators of incident or outgoing particles.

Particle designator	Particle
0	None[a]
1	Neutron
2	Proton
3	Deuteron
4	Triton
5	^{3}He
6	^{4}He
7	Photon
8	Beta plus
9	Beta minus

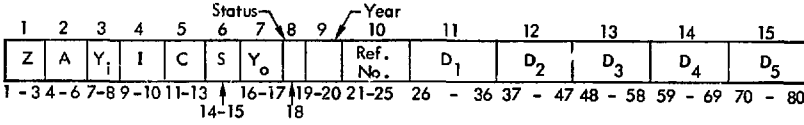
[a]A secondary particle is designated only if a property of the secondary particle is being described (e.g., $\sigma(p, p')$ cross section has $Y_o = 0$, while the $\sigma(p, p')$ angular distribution of the proton has $Y_o = 2$).

At present the system is designed to handle only light Y_i and Y_o. The assignment of numerical equivalents is not systematic and may be extended as needed.

Extended ECSIL Data Card Format

The extended ECSIL system uses a completely new numeric data card image format, but requires minimum changes to the binary library and no changes to the bibliographic format. The new numeric data card image format uses the same conventions for continuation on to a second card, to allow up to 10 measured quantities, as well as the same conventions for all fields defined in the original ECSIL numeric data card image format. The new format is diagrammed below.

CARD 1



Field 1 (Z) Atomic Number

Identical to original ECSIL conventions.

Field 2 (A) Atomic Weight

Identical to original ECSIL conventions.

Field 3 (Y_i) Incident Particle

Table 12 presents conventions for Y_i. More will be defined as required.

Field 4 (I) Interaction Property

Similar to C increment in original ECSIL conventions, see Table 3. Presently directly derivable from the C increment as I = (C increment)/50.

Field 5 (C) Interaction

Identical to basic C in original ECSIL, see Table 2.

Field 6 (S) Interaction Modifier

Identical to interaction modifier in original ECSIL, see Table 7.

Field 7 (Y_o) Outgoing Particle

Uses same conventions as Y_i, field 3 above, and Table 12. More will be defined as required. Outgoing particle is defined as Y_o = 0 for I = 0 or 1 (energy dependent or energy average cross sections) where the interaction, not the outgoing particle, is being described.

Field 8 – Status

Identical to status in original ECSIL, including use for continuation.

Field 9 – Year

Identical to year in original ECSIL.

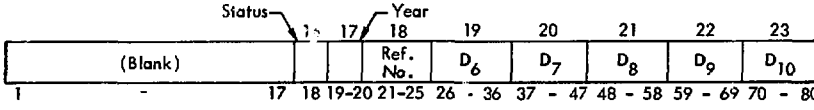
Field 10 – Reference Number

Identical in content to original ECSIL, except now five digits long. Note the sub-reference number is no longer used.

Fields 11-15

Similar to D_1 through D_5 of original ECSIL, only now in E11.4 format. (Note: The new format contains only five measured quantities on the first card compared to six in the old format. However over 97% of the data points in the library are described by five or fewer measured quantities. Therefore the new format will not appreciably increase the number of cards for inputting or retrieving data).

CARD 2



Card 2 is present only if over five measured quantities are required to describe the data point. The presence of card 2, the continuation card, is indicated as in the original ECSIL system by a status of 5 or greater. The status, as well as year and reference must be identical on both first and second cards. As before, the status will be stored in the library as 0, 1, or 2 and reconstituted on output as required.

Fields 16-18

The status, year and reference number on the continuation card must be identical to the corresponding fields on the first card.

Fields 19-23

Similar to D_6 through D_{12} of original ECSIL, only D_6 is now on second card and all are in E11.4 format.

Extended ECSIL Data Library Organization and Format

The organization of the extended ECSIL binary library is similar to that of the original ECSIL, except that instead of sorting each ZA into C, S, X, etc. order it is sorted into: Y_i, I, C, S, X_i, Y_o, etc. order. For a given ZA all data due to incident neutrons precedes that for incident protons, etc. For a given ZA the angular distributions for an $\sigma(n, n'p)$ interaction will have the angular distributions for the neutron and proton grouped together, with the neutron angular distribution preceding the proton angular distribution.

The library file structure of the extended ECSIL system is identical to the file structure of the original ECSIL system down to the date point level (see Fig. 1). The only differences between the original data point format and the extended data point format are in the second and seventh words of each data point. The second words which contained the combined C and S in the form $C \times 10^2 + S$, now contains the combined Y_i, C, S and Y_o in the form

$$Y_i \times 10^7 + C \times 10^4 + S \times 10^2 + Y_o.$$

The seventh word has been adjusted to drop the subreference number and to allow for a five digit reference number. It stores the combined reference in the form Status $\times 10^7$ + year $\times 10^5$ + (reference No.).

Adoption of these conventions allows the current library size to be maintained. Conversion to the new system only requires the data points within each ZA to be converted to the new format where for all present points $Y_i = 1$ and $Y_o = 1$ or 0 (I = 0 or 1). The library need not be re-sorted; the present neutron data is already in the correct sort order for the extended ECSIL system.

References

1. D. E. Cullen, R. C. Haight, R. J. Howerton, M. H. MacGregor, and S. T. Perkins, Graphical Experimental Data for Major Neutron-Induced Interactions, Lawrence Livermore Laboratory, Rept. UCRL-50400, Vol. 7, (1974).
2. D. E. Cullen, R. C. Haight, R. J. Howerton, M. H. MacGregor, and S. T. Perkins, Graphical Experimental Data for Supplemental Neutron-Induced Interactions, Lawrence Livermore Laboratory, Rept. UCRL-50400, Vol. 8, to be published.
3. S. T. Perkins, D. E. Cullen, R. C. Haight, R. J. Howerton, and M. H. MacGregor, Tabulated Experimental Data for Neutron-Induced Interactions, Lawrence Livermore Laboratory, Rept. UCRL-50400, Vol. 10, (1974).
4. S. T. Perkins, D. E. Cullen, R. C. Haight, R. J. Howerton and M. H. MacGregor, An Index of the Experimental Data of Neutron-Induced Interactions, Lawrence Livermore Laboratory, Rept. UCRL-50400, Vol. 3, (1974).
5. S. T. Perkins, D. E. Cullen, R. C. Haight, R. J. Howerton and M. H. MacGregor, A Bibliography of the Experimental Data of Neutron-Induced Interactions, Lawrence Livermore Laboratory, Rept. UCRL-50400, Vol. 2, (1974).
6. C. R. Hunt, FROG, Lawrence Livermore Laboratory, Internal Document DC-606 (1973). Readers outside the Laboratory who desire further information on LLL internal documents should address their inquiries to the Technical Information Department, Lawrence Livermore Laboratory, Livermore, California 94550.
7. R. J. Howerton, R. J. Doyas, T. C. Michels, S. T. Perkins, Evaluated Nuclear Cross Section Library, Lawrence Livermore Laboratory, Rept. UCRL-50400, Vol. 4, (1971).
8. M. K. Drake, Data Formats and Procedures for the ENDF Neutron Cross Section Library, Brookhaven National Laboratory, BNL-50274 (T-601), ENDF-102 (1970).

Appendix A
Example Reference

The following figures illustrate a typical reference, how it is prepared for inclusion in ECSIL, and how the reference appears in the listings, plots and indexes normally obtained after each library update.

For illustrative purposes consider the ^{232}Th and ^{238}U prompt $\bar{\nu}$ measurements of B. D. Kuz'minov, published in Soviet Progress in Neutron Physics, page 177 (1961).

Figure A-1 illustrates the data transcribed onto the standard data coding sheet. The reference has been assigned the Ref. No. 1079 and the prompt $\bar{\nu}$ numerical equivalent C = 46 has been defined.

Figure A-2 illustrates the bibliographic information transcribed onto the standard bibliographic code sheet. The bibliographic information and the data (Fig. A-1) are now linked through the use of Ref. No. 1079.

After the data and bibliographic information have been checked they are merged into the ECSIL system. The reference will appear in subsequent listings and indexes to the libraries. These listings and indexes are prepared after each library update and are periodically published. The following figures illustrate where Ref. No. 1079 appears within the various publications associated with ECSIL.

Figures A-3a, A-3b and A-3c illustrate how the data appears in UCRL-50400, Vol. 7. The ^{232}Th and ^{238}U prompt $\bar{\nu}$ now appear separately under the correct isotope and energy ordered with all other prompt $\bar{\nu}$ for the respective isotopes.

Figures A-4a and A-4b illustrate how the ZA ordered reaction index to Ref. 1079 appears in the first section of UCRL-50400, Vol. 3. The reaction index is here in Z/A/C/S/E-low order (e.g. all prompt $\bar{\nu}$ date for ^{232}Th together, in energy order).

Figures A-5a and A-5b illustrate how the reaction number (C) ordered reaction index to Ref. 1079 appears in the second section of UCRL-50400, Vol. 3. The reaction index is here in C/Z/A/C/S/E-low order (e.g. all prompt $\bar{\nu}$ data together, in ZA and energy order).

Figure A-6 illustrates how the reference number ordered reaction index to Ref. 1079 appears in the third section of UCRL-50400, Vol. 3. The reaction index is here in Ref. No./Z/A/C/S/E-low order (e.g., all reaction indexes to Ref. 1079, in ZA order).

Figure A-7 illustrates how the author citation to Kuz'minov, B. D. for Ref. 1079 appears in the first section of UCRL-50400, Vol. 2. Kuz'minov, B. D. is indicated to be the first author by the asterisk following the reference number (i.e. 1079*).

Figure A-8 illustrates how the alphabetically ordered reference to Ref. 1079 appears in the second section of UCRL-50400, Vol. 2. Following a sort on the alphabetic portion of the reference the references are sorted into volume, section, page, etc. order.

Figures A-9a and A-9b illustrate how the combined bibliographic information and reaction indexes to Ref. 1079 appear in the third section of UCRL-50400, Vol. 2. There is now no limit to the amount of bibliographic information that may be associated with a given reference.

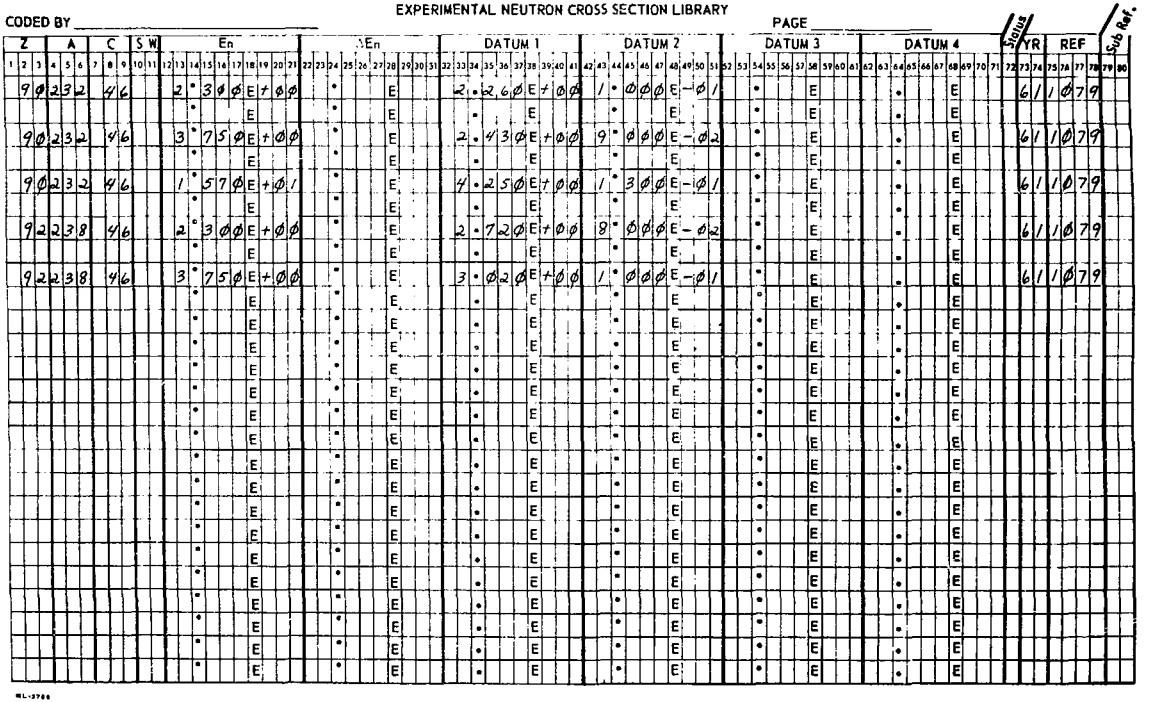


Fig. A-1. Data from Ref. 1079, transcribed onto an input coding sheet.

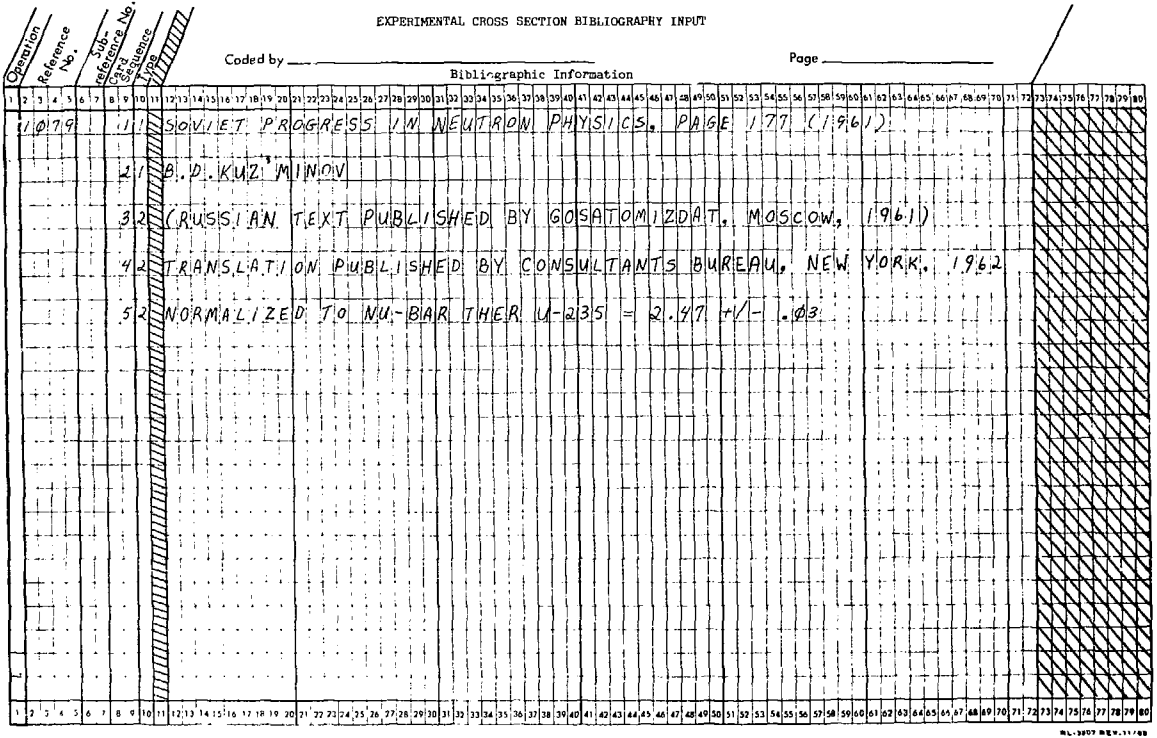


Fig. A-2. Bibliographic data for Ref. 1079 transcribed onto an input coding sheet.

03/01/74 TOTAL 90-TH-232

CROSS SECTION

REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS	REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS
65	949	1.4400- 6		1.3280+ 1	6.0000- 2	61	233	2.8400+ 1		5.4910+ 0	3.4000- 1
52	81	1.4000+ 1		5.6910+ 0	1.1000- 1	50	281	4.2000+ 1	1.0000+ 0	5.0310+ 0	7.0010- 2

03/01/74 ELASTIC 90-TH-232

REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS	REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS
54	103	1.0000+ 0	8.0000- 2	5.3000+ 0	7.9500- 1	61	846	3.1000+ 0		3.7000+ 0	1.0000- 1
65	1509	2.0000+ 0	5.0000- 2	5.0000+ 0							

03/01/74 FISSION 90-TH-232

REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS	REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS
68	2192	1.2000+ 0	2.0000- 2	3.5000- 3	3.0000- 4	69	2354	1.4600+ 1	2.0000- 1	4.5000- 1	4.0000- 2
68	2192	1.4000+ 0	2.0000- 2	5.5400- 2	3.7000- 3	69	2354	1.4600+ 1	2.0000- 1	5.6000- 1	1.4000- 1
68	2192	1.6000+ 0	2.0000- 2	1.1780- 1	7.0000- 3	58	608	1.4600+ 1		3.7000- 1	2.0000- 2
50	1413	1.4000+ 1		3.4000- 1	1.0000- 2	58	528	1.4600+ 1		3.5000- 1	2.0000- 2
56	771	1.4100+ 1		3.4700- 1	1.8000- 2	55	461	3.6000+ 2		9.0000- 1	

03/01/74 N,GAMMA 90-TH-232

REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS	REFERENCE		ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS
57	337	2.5300- 8		7.6000+ 0	1.6000- 1	58	363	2.0000- 1	1.5000- 2	2.1700- 1	1.1000- 2
55	191	2.5300- 8		7.3100+ 0	1.2000- 1	58	363	2.0000- 1		2.1000- 1	4.0000- 2
65	867	2.4000- 2		4.8000- 1	5.0000- 2	60	633	2.2000- 1	2.0000- 2	2.1300- 1	5.0000 3
57	305	2.4000- 2	5.0000- 3	5.0000- 1	1.0000- 1	57	521	1.4500+ 1		5.2010- 3	8.0010 4

03/01/74 PROMPT NEUTRONS/FISSION 90-TH-232

REFERENCE		ENERGY MEV	DELTA MEV	NU-BAR	DELTA	REFERENCE		ENERGY MEV	DELTA MEV	NU-BAR	DELTA
59	1151	1.4000+ 0		2.5600+ 0	2.0000- 1	61	1138	3.6000+ 0	3.0000- 1	2.4200+ 0	1.0000- 1
→ 61	1079	2.3000+ 0		2.2600+ 0	1.0000- 1	61	1079	3.7500+ 0		2.4300+ 0	9.0000- 2 ←

Fig. A-3a. Data from Ref. 1079, as it appears in UCRL-50400, Vol. 7.

03/01/74 NEUTRONS/FISSION 90-TH-232

PROMPT

REFERENCE		ENERGY MEV	DELTA MEV	NU-BAR	DELTA
58	1447	4.0000+ 0		2.7000+ 0	1.0000- 1
56	1321	1.4100+ 1		3.5500+ 0	2.8000- 1
58	1330	1.4200+ 1		4.6400+ 0	2.0000- 1
61	1138	1.4900+ 1	3.0000- 1	4.4300+ 0	1.3000- 1
→ 61	1079	1.5700+ 1		4.2500+ 0	1.3000- 1

03/01/74 DELAYED NEUTRONS/FISSION 90-TH-232

	REFERENCE		ENERGY MEV	DELTA MEV	NU-BAR	DELTA
1	55	1341	2.0000+ 0	1.0000+ 0	3.7280- 2	8.6400- 3
	59	1425	2.4000+ 0		5.4000- 2	4.0000- 3
	69	1533	3.1000+ 0	2.0000- 1	6.0000- 2	6.0000- 3
	59	1425	3.3000+ 0		5.1000- 2	4.0000- 3
	68	2357	1.4000+ 1		1.9000- 2	5.0000- 3
	61	1410	1.4000+ 1		5.7000- 2	1.5000- 2
	61	1423	1.4500+ 1		7.5000- 2	7.0000- 3
	69	1533	1.4900+ 1	5.0000- 1	3.1000- 2	3.0000- 3
	59	1425	1.5000+ 1		8.2000- 2	6.0000- 3

03/01/74 NEUTRONS/NONELASTIC EVENT 90-TH-232

REFERENCE		ENERGY MEV	DELTA MEV	RATIO	DELTA
63	277	1.4000+ 1		2.3400+ 0	8.0000- 2

Fig. A-3b. Data from Ref. 1079, as it appears in UCRL-50400, Vol. 7

03/01/74 FISSION 92-U -238

CROSS SECTION

REFERENCE	ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS	REFERENCE	ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS
69 2354	1.4600+ 1	2.0000- 1	1.1600+ 0	2.3000- 1	55 461	1.2000+ 2		1.1400+ 0	
69 2354	1.4600+ 1	2.0000- 1	1.2400+ 0	6.0000- 2	55 461	3.8000+ 2		1.0300+ 0	
58 610	1.4600+ 1		1.1300+ 0	5.0000- 2					

03/01/74 N,GAMMA 92-U -238

REFERENCE	ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS	REFERENCE	ENERGY MEV	DELTA MEV	X-SEC BARNS	DELTA BARNS
69 2156	2.5300- 8		2.6900+ 0	3.0000- 2	63 1	6.5000- 2	2.1000- 2	3.0200- 1	2.7000- 2
55 191	2.5300- 8		2.7500+ 0	1.0000- 1	61 677	6.5000- 2	2.0000- 2	3.0200- 1	3.0000- 2
55 1415	2.5300- 8		2.7300+ 0	7.0000- 2	59 526	1.9500- 1	2.7300- 2	1.2000- 1	1.7000- 2
69 2190	2.3000- 2		4.9500- 1	3.9600- 2	58 363	2.0000- 1	1.5000- 2	1.9400- 1	8.0000- 3
57 305	2.4000- 2	5.0000- 3	6.1010- 1	6.1010- 2	60 633	2.2000- 1	2.0000- 2	1.4600- 1	1.6000- 2
60 633	2.5000- 2	1.0000- 3	5.6810- 1	1.0000- 2	60 633	8.3000- 1	4.0000- 2	1.6100- 1	6.0010- 3
62 1462	3.0000- 2	8.0000- 3	5.3100- 1	6.0000- 2	58 363	2.7000+ 0		5.9300- 2	1.6000- 3
61 677	3.0000- 2	7.0010- 3	4.7300- 1	4.7000- 2	58 363	4.0000+ 0		3.3300- 2	1.2000- 3
63 1	3.0000- 2	8.0010- 3	4.7300- 1	4.3000- 2	71 3194	1.4000+ 1		8.4500- 4	2.1120- 4
62 1462	6.4000- 2	2.0000- 2	3.4000- 1	4.0000- 2	57 521	1.4500+ 1		3.3000- 3	5.0000- 4

03/01/74 PROMPT NEUTRONS/FISSION 92-U -238

REFERENCE	ENERGY MEV	DELTA MEV	NU-BAR	DELTA	REFERENCE	ENERGY MEV	DELTA MEV	NU-BAR	DELTA
57 1190	1.5000+ 0		2.6500+ 0	9.0000- 2	63 1126	1.4000+ 1		4.3600+ 0	3.4000- 1
61 1334	1.5800+ 0		2.5600+ 0	3.0000- 2	56 1321	1.4100+ 1		4.1300+ 0	2.5000- 1
61 1079	2.3000+ 0		2.7200+ 0	8.0000- 2	58 1330	1.4200+ 1		4.5500+ 0	1.5000- 1
56 1321	2.5000+ 0		2.3500+ 0	1.8000- 1	58 1134	1.4200+ 1		4.4400+ 0	2.0000- 1
61 1138	3.6000+ 0	3.0000- 1	2.7900+ 0	9.0000- 2	61 1068	1.4200+ 1		4.4400+ 0	1.2000- 1
61 1079	3.7500+ 0		3.0200+ 0	1.0000- 1	60 1325	1.4300+ 1		4.2800+ 0	3.0000- 1
55 1383	4.5000+ 0		3.1000+ 0	4.0000- 1	61 1138	1.4900+ 1	3.0000- 1	4.7500+ 0	1.2000- 1
58 1324	1.4000+ 1		4.4600+ 0	3.2000- 1					

Fig. A-3c. Data from Ref. 1079, as it appears in UCRL-50400, Vol. 7.

TARGET	CODE	S	E-MIN-MEV	E-MAX-MEV	REFERENCE	POINTS	REACTION DESCRIPTION	
90-TH-232	23		3.000E-03	3.900E-01	66 313	9	N,GAMMA	
90-TH-232	23		5.500E-03	1.000E-01	63 1438	10	N,GAMMA	
90-TH-232	23		5.500E-03	1.480E-01	63 1510	98	N,GAMMA	
90-TH-232	23		1.000E-02	5.850E-02	64 454	127	N,GAMMA	
90-TH-232	23		1.700E-02	6.300E-01	57 236	19	N,GAMMA	
90-TH-232	23		2.400E-02	2.400E-02	57 305	1	N,GAMMA	
90-TH-232	23		2.400E-02	2.400E-02	65 867	1	N,GAMMA	
90-TH-232	23		3.000E-02	9.500E-01	61 715	27	N,GAMMA	
90-TH-232	23		3.000E-02	3.970E+00	61 759	26	N,GAMMA	
90-TH-232	23		1.000E-01	1.230E+00	59 1402	24	N,GAMMA	
90-TH-232	23		1.910E-01	1.170E+00	63 774	22	N,GAMMA	
90-TH-232	23		2.000E-01	2.000E-01	58 363	2	N,GAMMA	
90-TH-232	23		2.200E-01	2.200E-01	60 633	1	N,GAMMA	
90-TH-232	23		3.000E-01	1.200E+00	59 627	15	N,GAMMA	
90-TH-232	23		1.450E+01	1.450E+01	57 521	1	N,GAMMA	
90-TH-232	24	7	7.000E-01	1.650E+00	61 11	114	N,X GAMMA	
90-TH-232	43		4.200E-08	4.200E-08	62 1275	1	COHERENT SCATTERING	
90-TH-232	46		1.390E+00	4.020E+00	65 1074	4	NU-BAR PROMPT	
90-TH-232	46		1.400E+00	1.400E+00	59 1151	1	NU-BAR PROMPT	
90-TH-232	46		1.420E+00	1.480E+01	65 1378	7	NU-BAR PROMPT	
90-TH-232	46		1.480E+00	3.280E+00	66 219	7	NU-BAR PROMPT	
90-TH-232	46		2.300E+00	1.570E+01	61 1079	3	NU-BAR PROMPT	
90-TH-232	46		3.600E+00	1.490E+01	61 1138	2	NU-BAR PROMPT	
90-TH-232	46		4.000E+00	4.000E+00	58 1447	1	NU-BAR PROMPT	
90-TH-232	46		1.410E+01	1.410E+01	56 1321	1	NU-BAR PROMPT	
90-TH-232	46		1.420E+01	1.420E+01	58 1330	1	NU-BAR PROMPT	
90-TH-232	47		2.000E+00	2.000E+00	1 55 1341	1	NU-BAR DELAYED	
90-TH-232	47		2.400E+00	1.500E+01	59 1425	3	NU-BAR DELAYED	
90-TH-232	47		3.100E+00	1.490E+01	69 1533	2	NU-BAR DELAYED	
90-TH-232	47		1.400E+01	1.400E+01	61 1410	1	NU-BAR DELAYED	
90-TH-232	47		1.400E+01	1.400E+01	68 2357	1	NU-BAR DELAYED	
90-TH-232	47		1.450E+01	1.450E+01	61 1423	1	NU-BAR DELAYED	
90-TH-232	48		1.400E+01	1.400E+01	63 277	1	ETA	
90-TH-232	51		3.900E-04	6.000E-02	61 408	33	TOTAL	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	52		2.500E-08	2.500E-08	51 1303	1	ELASTIC	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	52		2.500E-08	2.500E-08	51 1397	1	ELASTIC	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	62		2.000E+00	2.000E+00	58 1519	1	N,2N	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	71		2.500E-08	2.500E-08	55 1406	1	ABSORPTION	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	71		2.500E-08	2.500E-08	57 1478	1	ABSORPTION	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	72		2.500E-08	2.500E-08	59 1540	1	N,F	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	72		2.500E-08	2.500E-08	68 1525	1	N,F	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	73		2.500E-08	2.500E-08	44 1444	1	N,GAMMA	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	73		2.500E-08	2.500E-08	44 1458	1	N,GAMMA	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	73		2.500E-08	2.500E-08	52 342	1	N,GAMMA	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	73		2.500E-08	2.500E-08	57 339	1	N,GAMMA	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	93		2.500E-08	2.500E-08	51 1397	1	COHERENT SCATTERING	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	96		3.500E+00	3.500E+00	58 1198	1	NU-BAR PROMPT	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	97		2.000E+00	2.000E+00	55 1427	1	NU-BAR DELAYED	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	97		2.000E+00	2.000E+00	57 1066	1	NU-BAR DELAYED	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	97		1.400E+01	1.400E+01	50 1422	1	NU-BAR DELAYED	SPECTRUM AVERAGED CROSS SECTION
90-TH-232	102		5.000E-01	1.550E+00	55 1495	3	ELASTIC	ANGULAR DISTRIBUTION
90-TH-232	102		5.600E-01	1.500E+00	62 693	41	ELASTIC	ANGULAR DISTRIBUTION

Fig. A-4a. Reaction index to Ref. 1079, as it appears in UCRL-50400, Vol. 3, Sec. 1.

TARGET	CODE	S	E-MIN-MEV	E-MAX-MEV	REFERENCE	POINTS	REACTION DESCRIPTION
92-U -238	23		2.000E-03	2.000E-03	2 69 2096	1	N,GAMMA
92-U -238	23		3.000E-03	2.200E-01	60 727	17	N,GAMMA
92-U -238	23		5.000E-03	5.900E+00	46 313	14	N,GAMMA
92-U -238	23		6.050E-03	9.700E-02	63 1880	92	N,GAMMA
92-U -238	23		1.008E-02	5.835E-02	64 454	126	N,GAMMA
92-U -238	23		1.300E-02	1.700E-01	63 1438	10	N,GAMMA
92-U -238	23		1.800E-02	3.000E-01	62 1407	8	N,GAMMA
92-U -238	23		2.300E-02	2.300E-02	69 2190	1	N,GAMMA
92-U -238	23		2.400E-02	2.400E-02	57 305	1	N,GAMMA
92-U -238	23		2.440E-02	5.030E-01	68 1547	9	N,GAMMA
92-U -238	23		2.500E-02	8.300E-01	60 633	3	N,GAMMA
92-U -238	23		2.900E-02	8.400E-01	59 1402	10	N,GAMMA
92-U -238	23		3.000E-02	6.400E-02	62 1462	2	N,GAMMA
92-U -238	23		3.000E-02	6.500E-02	61 677	2	N,GAMMA
92-U -238	23		3.000E-02	6.500E-02	63 1	2	N,GAMMA
92-U -238	23		3.000E-02	9.000E-01	69 2523	4	N,GAMMA
92-U -238	23		1.270E-01	7.600E+00	64 1401	13	N,GAMMA
92-U -238	23		1.750E-01	1.000E+00	60 674	7	N,GAMMA
92-U -238	23		1.950E-01	1.950E-01	59 526	1	N,GAMMA
92-U -238	23		2.000E-01	4.000E+00	58 363	3	N,GAMMA
92-U -238	23		4.000E-01	3.000E+00	45 1403	5	N,GAMMA
92-U -238	23		1.400E+01	1.400E+01	7 3194	1	N,GAMMA
92-U -238	23		1.450E+01	1.450E+01	57 521	1	N,GAMMA
92-U -238	24		1.090E+00	1.480E+01	66 1027	6	N,X GAMMA
92-U -238	24	7	6.000E-01	1.700E+00	61 11	135	N,X GAMMA
92-U -238	34		1.450E+01	1.450E+01	59 550	1	N,ALPHA
92-U -238	43		0.	0.	55 902	1	COHERENT SCATTERING
92-U -238	46		-6.140E+00	-6.140E+00	71 2509	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	52 1366	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	54 1128	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	57 1370	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	59 1157	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	60 1133	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	60 1454	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	63 1075	1	NU-BAR PROMPT
92-U -238	46		1.360E+00	1.479E+01	67 211	27	NU-BAR PROMPT
92-U -238	46		1.410E+00	4.020E+00	65 1074	4	NU-BAR PROMPT
92-U -238	46		1.490E+00	1.480E+01	64 1379	9	NU-BAR PROMPT
92-U -238	46		1.500E+00	1.500E+00	57 1190	1	NU-BAR PROMPT
92-U -238	46		1.580E+00	1.580E+00	61 1334	1	NU-BAR PROMPT
92-U -238	46		2.300E+00	3.750E+00	61 1079	2	NU-BAR PROMPT
92-U -238	46		2.500E+00	1.410E+01	56 1321	2	NU-BAR PROMPT
92-U -238	46		3.600E+00	1.490E+01	61 1138	2	NU-BAR PROMPT
92-U -238	46		4.500E+00	4.500E+00	55 1383	1	NU-BAR PROMPT
92-U -238	46		7.000E+00	8.000E+00	2 69 2092	2	NU-BAR PROMPT
92-U -238	46		1.400E+01	1.400E+01	58 1324	1	NU-BAR PROMPT
92-U -238	46		1.400E+01	1.400E+01	63 1126	1	NU-BAR PROMPT
92-U -238	46		1.420E+01	1.420E+01	58 1134	1	NU-BAR PROMPT
92-U -238	46		1.420E+01	1.420E+01	58 1330	1	NU-BAR PROMPT
92-U -238	46		1.420E+01	1.420E+01	61 1068	1	NU-BAR PROMPT
92-U -238	46		1.430E+01	1.430E+01	60 1325	1	NU-BAR PROMPT
92-U -238	47		2.000E+00	2.000E+00	1 55 1341	1	NU-BAR DELAYED

Fig. A-4b. Reaction index to Ref. 1079, as it appears in UCRL-50400, Vol. 3, Sec. 1.

03/01/74 ECSIL-7600 REACTION INDEX (REACTION NO. ORDERED) C = 44

TARGET	CODE	S	E-MIN-MEV	E-MAX-MEV	REFERENCE	POINTS	REACTION DESCRIPTION
12-MG-NAT	44		2.530E-08	2.530E-08	57 2833	1	INCOHERENT SCATTER.
13-AL-27	44		2.530E-08	2.530E-08	63 2663	1	INCOHERENT SCATTER.
14-SI-NAT	44		9.420E-06	9.420E-06	66 1759	1	INCOHERENT SCATTER.
29-CU-NAT	44		0.	0.	58 404	1	INCOHERENT SCATTER.
39-Y -89	44		2.530E-08	2.530E-08	65 2118	1	INCOHERENT SCATTER.
52-TE-NAT	44		2.500E-08	2.500E-08	51 2398	1	INCOHERENT SCATTER.
82-PB-NAT	44		9.420E-06	9.420E-06	66 1759	1	INCOHERENT SCATTER.
83-BI-209	44		2.530E-08	2.530E-08	63 2663	1	INCOHERENT SCATTER.
90-TH-229	46		2.530E-08	2.530E-08	58 1156	1	NU-BAR PROMPT
90-TH-229	46		2.530E-08	2.530E-08	61 1088	1	NU-BAR PROMPT
90-TH-232	46		1.390E+00	4.020E+00	65 1074	4	NU-BAR PROMPT
90-TH-232	46		1.400E+00	1.400E+00	59 1151	1	NU-BAR PROMPT
90-TH-232	46		1.420E+00	1.480E+01	65 1378	7	NU-BAR PROMPT
90-TH-232	46		1.480E+00	3.280E+00	66 219	7	NU-BAR PROMPT
90-TH-232	46		2.300E+00	1.570E+01	61 1079	3	NU-BAR PROMPT
90-TH-232	46		3.600E+00	1.490E+01	61 1138	2	NU-BAR PROMPT
90-TH-232	46		4.000E+00	4.000E+00	58 1447	1	NU-BAR PROMPT
90-TH-232	46		1.410E+01	1.410E+01	56 1321	1	NU-BAR PROMPT
90-TH-232	46		1.420E+01	1.420E+01	58 1330	1	NU-BAR PROMPT
92-U -232	46		2.530E-08	2.530E-08	61 1088	1	NU-BAR PROMPT
92-U -232	46		2.530E-08	2.530E-08	69 1912	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	46 1313	1	NU-BAR PROMPT
92-U -233	46		2.53 E-08	2.530E-08	55 1097	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	55 1098	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	55 1099	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	56 1065	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	58 1063	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	58 1178	1	NU-BAR PROMPT
92-U -233	46		2.540E-08	2.530E-08	59 1092	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	65 1085	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	66 1336	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	2.530E-08	67 1417	1	NU-BAR PROMPT
92-U -233	46		2.530E-08	3.930E+00	63 1073	6	NU-BAR PROMPT
92-U -233	46		2.530E-08	4.000E+00	65 1074	5	NU-BAR PROMPT
92-U -233	46		8.000E-02	8.000E-02	56 1145	1	NU-BAR PROMPT
92-U -233	46		8.000E-02	7.000E-01	67 226	7	NU-BAR PROMPT
92-U -233	46		4.000E+00	1.500E+01	58 1121	2	NU-BAR PROMPT
92-U -233	46		1.400E+01	1.400E+01	61 1269	1	NU-BAR PROMPT
92-U -233	46		1.410E+01	1.410E+01	56 1321	1	NU-BAR PROMPT
92-U -233	46		1.480E+01	1.480E+01	58 1122	1	NU-BAR PROMPT
92-U -234	46		9.900E-01	4.020E+00	65 1074	4	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	44 1316	1	NU-BAR PROMPT
92-U -235	46		2.520E-08	2.530E-08	55 1097	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	56 1065	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	58 1320	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	66 1071	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	66 1323	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	66 1336	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.530E-08	67 1417	1	NU-BAR PROMPT
92-U -235	46		2.530E-08	1.900E+00	70 3278	15	NU-BAR PROMPT
92-U -235	46		2.530E-08	2.072E+00	65 1085	10	NU-BAR PROMPT
92-U -235	46		2.530E-08	7.960E+00	64 1155	19	NU-BAR PROMPT

Fig. A-5a. Reaction index to Ref. 1079, as it appears in UCRL-50400, Vol. 3, Sec. 2.

TARGET	CODE	S	E-MIN-MEV	E-MAX-MEV	REFERENCE	POINTS	REACTION DESCRIPTION
92-U -235	46		2.530E-08	1.45GE+01	63 1073	7	NU-BAR PROMPT
92-U -235	46		2.530E-08	1.480E+01	65 1319	3	NU-BAR PROMPT
92-U -235	46		3.000E-02	1.760E+00	62 1154	6	NU-BAR PROMPT
92-U -235	46		3.900E-02	1.000E+00	66 1327	16	NU-BAR PROMPT
92-U -235	46		7.500E-02	1.420E+01	61 1068	3	NU-BAR PROMPT
92-U -235	46		8.000E-02	8.000E-02	56 1195	1	NU-BAR PROMPT
92-U -235	46		8.000E-02	7.000E-01	67 226	7	NU-BAR PROMPT
92-U -235	46		8.000E-02	9.990E-01	64 1326	12	NU-BAR PROMPT
92-U -235	46		2.100E-01	1.580E+00	61 1334	4	NU-BAR PROMPT
92-U -235	46		3.700E-01	2.130E+00	69 3281	21	NU-BAR PROMPT
92-U -235	46		3.700E-01	3.250E+00	66 219	14	NU-BAR PROMPT
92-U -235	46		7.000E-01	7.000E-01	55 1374	1	NU-BAR PROMPT
92-U -235	46		1.000E+00	1.000E+00	55 1373	1	NU-BAR PROMPT
92-U -235	46		1.150E+00	6.600E+00	70 3314	26	NU-BAR PROMPT
92-U -235	46		1.250E+00	4.600E+00	57 1190	2	NU-BAR PROMPT
92-U -235	46		1.360E+00	1.479E+01	67 211	27	NU-BAR PROMPT
92-U -235	46		2.500E+00	1.410E+01	56 1321	2	NU-BAR PROMPT
92-U -235	46		4.000E+00	4.500E+00	55 1383	2	NU-BAR PROMPT
92-U -235	46		4.000E+00	1.500E+01	58 1121	2	NU-BAR PROMPT
92-U -235	46		7.000E+00	8.000E+00	2 69 2092	2	NU-BAR PROMPT
92-U -235	46		1.400E+01	1.400E+01	58 1324	1	NU-BAR PROMPT
92-U -235	46		1.430E+01	1.430E+01	60 1325	1	NU-BAR PROMPT
92-U -235	46		1.480E+01	1.480E+01	58 1322	1	NU-BAR PROMPT
92-U -236	46		-6.400E+00	-6.400E+00	1 69 2509	1	NU-BAR PROMPT
92-U -236	46		7.700E-01	6.700E+00	71 2509	21	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	52 1366	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	54 1128	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	57 1370	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	53 1157	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	60 1133	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	60 1454	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	63 1075	1	NU-BAR PROMPT
92-U -238	46		-6.140E+00	-6.140E+00	71 2509	1	NU-BAR PROMPT
92-U -238	46		1.360E+00	1.479E+01	67 211	27	NU-BAR PROMPT
92-U -238	46		1.410E+00	4.020E+00	65 1074	4	NU-BAR PROMPT
92-U -238	46		1.490E+00	1.480E+01	64 1379	9	NU-BAR PROMPT
92-U -238	46		1.500E+00	1.500E+00	57 1190	1	NU-BAR PROMPT
92-U -238	46		1.580E+00	1.580E+00	61 1334	1	NU-BAR PROMPT
92-U -238	46		2.300E+00	3.750E+00	61 1078	2	NU-BAR PROMPT
92-U -238	46		2.500E+00	1.410E+01	56 1321	2	NU-BAR PROMPT
92-U -238	46		3.600E+00	1.490E+01	61 1138	2	NU-BAR PROMPT
92-U -238	46		4.500E+00	4.500E+00	55 1383	1	NU-BAR PROMPT
92-U -238	46		7.000E+00	8.000E+00	2 69 2092	2	NU-BAR PROMPT
92-U -238	46		1.400E+01	1.400E+01	58 1324	1	NU-BAR PROMPT
92-U -238	46		1.400E+01	1.400E+01	63 1126	1	NU-BAR PROMPT
92-U -238	46		1.420E+01	1.420E+01	58 1134	1	NU-BAR PROMPT
92-U -238	46		1.420E+01	1.420E+01	58 1330	1	NU-BAR PROMPT
92-U -238	46		1.420E+01	1.420E+01	61 1060	1	NU-BAR PROMPT
92-U -238	46		1.430E+01	1.430E+01	60 1325	1	NU-BAR PROMPT
93-NP-236	46		2.530E-08	2.530E-08	61 1088	1	NU-BAR PROMPT
94-PU-236	46		7.350E+00	-7.350E+00	56 1146	1	NU-BAR PROMPT
94-PU-236	46		-7.350E+00	-7.350E+00	56 1147	1	NU-BAR PROMPT

Fig. A-5b. Reaction index to Ref. 1079, as it appears in UCRL-50400, Vol. 3, Sec. 2.

TARGET	CODE	S	E-MIN-MEV	E-MAX-MEV	REFERENCE	POINTS	REACTION DESCRIPTION	
98-CF-252	46		-6.350E+00	-6.350E+00	63 1073	1	NU-BAR PROMPT	
90-TH-232	46		1.390E+00	4.020E+00	65 1074	4	NU-BAR PROMPT	
92-U -233	46		2.530E-08	4.000E+00	65 1074	5	NU-BAR PROMPT	
92-U -234	46		9.900E-01	4.020E+00	65 1074	4	NU-BAR PROMPT	
92-U -238	46		1.410E+00	4.020E+00	65 1074	4	NU-BAR PROMPT	
94-PU-239	46		2.530E-08	4.020E+00	65 1074	5	NU-BAR PROMPT	
92-U -238	46		-6.140E+00	-6.140E+00	63 1075	1	NU-BAR PROMPT	
94-PU-240	46		-6.680E+00	-6.680E+00	63 1075	1	NU-BAR PROMPT	
92-U -233	48		2.500E-08	5.700E-08	65 1076	2	ETA	
92-U -233	49		2.500E-08	5.700E-08	65 1076	2	ALPHA	
92-U -235	48		2.500E-08	2.500E-08	65 1076	1	ETA	
92-U -235	49		2.500E-08	2.500E-08	65 1076	1	ALPHA	
94-PU-239	49		2.500E-08	5.700E-08	65 1076	2	ETA	
94-PU-239	49		2.500E-08	5.700E-08	65 1076	2	ALPHA	
92-U -233	49		2.530E-08	2.530E-08	66 1077	1	ALPHA	
92-U -233	99		2.500E-08	2.500E-08	66 1077	1	ALPHA	SPECTRUM AVERAGED CROSS SECTION
92-U -235	49		2.530E-08	2.530E-08	66 1077	1	ALPHA	
92-U -235	99		2.500E-08	2.500E-08	66 1077	1	ALPHA	SPECTRUM AVERAGED CROSS SECTION
94-PU-240	46		3.600E+00	1.500E+01	61 1078	2	NU-BAR PROMPT	
90-TH-232	46		2.300E+00	1.570E+01	61 1079	3	NU-BAR PROMPT	
92-U -238	46		2.300E+00	3.750E+00	61 1079	2	NU-BAR PROMPT	
94-PU-239	22		1.000E-04	2.993E-02	68 1080	5293	N,F	
94-PU-239	48		1.000E-04	2.993E-02	68 1080	5292	ETA	
94-PU-239	72		1.500E-04	2.500E-02	68 1080	29	N,F	SPECTRUM AVERAGED CROSS SECTION
94-PU-239	73		1.500E-04	2.500E-02	68 1080	20	N,GAMMA	SPECTRUM AVERAGED CROSS SECTION
94-PU-239	99		1.500E-04	2.500E-02	68 1080	20	ALPHA	SPECTRUM AVERAGED CROSS SECTION
94-PU-239	22		1.400E-01	1.740E+00	63 1081	75	N,F	
94-PU-242	1		2.500E-08	3.882E-04	66 1082	189	TOTAL	
94-PU-242			2.000E-08	4.000E-04	66 1082	1	AVERAGE RESONANCE PARAMETERS	
94-PU-242			2.640E-06	3.860E-04	66 1082	16	RESONANCE PARAMETERS	
94-PU-238	22		2.090E-06	2.992E-04	66 1083	217	N,F	
94-PU-238			2.900E-06	2.800E-04	66 1083	1	AVERAGE RESONANCE PARAMETERS	
94-PU-238			1.510E-04	2.600E-04	66 1083	6	RESONANCE PARAMETERS	
95-AM-241	22		3.210E-08	9.000E-04	65 1084	470	N,F	
95-AM-241			3.100E-07	1.504E-05	65 1084	26	RESONANCE PARAMETERS	
92-U -233	46		2.530E-08	2.530E-08	65 1085	1	NU-BAR PROMPT	
92-U -233	896		2.500E-08	2.500E-08	65 1085	1	NU-BAR PROMPT	CROSS SECTION RATIO
92-U -235	46		2.530E-08	2.572E+00	65 1085	10	NU-BAR PROMPT	
92-U -235	896		1.010E-01	2.572E+00	65 1085	9	NU-BAR PROMPT	CROSS SECTION RATIO
94-PU-239	46		2.530E-08	2.530E-08	65 1085	1	NU-BAR PROMPT	
94-PU-239	896		2.500E-08	2.500E-08	65 1085	1	NU-BAR PROMPT	CROSS SECTION RATIO
94-PU-240	46		-6.680E+00	-6.680E+00	65 1085	1	NU-BAR PROMPT	
94-PU-240	896		-6.680E+00	-6.680E+00	65 1085	1	NU-BAR PROMPT	CROSS SECTION RATIO
94-PU-241	46		2.530E-08	2.530E-08	65 1085	1	NU-BAR PROMPT	
94-PU-241	896		2.500E-08	2.500E-08	65 1085	1	NU-BAR PROMPT	CROSS SECTION RATIO
98-CF-252	46		-6.350E+00	-6.350E+00	65 1085	1	NU-BAR PROMPT	
98-CF-252	896		-6.350E+00	-6.350E+00	65 1085	1	NU-BAR PROMPT	CROSS SECTION RATIO
94-PU-241	71		4.798E-05	4.585E-03	2 65 1086	7	ABSORPTION	SPECTRUM AVERAGED CROSS SECTION
94-PU-239	46		4.220E+00	1.480E+01	68 1087	5	NU-BAR PROMPT	
94-PU-241	46		5.200E-01	1.480E+01	66 1087	5	NU-BAR PROMPT	
90-TH-229	46		2.530E-08	2.530E-08	61 1088	1	NU-BAR PROMPT	
92-U -232	46		2.530E-08	2.530E-08	61 1088	1	NU-BAR PROMPT	

Fig. A-6. Reaction index to Ref. 1079, as it appears in UCRL-50400, Vol. 3, Sec. 3.

AUTHOR	CITATIONS				AUTHOR	CITATIONS			
KREGER, W.E.	495	831*			LANE, R.O.	1259	1606	1647*	1757*
KREISLER, M.N.	1948*	2350	3180			3057	3058	3133*	3143*
KRIVOKHATSKII, A.S.	2193	2363			LANG, J.	2798			
KRIZHANSKY, L.M.	2235				LANGKAU, R.	562	713		
KROGULSKI, T.	2312				LANGMANN, J.	2167*			
KROHN, V.E.	1691*	2680*			LANGSDORF,JR., A.S.	3*	6	75	223
KROPP, L.	-2517	3091	3329			231*	234*	283	571
KRUGER, G.	2734					784	970	1002	1259
KRUGER, K.	1629	1684				1606	1647	1757	2351
KRUGER, P.G.	1587					2324*	3057	3058	3133
KRUPCHINSKY, P.A.	412*					3143			
KUCHLY, J.M.	3043				LANGSFORD, A.	1514*	-1514*	1563	-1563
KUCHNIR, F.T.	2351*					1692*	2015	3149	3332*
KUKAVADZE, G.M.	1414*	1490	2196	2226	LANNING, O.D.	2570			
	2235	2247	2362	2684	LANTZ, P.	944			
KULABUKHOV, YU.S.	1908				LANTZ, P.M.	2311	2722*	2723*	2725*
KULISIC, P.	1975*	2036*	2326*			2956*	2967*		
KUMABE, I.	474*	536*	537*	630*	LAPP, R.E.	2963*			
	667*				LARGE, R.S.	2227			
KUNNMANN, W.	3188				LASDAY, A.M.	65*			
KUO, L.G.	986				LASHUK, A.I.	717	865	1845	3388
KURODA, P.K	1945	2314	2707	3150		-3386			
KUSCH, W.	1890				LASINGER, V.F.	3334*			
KUSHNERIUK, S.A.	1386	2915			LATHAM, D.W.	1935			
KUTIKOV, I.E.	1118	-1158	1360		LATHROP, K.A.	2676			
KUTSAEVA, L.S.	1121	1157	1198	1447	LATYSHEV, G.D.	868			
KUZ'MINOV, B.D.	1078*	1079*	1157*	1198*	LAUBER, A.	762	1841*		
	1447				LAURAT, M.	455	971	1683	1737
KUZNETSOV, V.F.	226*	1326				2061			
KVITEK, J.	2881*	3070*	3275		LAVALLE, D.E.	2937			
KYKER,JR., G.C.	719*	720			LAVATELLI, L.S.	2798			
L'HERITEAU, J.P.	3122				LAVRENCHIK, V.N.	-1159	1360		
LA BAUVE, R.	-1061				LAWRENCE, G.P.	656			
LABAT, M.	211				LAZAR, N.	345			
LAGERWALL, T.	2034*				LAZAR, N.H.	305			
LAKATOS, T.	2762				LBOV, A.A.	580	1520	1882	2300
LAKIN, W.L.	3195*				LE COQ, G.	3122			
LALOVIC, B.	1613	1975	2036		LE PIPEC, C.	19	2283*		
LAMB, R.C.	1822*				LE POITEVIN, G.	-1813	-1817	-1878	1951
LAMBROPOULOS, P.	-3146	3154				2003	2129*	-2547	-3118
LAMOREAUX, R.D.	3257				LE RIGOLEUR, C.O.	3172			
LAMPHERE, R.W.	132*	152*	268*	293*	LEACHMAN, R.B.	346	1161*	-1373*	-1374*
	1528*				LEARY, J.A.	2629	3242		
LAMPI, E.E.	64	183*			LEBEDEV, P.P.	877*			
LANDER, O.H.	3239*				LEBEDEV, V.I.	1097	1098	1120	1123*
LANDON, H.H.	497*	1057	1139*	2022*		1124*	1156*	1193	
	2289*	2327	2396*	2432	LEBEDEVA, N.S.	204	755	1643	
	-2440	2441*	2493	2502*	LEBEDEW, A.W.	2826			
	3034*				LEBLANC, J.M.	20	-548	593	683
LANDRUM, J.H.	3287*					-936	1774*		
LANE, A.M.	40				LEBOWITZ, J.	3197*			
LANE, R.O.	231	571*	665	807*	LEBOWITZ, J.M.	280			

Fig. A-7. Author citation to Ref. 1079, as it appears in UCRL-50400, Vol. 2, Sec. 1.

REF-N	REFERENCE	YR	AUTHOR	AUTHOR
1079	SOVIET PROGRESS IN NEUTRON PHYSICS,P.177	61	KUZ'MINOV, B.D.	
1078	SOVIET PROGRESS IN NEUTRON PHYSICS,P.181	61	KUZ'MINOV, B.D	
487	SOVIET PROGRESS IN NEUTRON PHYSICS,P.185	61	MIKHAILINA, K.M.	NOMOFILOV, A.A.
			ROMANOVA, T.A.	SVIRIDOV, Y.A.
			TIKHOMIROV, F.A.	TOLSTOV, K.D.
581	SOVIET PROGRESS IN NEUTRON PHYSICS,P.191	61	AVERCHENKOV, V.YA.	VERETENNIKOV, A.I.
753	SOVIET PROGRESS IN NEUTRON PHYSICS,P.209	61	KHULELIDZE, O.E.	CHULIOS, V.F.
			VLASENKO, V.P.	GRITS, YU.A.
754	SOVIET PROGRESS IN NEUTRON PHYSICS,P.211	61	ANDREEV, V.N.	
848	SOVIET PROGRESS IN NEUTRON PHYSICS,P.216	61	LOVCHIKOVA, G.N.	SAL'NIKOV, O.A.
755	SOVIET PROGRESS IN NEUTRON PHYSICS,P.219	61	MOROZOV, V.M.	
			ZUBOV, YU.G	LEBEDEVA, N.S.
846	SOVIET PROGRESS IN NEUTRON PHYSICS,P.224	61	POPOV, V.I.	
2135	SOVIET PROGRESS IN NEUTRON PHYSICS,P.227	61	STAVISSKII, YU.YA.	SHAPAR', A.V.
2138	SOVIET PROGRESS IN NEUTRON PHYSICS,P.228	61	TOLSTIKOV, V.A.	STAVISSKII, YU.YA.
850	SOVIET PROGRESS IN NEUTRON PHYSICS,P.241	61	NEFEDOV, V.V.	POPOV, V.I.
			YAZVETSKII, YU.S.	
760	STANFORD UNIVERSITY THESIS	63	HARRIS, K.K.	
2050	SUMP-69-2	69	BARRALL, R.C.	SILBERGELD, M.
			GARDNER, D.G.	
-2569	SYMPOSIUM PILE OSCIL.MEAS.NEUT.ABSORP.BUCHAREST,P.553	61		
1042	TEXAS NUCLEAR CORPORATION REPORT	66	MATHUR, S.C.	BUCHANAN, P.S.
			MORGAN, I.L.	
1724	TEXAS NUCLEAR CORPORATION REPORT	62	ASHE, J.B.	PRUD'HOMME, J.T.
			MORGAN, I.L.	
			NELLIS, D.O.	BENJAMIN, R.W.
1725	TEXAS NUCLEAR CORPORATION REPORT	62	ASHE, J.B.	MORGAN, I.L.
			HENDERSON, J.D.	PREWETT, R.L
			NELLIS, D.O.	BENJAMIN, R.W.
			PRUD'HOMME, J.T.	
1728	TEXAS NUCLEAR CORPORATION REPORT	63	BENJAMIN, R.W.	HUDSON,JR., O.M.
			MATHUR, S.C.	NELLIS, D.O.
			MORGAN, I.L.	ASHE, J.B.
			PARKER, C.V.	TUCKER, W.E.
1730	TEXAS NUCLEAR CORPORATIC REPORT	64	HUDSON,JR., O.M.	BUCHANAN, P.S.
			MATHUR, S.C.	TUCKER, W.E.
			MORGAN, I.L.	ASHE, J.B.
			NELLIS, D.O.	BENJAMIN, R.W.
1382	TID-2019 P.405	55	TINCEY, F.H.	VANCE, F.P.
1505	TID-5157	53	WALT, M.	BARSCHALL, H.H.
334	TID-5223 (PART 2) P.617	52	VAN WINKLE, Q.	
244	TID-5223 (PART 2) PAPER 9.1 P 508	52	HAGEMANN, F.	
			STUDIER, M.H.	GHIORSO, A.
1201	TID-5223,PART 2,P.532	52	JAFFEY, A.H.	HYDE, E.K.
1202	TID-5223,PART 2,P.543	52	KATZIN, L.I.	HAGEMANN, F.
1203	TID-5223,PART 2,P.604	52	JAFFEY, A.H.	VAN WINKLE, Q.
337	TID-7547 P.39	57	HUBERT, P	JOLY, R.
			SIGNARBIEUX, C.	
1391	TID-7547 P.115	57	LEONARD JR., B.R.	
-1066	TID-7547 P.130	57	KEEPIN, G.R.	
-1164	TID-7547 PP 112 AND 113	57		
696	TID-11005 P.19	60	GALLOWAY,III, L.A.	

Fig. A-8. Alphabetically ordered listing of Ref. 1079, as it appears in TCRL-50400, Vol. 2, Sec. 2.

REF	BIBLIOGRAPHY	TARGET	EN. RANGE (MEV)	PTS	DESCRIPTION	
1071	BORON PILE. EANDC(UK)-64S (1966)					
1072	J. NUCLEAR ENERGY, PARTS A/B, 19, 423 (1965) J.L.PERKIN, P.H.WHITE, P.FIELDHOUSE EANDC(UK)-50S (0000) NEUTRON FLUX DETERMINED BY THREE INDEPENDENT ABSOLUTE FLAT RESPONSE DETECTORS	92-U -233 92-U -234 92-U -235 93-NP-237 94-PU-239 94-PU-240 94-PU-241	2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02 2.40-02	1 1 1 1 1 1 1	N,FISS N,FISS N,FISS N,FISS N,FISS N,FISS N,FISS	
1073	NUCLEAR PHYS. 48, 433 (1963) J.C.HOPKINS, B.C.DIVEN RELATIVE TO SPONTANEOUS FISSION NU BAR OF CF-252. SEE ALSO PHYS. OF FAST AND INTERMED. REACTORS.VIENNA,SM-18/56(1961) FOR PRELIMINARY RESULTS.	92-U -233 92-U -235 94-PU-239 94-PU-240 98-CF-252	2.53-08 3.93+00 2.53-08 1.45+01 2.53-08 1.45+01 -6.68+00-6.68+00 -6.35+00-6.35+00	6 7 7 1 1	NU-PRMT NU-PRMT NU-PRMT NU-PRMT NU-PRMT	
1074	NUCLEAR PHYS. 66, 149 (1965) D.S.MATHER, P.FIELDHOUSE, A.MOAT (AWRE) LIQUID SCINTILLATOR COUNTER EANDC(UK)-49S (0000) RELATIVE TO CF252 SPONTANEOUS FISSION NU-BAR P = 3.782+-.024	90-TH-232 92-U -233 92-U -234 92-U -238 94-PU-239	1.39+00 4.02+00 2.53-08 4.00+00 9.90-01 4.02+00 1.41+00 4.02+00 2.53-08 4.02+00	4 5 4 4 9	NU-PRMT NU-PRMT NU-PRMT NU-PRMT NU-PRMT	
1075	NUCLEAR SCIENCE AND ENGINEERING 15, 213 (1963) I.ASPLUND-NILSSON, H.CONDE, N.STARFELT RELATIVE TO NU FOR SPONTANEOUS FISSION OF CF-252 (3.80). LIQUID SCINTILLATOR	92-U -238 94-PU-240	-6.14+00-6.14+00 -6.68+00-6.68+00	1 1	NU-PRMT NU-PRMT	
1076	BULL. AM. PHYS. SOC. 10, 1099 (1965) J.R.SMITH, S.D.REEDER, R.G.FLUHARTY (PHILLIPS) CONF. ON NEUTRON C/S TECHNOLOGY. WASH.D.C., P.919 (1966) J.R.SMITH, E.FAST IDO-17140 PAGE 30 (1965) MTR CRYSTAL SPECTROMETER. WE HAVE DETERMINED ALPHA HERE BY TAKING NU = 2.494, 2.430 AND 2.871 FOR U233, U235, AND PU239, RESPECTIVELY	92-U -233 92-U -233 92-U -235 92-U -235 94-PU-239 94-PU-239	2.50-08 5.70-08 2.50-08 5.70-08 2.50-08 2.50-08 2.50-08 2.50-08 2.50-08 5.70-08 2.50-08 5.70-08	2 2 1 1 2 2	ETA ALPHA ETA ALPHA ETA ALPHA	
1077	AMERICAN CHEMICAL SOCIETY MEETING. PITTSBURGH (1966) F.L.LISMAN, W.J.MAECK, J.E.REIN (CONF-660303 BOOK 2 PHYSICS TID-4500) CONF. ON NEUTRON C/S TECHNOLOGY. WASH.D.C., P.919 (1965) J.R.SMITH, E.FAST MASS SPECTROMETER. IRRADIATION IN MTR	92-U -233 92-U -233 92-U -235 92-U -235	2.53-08 2.53-08 2.50-08 2.50-08 2.53-08 2.53-08 2.50-08 2.50-08	1 1 1 1	ALPHA ALPHA ALPHA ALPHA	SPECT.AV. SPECT.AV.
1078	SOVIET PROGRESS IN NEUTRON PHYSICS, PAGE 101 (1961) B.D.KUZ'MINOV (RUSSIAN TEXT PUBLISHED BY GOSATOMIZDAT, MOSCOW, 1961 - TRANSLATION PUBLISHED BY CONSULTANTS BUREAU, NEW YORK, 1962) NORMALIZED TO NU-BAR PU-239 = 2.9 +/- .04 AEC-TR-4710 (1960)	94-PU-240	3.60+00 1.50+01	2	NU-PRMT	
1079	SOVIET PROGRESS IN NEUTRON PHYSICS, PAGE 177 (1961)	90-TH-232	2.30+00 1.57+01	3	NU-PRMT	

Fig. A-9a. Bibliographic information for Ref. 1079, as it appears in UCRL-50400, Vol. 2, Sec. 3.

REF	BIBLIOGRAPHY	TARGET	EN. RANGE (MEV)	PTS	DESCRIPTION	
→ 1079	B.D.KUZ'MINOV (RUSSIAN TEXT PUBLISHED BY GOSATOMIZDAT, MOSCOW, 1961 - TRANSLATION PUBLISHED BY CONSULTANTS BUREAU, NEW YORK, 1962) *NORMALIZED TO NU-BAR THER U-235 = 2.47 +/- .03*	92-U -238	2.30+00 3.75+00	2	NU-PRMT	
1080	CANDC(UK)-96AL (1968) B.H.PATRICK, M.G.SOWERBY, M.G.SHOMBERG (AERE) AERE-PR/NP-14 PAGE 14 (1968) IAEA CONF. ON NUCLEAR DATA, PARIS, PAPER CN-23/30 (1966) B.H.PATRICK, M.G.SCHOMBERG, M.G.SOWERBY, J.E.JOLLY TIME OF FLIGHT MEASUREMENT OF ETA, ALPHA AND NEUTRON CROSS SECTIONS. ALPHA HERE *IS THE RATIO OF THE AVERAGE* CAPTURE CROSS SECTION TO THE AVERAGE FISSION CROSS SECTION	94-PU-239 94-PU-239 94-PU-239 94-PU-239 94-PU-239	1.00-04 2.99-02 1.00-04 2.99-02 1.50-04 2.50-02 1.50-04 2.50-02 1.50-04 2.50-02	5293 5292 28 20 20	N,FISS ETA N,FISS N,G ALPHA	 SPECT.AV. SPECT.AV. SPECT.AV.
1081	BULL. AM. PHYS. SOC. 8, 369 (1963) D.K.BUTLER, R.K.SJOBLOM (ANL) *GAS SCINTILLATION COUNTER.* RELATIVE TO U-235 SIGMA F. DATA TAKEN FROM BNL-325 (1965) WASH-1044 PP. 5, 12, 13 (1963) D.K.BUTLER	94-PU-238	1.40-01 1.74+00	75	N,FISS	
1082	PHYS. REV. 146, 840 (1966) G.F.AUCHAMPAUGH, C.D.BOWMAN, M.S.COOPS, S.C.FULTZ (LRL) TIME OF FLIGHT TECHNIQUE. CROSS SECTION DATA OBTAINED FROM G.F.AUCHAMPAUGH BULL. AM. PHYS. SOC. 10, 512 (1965)	94-PU-242 94-PU-242 94-PU-242	2.50-08 3.88-04 2.00-08 4.00-04 2.64-06 3.86-04	189 1 15	TOTAL AV.RES.PARAM. RES.PARAM.	
1083	PRIVATE COMMUNICATION (1966) G.F.AUCHAMPAUGH (LRL) TIME OF FLIGHT TECHNIQUE. BULL. AM. PHYS. SOC. 10, 1099 (1965) UCRL-70033 (1966) AREA ANALYSIS. RESONANCE PARAMETERS BELOW 150 EV REPORTED IN REFERENCE 1252. PHYS. REV. 154, 1111 (1967) W.F.STUBBINS, C.D.BOWMAN, G.F.AUCHAMPAUGH, M.S.COOPS	94-PU-238 94-PU-238 94-PU-238 94-PU-238	2.09-06 2.89-04 2.90-06 2.80-04 1.51-04 2.80-04	217 1 6	N,FISS AV.RES.PARAM. RES.PARAM.	
1084	PHYS. REV. 137, 326 (1965) C.D.BOWMAN, M.S.COOPS, G.F.AUCHAMPAUGH, S.C.FULTZ (LRL) TIME OF FLIGHT TECHNIQUE. CROSS SECTION NORMALIZED TO 3.13 PLUS/MINUS 0.15 BARNS AT 0.025 EV. CROSS SECTION DATA OBTAINED FROM C.D.BOWMAN. AREA AND SHAPE ANALYSIS. UCRL-7971 (1964)	95-AM-241 95-AM-241	3.21-08 9.00-04 3.10-07 1.50-05	470 28	N,FISS RES.PARAM.	
1085	PHYS. AND CHEM. OF FISSION, IAEA, SALZBURG, 2, 25 (1965) D.W.COLVIN, M.G.SOWERBY PARTIAL DATA PRESENTED IN AERE-PR/NP-9 PAGE 9 (1965) BORON PILE MEASUREMENT. WE HAVE TAKEN NU PROMPT AS 2.414 (THERMAL) AND 3.763 FOR U235 AND CF252, RESPECTIVELY. IAEA CONF. ON NUCLEAR DATA, PARIS, PAPER CN-23/33 (1966) CANDC(UK)-525 (1965)	92-U -233 92-U -233 92-U -235 92-U -235 94-PU-239 94-PU-239 94-PU-240 94-PU-240 94-PU-241	2.53-08 2.53-08 2.50-08 2.50-08 2.53-08 2.57+00 1.01-01 2.57+00 2.53-08 2.53-08 2.50-08 2.50-08 -6.68+00-6.68+00 -6.68+00-6.68+00 2.53-08 2.53-08	1 1 10 9 1 1 1 1 1	NU-PRMT NU-PRMT C/S RATIO NU-PRMT NU-PRMT C/S RATIO NU-PRMT NU-PRMT C/S RATIO NU-PRMT NU-PRMT C/S RATIO NU-PRMT	

Fig. A-9b. Bibliographic information for Ref. 1079, as it appears in UCRL-50400, Vol. 2, Sec. 3.