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OAK RIDGE NATIONAL LABORATORY LIBRARIES



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ORNL-RSIC-30
Vol. 1

ABSTRACTS of the DATA LIBRARY PACKAGES assembled by the Radiation Shielding Information Center

Robert W. Roussin

MARCH 1972

NOTE:

This Work Partially Supported by
DEFENSE NUCLEAR AGENCY
under Task PB05203

and

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
under Order H-79272A

RADIATION SHIELDING INFORMATION CENTER



ACKNOWLEDGEMENTS

This collection of abstracts, and the data libraries it describes, are the result of the work of many people. We are grateful to the contributors of the data who provided guidance in the preparation of abstracts. We are also grateful to the USAEC, to DNA, and to NASA for their encouragement and their financial support of the RSIC program.

It is a pleasure to acknowledge the help and cooperation of all RSIC staff members in the collection and distribution of the data libraries. David K. Trubey was instrumental in originating and developing the RSIC Data Library Collection and helped to write many of the abstracts. Our appreciation is extended to Juanita B. Wright, involved in all phases of data packaging and distribution since the inception of the collection, and to Henrietta R. Hendrickson who assists in the maintenance and distribution of the data libraries. The continual encouragement and support of RSIC Coordinator, Betty F. Maskewitz, are appreciated.

Robert W. Roussin
Data Coordinator

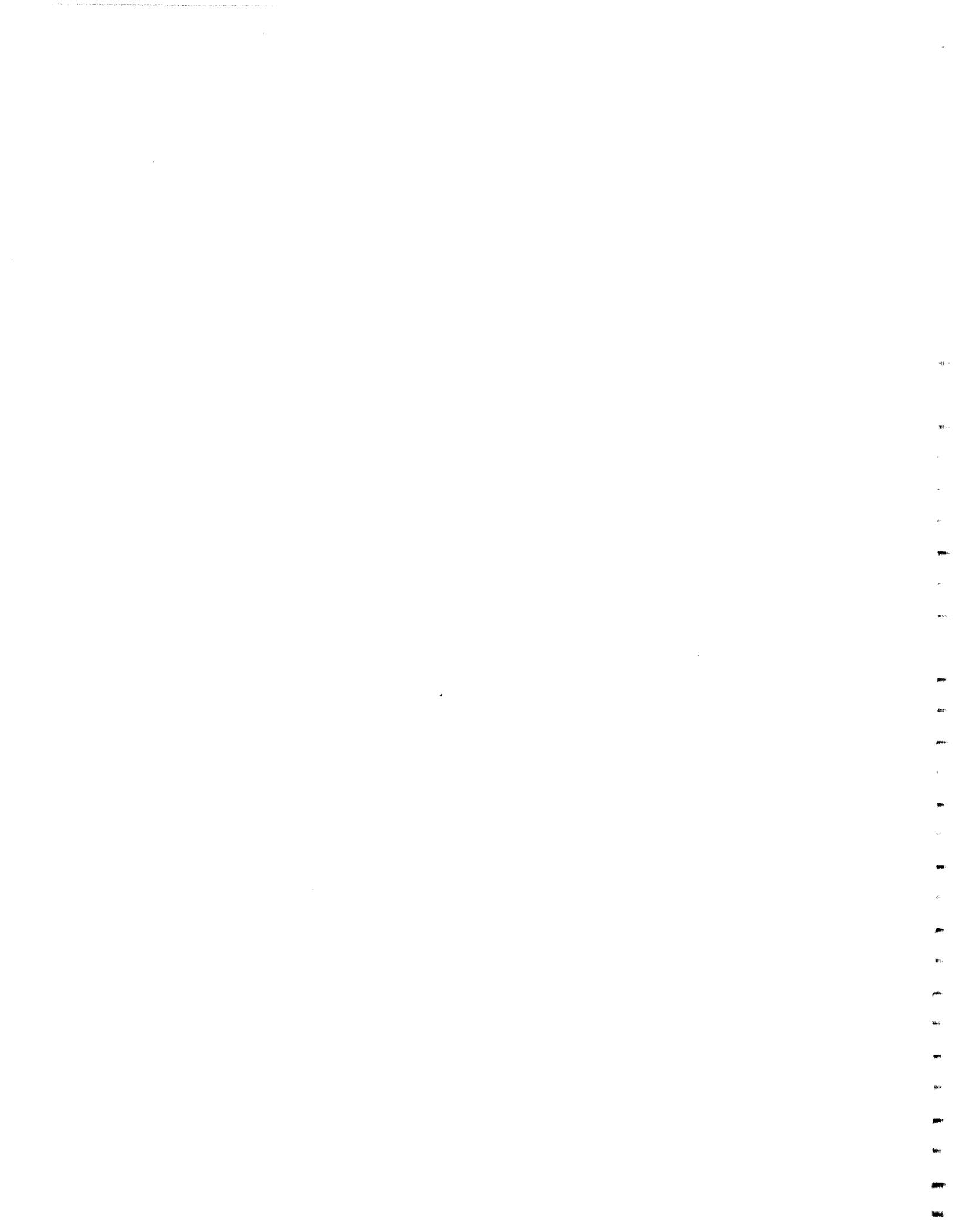
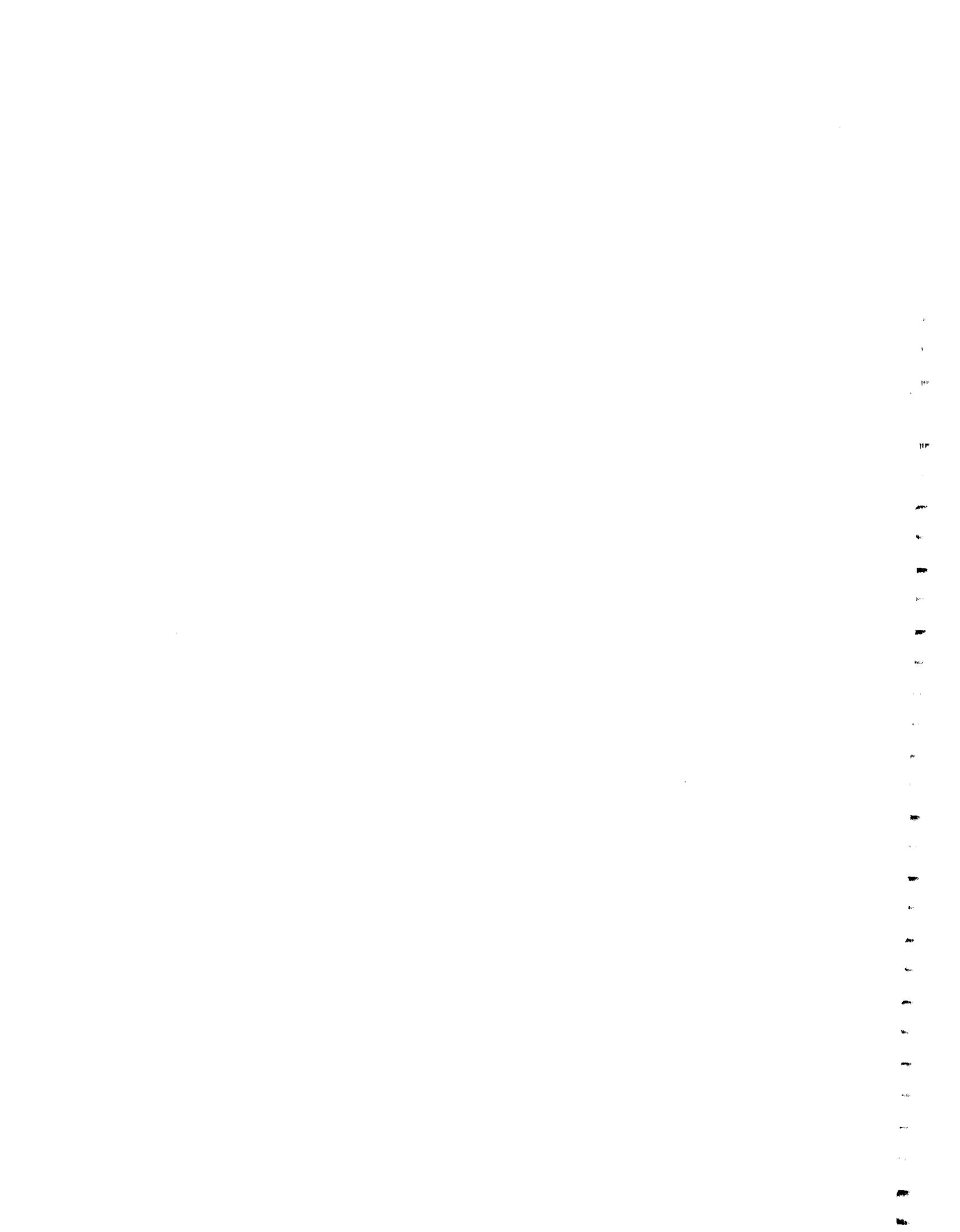


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PREFACE

Data libraries are now being packaged and organized by RSIC in a manner analogous to the RSIC code collection. Each data set will carry a Data Library Collection (DLC) number and be packaged as a unit. As with the code packages, a particular data package will not remain static, but will be subject to revision, updating, and expansion as required. Such changes will be announced in the RSIC Newsletter.

Data libraries were first announced as available from RSIC near the end of 1968. At that time it became evident that a collection of data libraries would be an extremely helpful companion to the RSIC Computer Code Collection. The main objective is the interchange of technology among installations engaged in radiation transport research, development, and applications.

The performance of digital computer calculations, in general, may be thought of as a three-part process, which can be identified with three components. The first part is the acquisition and preparation of a data base to be processed. The second is the development and use of a computer program to operate on the input data, perform certain logical operations, and finally produce output data. The output data, the third component, is then analyzed, often with the aid of machine manipulation. The output, after reduction, finally appears in reports and journal articles.

In radiation transport calculations, the three components normally take the form of (1) cross-section libraries, (2) radiation transport computer codes, and (3) radiation transport results (output).

Since inception, RSIC has been deeply involved, through its computer code library, in the second component mentioned above.

The data library collection has been developed such that it can include not only component (1), cross-section libraries, but also component (3), radiation transport results. In some cases, the volume of data from a problem may be so great that it is not feasible to publish it all. One can then publish samples of the results but place the entire output on magnetic tape for distribution, as needed, by RSIC. Processing codes for performing editing, plotting, interpolation, and certain

integrations would accompany the data. An example is the DLC-5 Hallmark data.

In addition to the two types already discussed, data are present which allow the recalculation, with a particular calculational method, of already published results. An example is the data in DLC-8 which allows the calculation of American Nuclear Society Shielding Benchmark Problem Number 3. This kind of calculation is useful for testing out a new computer code.

The abstract format used for DLC's is similar to that used to describe the code packages. Care was taken to make the format include all of the information necessary for adequately describing the contents and purpose of each data library.

The main purpose of the abstracts is to give to a potential data library user several criteria for deciding whether or not he wishes to obtain the data. In some cases, there may be significant gaps in the information given. The abstracts will be revised or updated as needed. The reader is urged to bring errors or omissions to our attention.

The abstracts included in this initial distribution were written and edited by members of the RSIC staff. In a few instances, the contributor supplied an abstract which was very useful. Ideally, the abstract should be written by individuals at the contributing installation, leaving only the job of editing to the RSIC staff. A copy of the RSIC format is included to be used as a guide for this purpose.

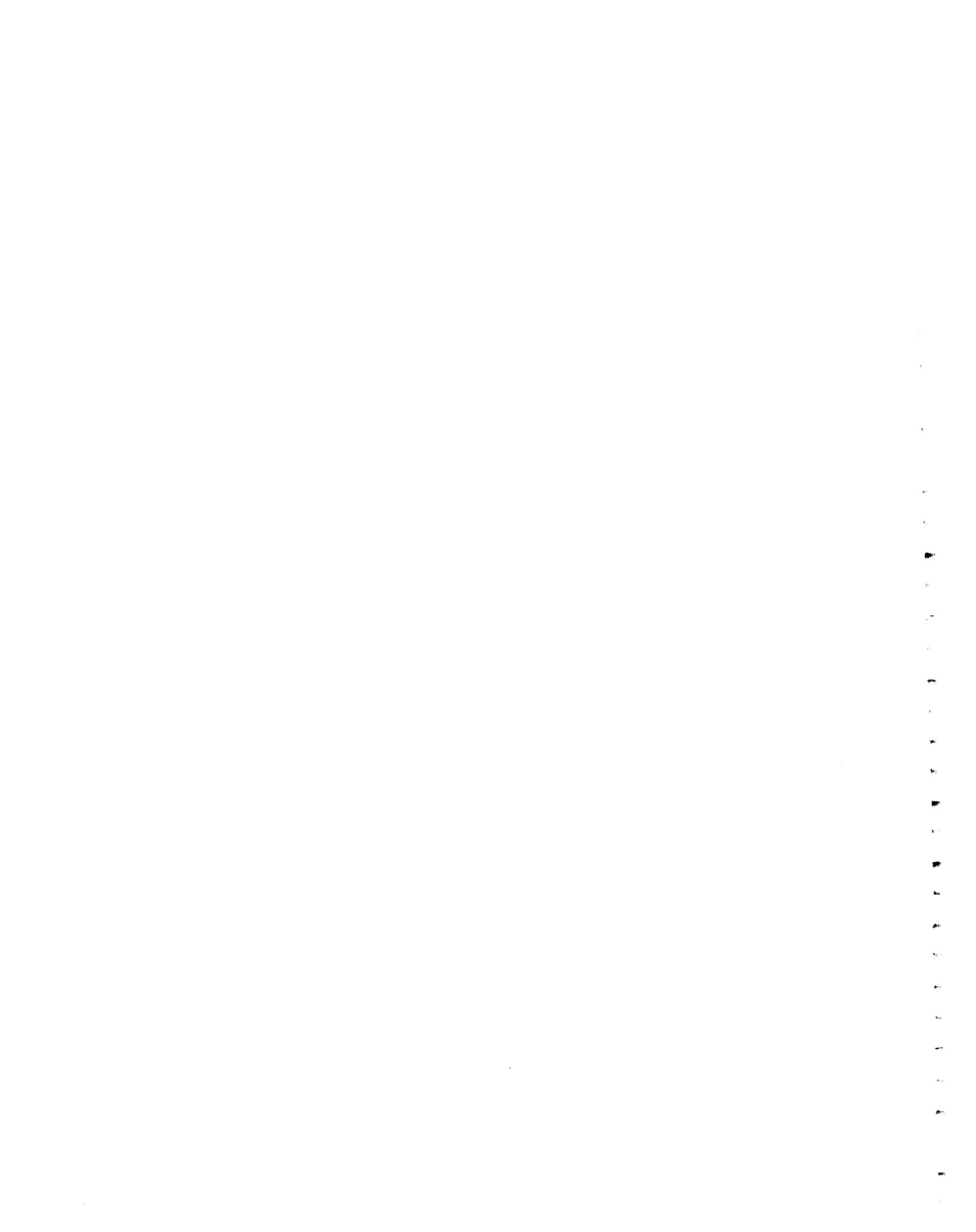
The loose-leaf notebook covers were chosen for practical reasons. From time to time, new abstracts will be issued, and existing ones will be updated, corrected, modified or deleted. The data library contributor, or any other volunteer, is invited to write to RSIC suggesting any desired change. Such changes, if coming from any other source, will be cleared with the contributor of the data library.

The RSIC staff is particularly anxious to note our contributors properly and to give credit, whenever merited. It is hoped that any lapse will be called to the attention of the Data Coordinator.

When a data library is to be placed in the RSIC collection the contributor is asked to designate an individual familiar with its purpose and contents to be available to answer questions. If the data is very complex, or if several libraries are being placed in the collection at a given time, RSIC requests that a briefing be given to members of the staff. This is ideally in the form of an informal workshop held at the contributing installation.

When data libraries are received by RSIC, they are put into the RSIC routine checking process. When fully processed, they are packaged, assigned a DLC number and an abstract is written. The distribution of an abstract indicates that in the data library described the data retrieval programs are operable, the sample problems having been run by the RSIC staff.

The sample cover, page xv, is included in this introduction to the abstracts to call attention to the cover for the documentation prepared for the data library.



RSIC ABSTRACT FORMAT - SHIELDING DATA LIBRARY COLLECTION

Pagination

In upper right corner give the number assigned to the package and the page number. Example: the four pages of the abstract for data library DLC-1 would be numbered 1.1, 1.2, 1.3, and 1.4.

Heading

RSIC Data Library DLC-NY, where N is the number assigned by the Center when the library is packaged and ready for distribution and Y is a letter representing an updated or revised version. Example: the first release of data library number 2 is called DLC-2 and the second release is called DLC-2B.

Descriptive Headings and Contents: Items 1 through 13

1. NAME AND TITLE OF DATA LIBRARY
 - a. Name given to library.
 - b. Give a descriptive title. This title should tell something of the nature of the library: the physical background of the data, the calculation (code) or experiment from which it was produced, the calculational methods (codes) in which it may be used, and any feature which distinguishes the library from others.
2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM
 - a. Name given to the retrieval program.
 - b. Give a descriptive title telling what functions the retrieval program has, i.e., does it edit, punch cards, write tapes, manipulate or operate on the **data**, etc.?
3. HISTORICAL BACKGROUND INFORMATION

Give any useful background information or history of the library. Such information should include the name of a library that might have been superseded or extended into this version. Establish credit for original work, explain a library name that has been changed, or give a specific meaning if there is one to the name selected.

4. APPLICATIONS OF THE DATA

Give a brief description of the basic purpose of the data, including, for example, the types of calculations and computer codes in which it may be used.

5. SOURCE AND SCOPE OF THE DATA

Give a description of the physical background of the data along with any experiment and/or computer codes used to generate the library, for example, the elements included, interactions considered, the angular scattering approximation, and the group structure and/or energy range covered. Appropriate references should be cited here and listed under Section 10.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

Discuss here details about the operation of the retrieval program in relation to the data in the library. It is useful to indicate other features of the program that might be of general interest.

7. CONTRIBUTORS

- a. Give name and location of installation where library was developed.
- b. If more than one installation is involved in the development, give name and location of installation with whom credit is to be shared.
- c. If an additional contribution is made to the library by an installation other than that listed in (a) or (b), give name and location of installation and itemize the addition.

8. DATA FORMAT AND COMPUTER

Make a brief statement, such as
"BCD card images; IBM 7090."

9. TYPICAL RUNNING TIME

Give enough detail to enable the potential user to estimate the running time for the retrieval program for a given choice of retrieval parameters.

10. REFERENCES

List by report author, title, number, and date:

- a. Documentation available with the library.
- b. Other documentation helpful in defining the library.

11. CONTENTS OF THE LIBRARY

Name items in the library, as

- a. documentation: listed references and any additional available material,
- b. the data and retrieval codes or auxiliary programs, relating in what form they are being distributed,
- c. software being distributed with the code package,
- d. sample problem input and output.

12. HOW TO OBTAIN LIBRARY

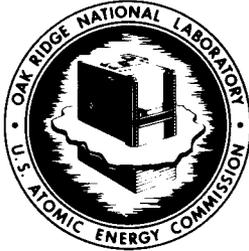
Where inquiries may be addressed.

13. DATE OF ABSTRACT AND CURRENT VERSION

The first entries here correspond to the original data library. Subsequent revisions are generally labelled by adding a capital letter to the original DLC number. Example: DLC-2 followed by DLC-2B. Any significant comments which indicate how the revised version differs from its predecessors should also be given.

DLC-2

Misc. Informal Notes
ORNL-TM-3049



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RSIC DATA LIBRARY COLLECTION

9 9 G

99-GROUP NEUTRON CROSS-SECTION DATA

BASED ON ENDF/B

Contributed by

Computing Technology Center

and

Oak Ridge National Laboratory

Union Carbide Corporation

Nuclear Division

Oak Ridge, Tennessee

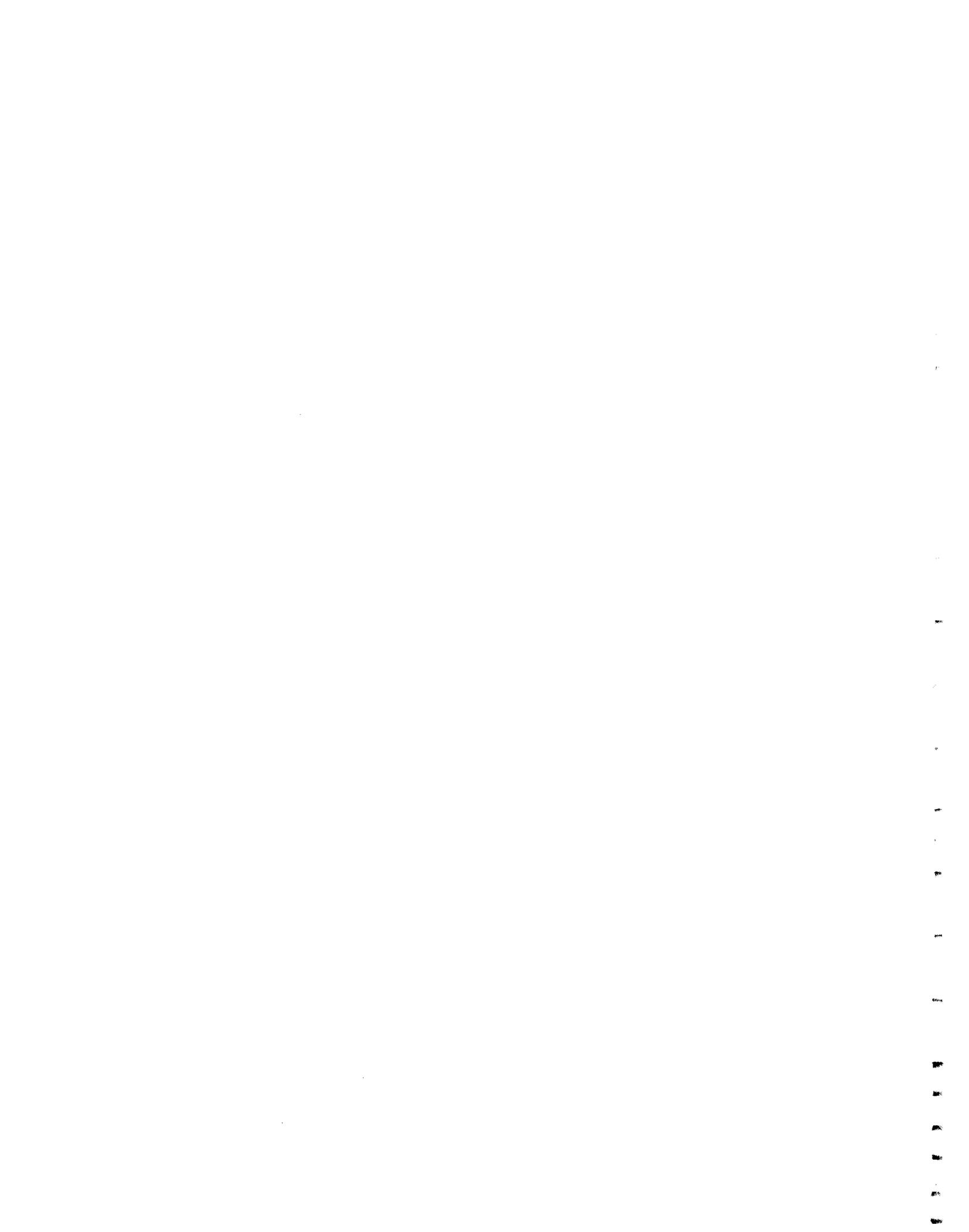
RADIATION SHIELDING INFORMATION CENTER





ALPHABETIC AND NUMERIC INDEX OF DATA LIBRARIES

<u>Data Library</u>	<u>Page No.</u>	<u>Data Library</u>	<u>Page No.</u>
AIR	DLC-14	DLC-1	LEP
AVKER	DLC-10	DLC-2	99G
BP-3	DLC-8	DLC-3	MEP
COBB	DLC-16	DLC-4	HPICO
FARS	DLC-9	DLC-5	HALLMARK
GAMLIB	DLC-6	DLC-6	GAMLIB
GARLIB	DLC-13	DLC-7	HPICE
HALLMARK	DLC-5	DLC-8	BP-3
HPICE	DLC-7	DLC-9	FARS
HPICO	DLC-4	DLC-10	AVKER
LEP	DLC-1	DLC-11	RITTS
MEP	DLC-3	DLC-12	POPLIB
POPLIB	DLC-12	DLC-13	GARLIB
RITTS	DLC-11	DLC-14	AIR
STORM-ISRAEL	DLC-15	DLC-15	STORM-ISRAEL
99G	DLC-2	DLC-16	COBB



DATA LIBRARIES, CATEGORIZED BY TYPE

1. For use as direct input to radiation transport or cross section processing codes.

MULTIGROUP (Format for CCC-82/ANISN)

- DLC-2: 99G (99 neutron, P_8 , 55 nuclides)
- DLC-8: BP-3 (22 neutron, P_5 , air)
- DLC-9: FARS (Coupled, 104 neutron, 18 gamma ray, P_8 , 9 nuclides)
- DLC-11: RITTS (Coupled, 100 neutron, 21 gamma ray, P_3 , 11 nuclides, 9 materials)
- DLC-14: AIR (Coupled, 22 neutron, 18 gamma ray, P_5 , air)

MULTIGROUP (Format for XSDRN)

- DLC-16: COBB (123 neutron, P_3 , 50 nuclides)

MULTIGROUP (Format for GGC)

- DLC-6: GAMLIB (99 neutrons, P_3 , 113 nuclides)

POINT (Format for OGRE)

- DLC 4: HPICO (Gamma rays, 87 elements)

POINT (ENDF Format)

- DLC-7: HPICE (Gamma ray, 5 cross section types, 87 elements)
- DLC-15: STORM-ISRAEL (Gamma ray, 17 cross-section types, 100 elements)

COMBINATION MULTIGROUP AND POINT (Format for POPOP4)

- DLC-12: POPLIB (Gamma-ray production, 243 data sets)

2. For use as indirect input to radiation transport codes

MULTIGROUP

- DCL-10: AVKER (Kerma factors)
- DLC-13: GARLIB (32 group neutron, resonance region, moderated tungsten and uranium slabs)

POINT

- DLC-1: LEP (Extensive data for interaction of low-energy neutrons and π -mesons on complex nuclei)

DLC-3: MEP (Extensive data for interaction of medium energy
nucleons and π -mesons on complex nuclei)

COMBINATION MULTIGROUP AND POINT

DLC-12: POPLIB (Gamma-ray production, 243 data sets)

3. Output from radiation transport calculations

MULTIGROUP (From O5R-ACTIFK-OGRE, DOT)

DLC-5: HALLMARK (Air-over-ground, coupled, differential in time,
angle, and energy)

DLC-13: GARLIB (32 group neutron cross sections and fluxes for
moderated tungsten and uranium slabs)

4. Data for repeating benchmark or other radiation transport calculations

DLC-8: BP-3 (22 neutron, P_5 , air, benchmark problem 3.0)

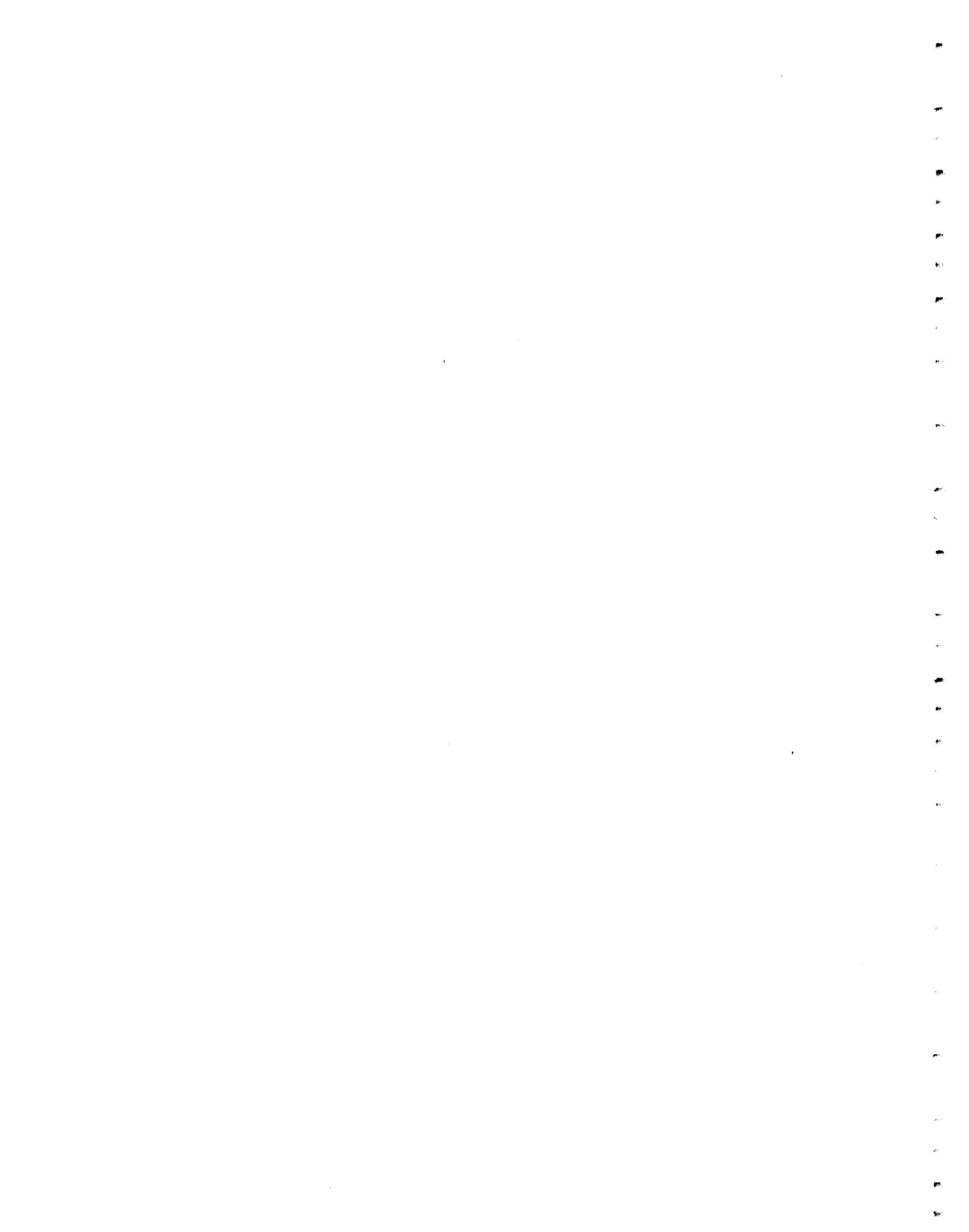
DLC-14: AIR (Coupled neutron, 22 neutron, 18 gamma ray, P_5 , air,
ORNL-4464)

LIST OF RSIC DATA LIBRARY TITLES, DESCRIPTIONS,
CONTRIBUTORS, AND PRIMARY REFERENCES

1
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Data Library Designation	Contributor ^a	Form	Data Type/Computer Code/Component
DLC-1/LEP	ORNL-N	16-mm microfilm magnetic tape machine listings	Bertini's low-energy intranuclear cascade results; output from ANALYSIS Codes I and II and from EVAP (ORNL-TM-1225, ORNL-3433).
DLC-2/99G	ORNL-N	Magnetic tape	99-group $\leq P_8$ -expanded neutron cross sections for input to ANISN/DOT/DTF-IV/MORSE; produced from ENDF/B category I version II data by SUPERTOG (1971); energy range from 14.92 MeV to 0.414 eV.
DLC-3/MECC-7	ORNL-N	16-mm microfilm, magnetic tape, machine listings	Bertini's medium-energy intranuclear cascade results; output from ANALYSIS Codes I and II and from EVAP (ORNL-TM-3336, ORNL-3433).
DLC-4/HPICO	ORNL-N	Magnetic tape	Gamma-ray photoelectric and pair-production data in OGRE format (ORNL-3805); data same as in DLC-7.
DLC-5/HALLMARK	ORNL-N	Magnetic tape	Output from DOT-05R-ACTIFK, and OGRE; Straker's time-dependent air-over-ground results for point isotropic sources; handling codes allow results for arbitrary energy spectrum; neutron sources range from 15 MeV to 3.3 keV; result include neutron and secondary gamma-ray fluxes (ORNL-4289, vol. II)
DLC-6/GAMLIB	ORNL-N	Magnetic tape	ORNL GAM-II library in GGC format; 99 neutron group, P_3 data for 113 nuclides based in part on ENDF/B-II data; neutron energy range 14.92 MeV to thermal (ORNL-TM-3334).
DLC-7/HPICE	LLL	Magnetic tape	Livermore gamma-ray interaction data in ENDF/B format; recommended as ENDF/B reference data; covers elements having Z values of 1-83, 86, 90, 92, and 94, and gamma rays having energies in the range from 1 keV to 100 MeV (UCRL-50400, vol. VI; UCRL-50174, Sect. II, May 1969).
DLC-8/BP-3	ORNL-N	Cards	22-group P_5 -expanded cross sections for air in the ANISN/DOT/MORSE format; data used by Straker for Benchmark Problem No. 3; neutron spectrum constructed from point sources in infinite air covering energy ranges from 15 MeV to thermal (ORNL-RSIC-25).
DLC-9/FARS	ORNL-N	Magnetic tape	P_8 -expanded coupled cross sections (104 neutron groups, 18 gamma-ray groups) for H, C, N, O, Mg, Al, Si, Ca, and Fe; data format for ANISN/DOT/DTF-IV/MORSE; compiled by F. Schmidt for concrete calculations (ORNL-RSIC-26); neutron energy range, 15 MeV to thermal; gamma-ray energy range, 10-0.02 MeV.
DLC-10/AVKER	ORNL-N	Magnetic tape	Data library of neutron fluence-to-kerma factors for many elements; retrieval program will compute energy group values for any composition for use with group fluence to calculate dose or heating (ORNL-TM-2558); neutron energy ranges from 19.2 MeV to 0.023 eV.
DLC-11/RITTS	ORNL-R ORNL-N CTC	Magnetic tape	P_3 -expanded coupled microscopic cross sections (100 groups, 21 gamma-ray groups) for H, C, O, N, Na, Mg, P, S, Cl, K, and Ca; 100-group neutron cross-section set alone also provided, plus coupled macroscopic cross sections for standard man, skin, bone, tissue, brain, lung, red marrow, and muscle; data format for ANISN/DOT/MORSE; neutron energy range, 15 MeV to thermal; gamma-ray energy range, 14 to 0.01 MeV (ORNL-TM-2291).
DLC-12/POPLIB	CTC ORNL-N	Magnetic tape	Compendium of neutron-induced secondary gamma-ray yield and production cross-section data; data library for PSR-11/POPOP4 code; current library has 243 data sets (1971) (CTC-INF-1004).
DLC-13/GARLIB	NASA-LE	Magnetic tape	32-group resonance-region neutron capture and scattering cross sections for moderated tungsten and uranium slabs; produced by the GAROL code; group fluxes calculated by GAROL also included for further collapsing of the group structure; energy range, 1.234 keV to 0.414 eV (NASA TM X-1909).
DLC-14/AIR	ORNL-N	Magnetic tape	ANISN input data for a P_3S_{16} coupled (22 neutron groups, 18 gamma-ray groups) transport calculations for a 12.2- to 15-MeV point source in air; output from ANISN run also provided; allows users to repeat the Straker-Gritzner infinite-air calculations (ORNL-4464).
DLC-15/STORM-ISRAEL	LASL	Magnetic tape	Los Alamos gamma-ray interaction data in ENDF format for elements from Z=1 to 100; energy range, 1 keV to 100 MeV; essentially equivalent to DLC-7 but has additional data for many derived cross sections (Nuclear Data, A7, 565-681).
DLC-16/COBB	ORNL-M	Magnetic	123-group P_3 -expanded neutron cross sections for input to XSDRN; produced from ENDF/B category I version II data by SUPERTOG-THERMOS (30 thermal groups); energy range, 14.92 MeV to thermal.

^aLibrary contributors: CTC, Computing Technology Center, Union Carbide Corp., Oak Ridge, Tenn.; NASA-LE, NASA Lewis Research Center, Cleveland, Ohio; ORNL-M, Mathematics Division, ORNL-N Neutron Physics Division, ORNL-R, ORNL Reactor Division; LLL, Lawrence Livermore Laboratory, Livermore, Calif.; LASL, Los Alamos Scientific Laboratory, Los Alamos, N.M.



ABSTRACTS OF RSIC
DATA LIBRARY PACKAGES



RSIC DATA LIBRARY DLC-1/LEP

1. NAME AND TITLE OF DATA LIBRARY

LEP: Cascade and Evaporation Particle Results from Low-Energy Intranuclear Cascade Calculations.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

No retrieval program required.

3. HISTORICAL BACKGROUND INFORMATION

This is the first library of its kind pertaining to the non-elastic interaction of energetic protons, neutrons, π^+ , and π^- mesons on complex nuclei. It represents output from running Analysis Codes I and II and EVAP, operating on data generated by LECC-15, all of which are auxiliary routines in the Low-Energy Intranuclear Cascade Code System packaged as CCC-47/LEP in the RSIC Computer Code Collection.

4. APPLICATIONS OF THE DATA

The data can be used in the calculation of the penetration of energetic protons, neutrons, π^+ or π^- mesons on thick shields. It provides the necessary information pertaining to the properties of the secondary particles that are emitted when the particles that are being transported through the shield collide with the nuclei of the elements of the shield.

The data can also be used in the design of experiments where thin targets are used and counting rates and backgrounds must be estimated, and it can be used in the theoretical interpretation of many of the results in these experiments.

5. SOURCE AND SCOPE OF THE DATA

The source of the data is the code LECC-15 (packaged in CCC-47/LEP). The nuclear model and physical assumptions incorporated in this code are described in ref. 3. The nonelastic interactions considered are for incident protons and neutrons with energies

varying from 25 to 400 MeV and π^+ and π^- mesons with energies ranging from 25 to 300 MeV on 12-C, 16-O, 27-Al, 52-Cr, 65-Cu, 100-Ru, 190-Ce, 184-W, 207-Pb, and 238-U. The type of information available from these reactions is described in detail in refs. 1 and 4.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

No retrieval program is required.

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD output, IBM 7090.

9. TYPICAL RUNNING TIME

Does not apply.

10. REFERENCES

a. Documentation available with library:

- (1) Hugo W. Bertini, "Results from Low-Energy Intranuclear Cascade Calculation," ORNL-TM-1225 (September 1965).
- (2) H. W. Bertini, "Description of Printed Output from Intranuclear Cascade Calculation," ORNL-3433 (May 1963).

b. Other documentation helpful in defining library:

- (3) Hugo W. Bertini, Phys. Rev. 131, 1801 (1963), with erratum, Phys. Rev. 138, AB2 (1965).
- (4) Hugo W. Bertini, Nucl. Phys. 87, 138 (1966).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. The documentation listed in 10a above;
- b. The data library in one of either form below:
 1. the printed results on the microfilm, or

2. the BCD output listing written on 10 reels of magnetic tape. (The data are so voluminous that requestors are asked to first make inquiries at the address listed below before transmitting tape reels for the data.)

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to:

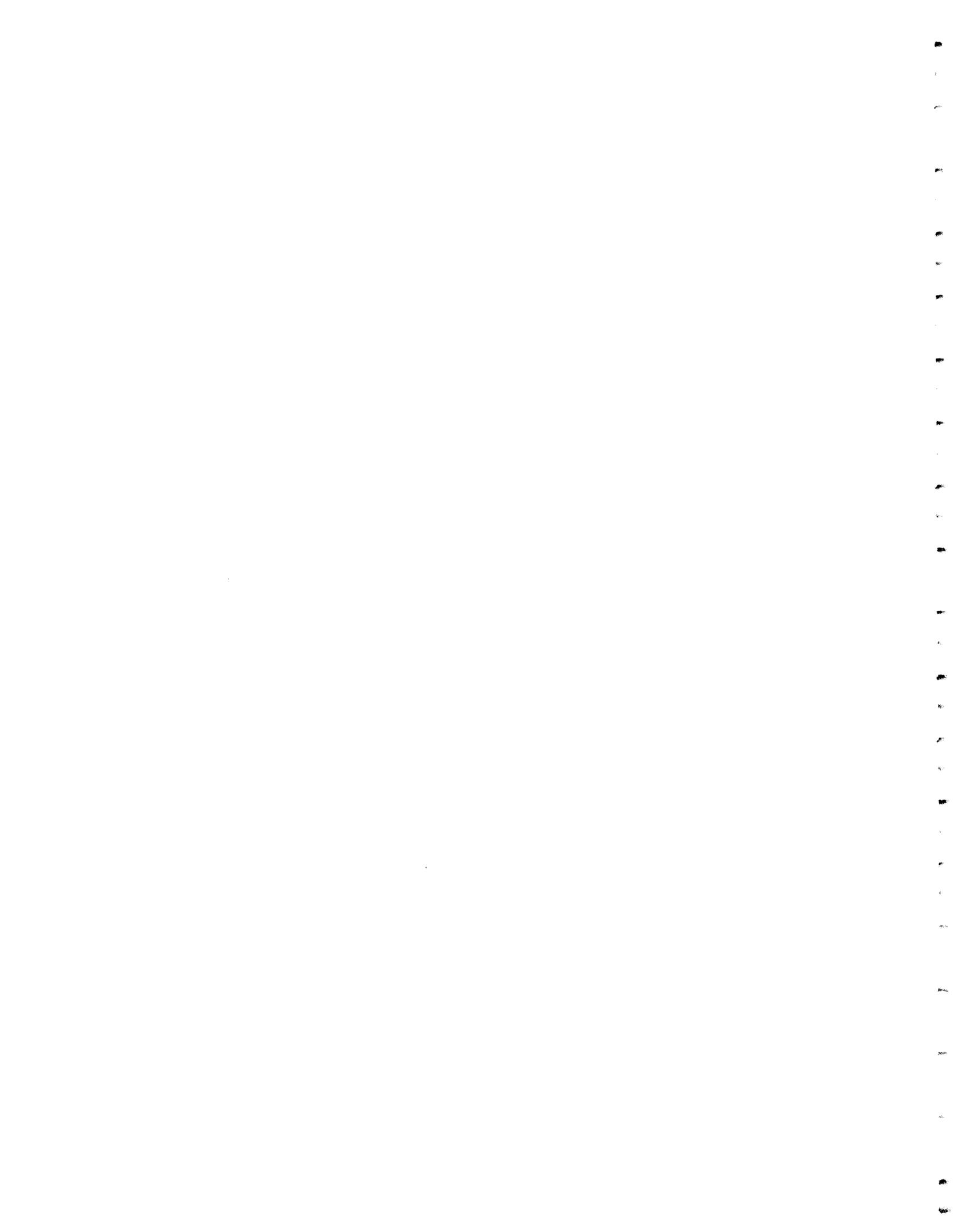
DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to:

Area Code 615; 483-8611, extension 3-6944, or to
FTS XX-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

December 1971.



RSIC DATA LIBRARY DLC-2/99G

1. NAME AND TITLE OF DATA LIBRARY

99G: 99-Group Neutron Transport Code Cross Section Data
Generated by SUPERTOG from ENDF/B.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAMS

SUPRET: A Program to Edit or Convert SUPERTOG Output to
Forms Suitable for Input to ANISN or DTF-IV (see
item 6).

APRFX-I: A Program to Collapse and Combine DLC-2 Cross-Section
Data.

3. HISTORICAL BACKGROUND INFORMATION

The DLC-2 data was produced to provide users of multigroup transport codes with a library based on the current ENDF/B category I point cross section data. The philosophy is to provide a fine-group set which is based on data that is reasonably well documented and which has undergone recent evaluation. The ENDF/B data meets both these requirements. The data was generated by R. Q. Wright of the ORNL Mathematics Division. See Section 13 for identification of the latest version of DLC-2.

4. APPLICATIONS OF THE DATA

Neutron transport calculations for non-thermal energies can be performed with DLC-2 data. Since the data are intended for use in multigroup discrete-ordinates or Monte Carlo transport codes which treat anisotropic scattering, possible cross section angular expansion is limited only by the options available in the particular code used. Specifically, the retrieval program manipulates DLC-2 such that it conforms to input requirements of the CCC-82/ANISN,⁹ CCC-89/DOT,¹⁰ or CCC-42/DTF-IV¹¹ codes, or any computer code using data in the ANISN or DTF-IV format.

5. SOURCE AND SCOPE OF THE DATA

DLC-2 was generated by PSR-13/SUPERTO¹² from nuclear data in either point-by-point or parametric representation as specified by ENDF/B.¹³ This data is averaged over each specified group width. The explicit assumption was made that the flux (weighting function) per unit lethargy was constant. When resonance data were available, resolved and unresolved resonance contributions were calculated, using the infinite dilution approximation. DLC-2 consists of fine group constants such as one-dimensional reaction arrays (absorption, fission, etc.), P_n elastic scattering matrices, and inelastic and (n,2n) scattering matrices which were generated, combined and written on tape as card images in the ANISN format. The units are barns rather than cm^2 .

DLC-2 represents a P_8 approximation to elastic scattering angular distributions. The data have a 100-group structure with energy group boundaries identical to those in the GAM-II¹⁴ library, with a group 1 upper boundary energy of 14.92 MeV and a group 99 lower energy of 0.414 eV. The group-to-group transfer matrices reflect only downscatter in energy, and group 100 serves as a "sink" group, itself having no data to describe absorption, fission, and scattering.

The nuclides in DLC-2 are those which have been released as Category I ENDF/B by the National Neutron Cross Section Center, Brookhaven National Laboratory. The library contains data for H, D, He, 6-Li, 7-Li, 9-Be, 10-B, 12-C, 14-N, 16-O, 23-Na, Mg, 27-Al, Ti, V, Cr, 55-Mn, Fe, Ni, Cu, 63-Cu, 65-Cu, 93-Nb, Mo, 135-Xe, 149-Sm, 151-Eu, 153-Eu, Gd, 164-Dy, 175-Lu, 176-Lu, 181-Ta, 182-W, 183-W, 184-W, 186-W, 185-Re, 187-Re, 197-Au, 232-Th, 233-U, 234-U, 235-U, 236-U, 238-U, 237-Np, 238-Pu, 239-Pu, 240-Pu, 241-Pu, 242-Pu, 241-Am, 243-Am, and 244-Cm.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAMS

There are two retrieval programs packaged with DLC-2, SUPRET and APRFX-I.

2.3

SUPRET (called the SUPERTOOG Data Retrieval Program in Ref. 12) will retrieve DLC-2 data from a maximum of four tapes and merge these data onto one tape. The program will then, by input option, edit the data, punch cards in either the ANISN or DTF-IV format, or write an unformatted tape for use by ANISN. The program was written by the authors of the SUPERTOOG program.

APRFX-I collapses the fine group cross sections to a broad group structure according to a flux spectrum either input by the user or calculated by the code. The code will average the fine group cross sections to form either macroscopic or microscopic isotope cross sections and any combination of macroscopic mixtures of these cross sections on the same problem. It also determines the broad group input source and generates averaged neutron velocities for use with transport calculations.

7. CONTRIBUTORS

Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD card image; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

Using the SUPRET retrieval program to produce an unformatted tape, for use by ANISN, containing elements hydrogen and oxygen for P_8 expansion requires approximately 2 minutes on the IBM 360/65.

To compile APRFX-I and collapse 100 group P_1 cross section to 7 groups using generated spectra requires 35 seconds on the IBM 360/91.

10. REFERENCES

a. Documentation available with library

(1) R. Q. Wright, "User's Manual for SUPERTOOG DATA RETRIEVAL Program," informal notes April 1969).

(2) R. W. Roussin, "Comments on ANISN and DTF-IV Format," informal notes (1969).

2.4

- (3) R. W. Roussin, "Adding Thermal Neutron Cross Section to DLC-2," informal note (1969).
 - (4) "99-Group Energy Structure and Fission Sources for Use in Discrete Ordinates Codes," taken from Ref. 12 below.
 - (5) R. W. Roussin, "Using ANISN to Reduce the DLC-2 100-Group Cross-Section Data to a smaller Number of Groups," ORNL-TM-3049 (May 1969).
 - (6) J. B. Wright and R. W. Roussin, "Comments on Reactions Included in the SUPERTOG Procedure and a Compilation of File 1 Information Listing References for the ENDF/B Data," informal notes (1971).
 - (7) P. S. Pickard and D. O. Williams, "Calculated Neutron Energy Spectra for the APRF Reactor," Memo for Record AMXRD-BNL (September 1970).
 - (8) P. S. Pickard, "APRFX-I, Neutron Cross Section Collapsing Code," Memo for Record, AMXRD-BNL (December 1970).
- b. Other documentation helpful in defining library
- (9) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967).
 - (10) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967).
 - (11) K. D. Lathrop, "DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering," LA-3373 (November 1965).
 - (12) R. Q. Wright, N. M. Greene, J. L. Lucius, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (Sept. 1969).
 - (13) M. K. Drake, Editor, "Data Formats and Procedures for the ENDF Neutron Cross Section Library," BNL-50274 (T-601) (ENDF 102, Vol. 1) (October 1970).

- (14) G. D. Joanou and J. S. Dudek, "GAM-II: A B₃ Code for the Calculation of Fast-Neutron Spectra and Associated Multigroup Constants," GA-4265 (1963).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in section 10a above,
- b. depending on the user's needs, a reel of magnetic tape or tapes with contents as listed below:
 - (1) 7-track, 556 bpi (unblocked)
 - 1 tape for 16 nuclides,
 - 1 tape for 21 nuclides,
 - 1 tape for the remaining 18 nuclides,
 - 1 tape for retrieval program, sample input and output.
 - (2) 9-track, 800 bpi (blocked)
 - 1 tape for entire library plus retrieval programs.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
 Radiation Shielding Information Center
 Oak Ridge National Laboratory
 P. O. Box X
 Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
 FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

February 1971.

DLC-2C is the library based on ENDF/B Version II Data. This ENDF release included data for nuclides listed in section 5 above

2.6

except for 6-Li, 7-Li, and 14-N. The DLC-2 data for these nuclides is taken from DLC-2B, which was based on the ENDF/B Version I data.

December 1971.

(1) APRFX-I code, sample input and output added to DLC-2.

(2) Li-6, Li-7 data based on UKAEA evaluations. DFN 214, 215, converted to ENDF/B format with UKE-II and processed through SUPERTOG by R. Q. Wright.

3.1

RSIC DATA LIBRARY DLC-3/MEP

1. NAME AND TITLE OF DATA LIBRARY

MEP: Cascade and Evaporation Particle Results from Medium Energy Cascade Calculation.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

No retrieval program required.

3. HISTORICAL BACKGROUND INFORMATION

This library is an extension to higher energies of that described in DLC-1/LEP, i.e., it gives results pertaining to the nonelastic interaction of high energy ($E \leq 3$ GeV) protons, neutrons, π^+ and π^- mesons on complex nuclei.

It represents output from running Analysis Codes I and II and EVAP, operating on data generated by MECC-7, all of which are auxilliary routines in the Medium-Energy Intranuclear Cascade Code System packaged as CCC-156/MEP in the RSIC Computer Code Collection.

4. APPLICATIONS OF THE DATA

The data can be used in the calculation of the penetration of energetic protons, neutrons, π^+ or π^- mesons on thick shields. It provides the necessary information pertaining to the properties of the secondary particles that are emitted when the particles that are being transported through the shield collide with the nuclei of the elements of the shield.

The data can also be used in the design of experiments where thin targets are used and counting rates and backgrounds must be estimated, and it can be used in the theoretical interpretation of many of the results in these experiments.

5. SOURCE AND SCOPE OF THE DATA

The source of the data is the code MECC-7 (packaged in CCC-156/MEP). The nuclear model and physical assumptions incorporated into

3.2

this code are described in refs. 3 and 4. The nonelastic interactions considered are for incident protons and neutrons with energies ranging 0.5 to 3 GeV and π^+ and π^- mesons with energies from 0.5 to 2.5 GeV on 16-O, 27-Al, 65-Cu, 100-Ru, and 207-Pb. The type of information available is described in detail in refs. 1 or 5.

6. DISCUSSION OF DATA RETRIEVAL PROGRAM

No retrieval program required

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD output, IBM 360/75/91.

9. TYPICAL RUNNING TIME

Does not apply.

10. REFERENCES

a. Documentation available with library:

- (1) Hugo W. Bertini and Miriam P. Guthrie, "Results from Medium-Energy Intranuclear Cascade Calculation," ORNL-TM-3336 (1970).
- (2) H. W. Bertini, "Description of Printed Output from Intranuclear Cascade Calculation," ORNL-3433 (1963).

b. Other documentation useful in defining library:

- (3) Hugo W. Bertini, Phys. Rev. 188, 1711 (1969).
- (4) Hugo W. Bertini (to be published in Phys. Rev. C).
- (5) Hugo W. Bertini and Miriam P. Guthrie, Nucl. Phys. A169, 670 (1971).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. the printed results on microfiche.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to:

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to:

Area Code 615; 483-8611, extension 3-6944, or
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

December 1971



RSIC DATA LIBRARY DLC-4/HPICO

1. NAME AND TITLE OF DATA LIBRARY

HPICO: Evaluated Photon Interaction Library in OGRE BCD Format.

2. NAME AND TITLE OF RETRIEVAL PROGRAMS

OGRE MASTAPE: Photon Interaction Cross Section Library and Data Handling Code.

PRINT SIG: An OGRE Routine to Print Gamma-Ray Total Cross Sections and Energy Deposition Coefficients.

3. HISTORICAL BACKGROUND INFORMATION

The original OGRE library (No. 1) compiled in 1962 was a combination of data from Grodstein [X-Ray Attenuation Coefficients from 10 keV to 100 MeV, NBS Circular 583 (1957)] and from Storm and Israel [Gamma-Ray Absorption Coefficients for Elements 1 Through 100 Derived from the Theoretical Values of the National Bureau of Standards, LA-2237 (1958)]. When the data of McMaster *et al.*⁴ and Plechaty and Terrall⁵ became available, the OGRE library was updated by adopting their photoelectric and pair production cross sections. Library No. 3 was established July 1969.

4. APPLICATIONS OF THE DATA

The photoelectric and pair-production cross sections provided are normally combined with Compton cross sections in transport codes such as OGRE to provide the data needed for transport calculations.

5. SOURCE AND SCOPE OF THE DATA

The photoelectric and pair-production data available as part of DLC-7 are reformatted to produce DLC-4.* Each energy point has a

*It is anticipated that eventually the OGRE format and DLC-4 will be abandoned and data will be made available only in ENDF/B format. In the meantime, DLC-4 provides a convenient link between new evaluations and OGRE.

4.2

value for both cross sections. When necessary, values are obtained by interpolation. The basic data are from Lawrence Radiation Laboratory, Livermore evaluation.^{4,5}

The data are given for energies 1 keV to 100 MeV and for elements $Z = 1-83, 86, 90, 92,$ and 94 . The tables are identified by atomic number (Z).

The number of atoms per gram are given with each element which permits composition data to be given in OGRE input in terms of partial densities.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAMS

The MASTAPE¹ program reads the DLC-4 BCD photon photoelectric and pair-production data and produces a binary master tape organized by element for the OGRE transport code system (Ref. 3). Edit and revision capabilities are available.

The PRINT-SIG² code contains the basic OGRE cross-section routines which produce macroscopic cross-section tables and provide look-up capability. The code is designed to print tables of total and energy-deposition coefficients for any media defined by input.

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD card Image; IBM 360/75/91.

9. TYPICAL RUNNING TIME

MASTAPE: To compile, produce a binary tape, and edit the entire library requires less than seconds on the IBM 360/91.

PRINT-SIG: To compile and print tables for H and H₂O requires less than 5 seconds on the IBM 360/91.

10. REFERENCES

- a. Documentation available with library
 - (1) D. K. Trubey and H. E. Francis, "OGRE MASTAPE - Photon Interaction Cross Section Library and Data Handling Code," ORNL-TM-3046 (1969).
 - (2) D. K. Trubey, "PRINT-SIG, An OGRE Routine to Print Gamma-Ray Total Cross Sections and Energy Deposition Coefficients," ORNL-TM-3048 (1968).
- b. Other documentation helpful in defining library
 - (3) S. K. Penny, D. K. Trubey, and M. B. Emmett, "OGRE, A Monte Carlo System for Gamma-Ray Transport Studies, Including an Example (OGRE-P1) for Transmission Through Laminated Slabs," ORNL-3805 (1966). (Code available from RSIC as CCC-46.)
 - (4) W. H. McMaster *et al.*, "Compilation of X-Ray Cross Sections," UCRL-50174, Sec. II, Rev. 1 (May 1969).
 - (5) E. F. Plechaty and J. R. Terrall, "Photon Cross Sections 1 keV to 100 MeV," UCRL-50400, Vol. VI (1968).

11. CONTENTS OF LIBRARY

- a. The references listed in section 10a above,
- b. One reel of magnetic tape containing the library, retrieval programs, and sample input and output.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to
DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-4966, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

December 1969.

DLC-4C (same data as DLC-7C).

RSIC DATA LIBRARY DLC-5/HALLMARK

1. NAME AND TITLE OF LIBRARY

HALLMARK: Discrete Ordinates and Monte Carlo Results of Neutron and Secondary Gamma-Ray Transport in Air-Over-Ground Geometry.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAMS

REPUT: An Edit Program for DOT Discrete Ordinates Neutron and Secondary Gamma-Ray Results.

DOTCOM: A Program for Combining DOT Discrete Ordinates Neutron and Secondary Gamma-Ray Results for Different Source Energies into Results for an Arbitrary Source Spectrum.

BSDPRINT: An Edit Program for O5R-ACTIFK-OGRE Neutron and Secondary Gamma-Ray Results.

BSDCOM: A Program for Combining O5R-ACTIFK-OGRE Neutron and Secondary Gamma-Ray Results for Different Source Energies into Results for an Arbitrary Source Spectrum.

ANGLE8: An Edit Program for O5R-ACTIFK Angular Dependent Neutron Results.

BSDCOM8: A Program for Combining O5R-ACTIFK Angular Dependent Neutron Results for Different Source Energies into Results for an Arbitrary Source Spectrum.

3. HISTORICAL BACKGROUND INFORMATION

The DOT and O5R-ACTIFK-OGRE results for neutron and secondary gamma-ray results in air-over-ground geometry were generated by E. A. Straker² of the Neutron Physics Division of Oak Ridge National Laboratory. The results were preserved on magnetic tape and are available to workers wishing to utilize them.

4. APPLICATIONS OF THE DATA

DLC-5 data can be used to study the energy, time, and angular

distribution of neutrons and secondary gamma rays as a function of slant range from a point isotropic neutron source 50 ft above the air-ground interface. The data are for neutron sources in given energy bands. Some of the retrieval programs can be used to edit the data in tabular form as in Ref. 2. Other retrieval programs can combine results for various neutron source energies to give the results for a neutron source of arbitrary energy spectrum.

5. SOURCE AND SCOPE OF THE DATA

DLC-5 data are results of Monte Carlo (O5R³- ACTIFK⁴- OGRE⁵) and discrete ordinates (DOT⁶) calculations of neutron fluxes and doses and secondary gamma-ray fluxes and doses due to a point isotropic neutron source located 50 ft in air above the ground surface. Sources of various energies up to 15 MeV were used and slant ranges up to 1500 meters were considered. The neutron source energy range from 0.111 to 15 MeV was divided into 8 non-overlapping intervals and separate calculations were made for each interval in which the source was assumed constant in energy. The discrete ordinates calculations considered one more interval from 3.3 to 111 keV, in which the source was assumed to be proportional to 1/E.

Information about the composition assumed for air and ground, the source energy bands and slant ranges chosen, the angular quadrature employed, and the dose conversion factors used is given in the first 23 pages of Ref. 2. For convenience these pages are being packaged with the DLC-5 documentation.

The Monte Carlo results include time-integrated and time-dependent neutron and gamma-ray dose rate as a function of slant range. Neutron fluxes for various time and energy bins for two directions are given for each range. Gamma-ray fluxes for various time and energy bins for four directions are also given for each range. Neutron fluxes for various time and energy bins for 8 angles are given for two slant ranges, 350.3 and 975.1 meters. Fractional standard deviations for all the above quantities are included in the DLC-5 data. The Monte Carlo results considered distributions of

neutrons with energies greater than 0.1 MeV and also the corresponding distributions of secondary gamma rays produced by inelastic scattering and fast-neutron capture. The Monte Carlo results that include the 2-direction neutron data occupy 8 files of computer tape, each file corresponding to one of the eight neutron source energy intervals studied (non-overlapping energy intervals between 0.111 and 15 MeV). The eight-direction neutron results are contained on one additional file of computer tape.

The discrete ordinates results for each of the 40 energy groups include the fluence in 40 directions for each slant range. The 40 energy groups include 22 neutron and 18 gamma-ray groups. The calculations were S_8P_3 with a total of 2790 mesh points. Neutrons of all energies were considered as well as the corresponding secondary gamma rays. The discrete ordinates results occupy 9 files of computer tape, each file corresponding to one of the 9 neutron source energy intervals studied (non-overlapping energy groups between 3.3 keV and 15 MeV).

6. DISCUSSION OF DATA RETRIEVAL PROGRAMS

There are six programs packaged with DLC-5. An edit and a combination program are provided for each of the three types of data (9 files of discrete ordinates results, 8 files of Monte Carlo results, and 1 file of Monte Carlo results for 8 directions).

REPUT is the edit program for discrete ordinates results. It will edit any or all of the nine files of HALLMARK discrete ordinates results and will produce tables like those shown in Ref. 2. It will also edit results for an arbitrary source spectrum which have been produced by program DOTCOM.

DOTCOM operates on the same HALLMARK data as REPUT. It produces results for an arbitrary source spectrum, edits these results in the same format as REPUT, and will write the results on tape for later use. The fraction of source particles in each of the nine non-overlapping energy intervals is input by means of cards. The results for several different sources may be produced in the same run.

Program BSDPRINT edits the 8 files of HALLMARK Monte Carlo results and produces tables like those in Ref. 2. It will also edit results for an arbitrary source spectrum which have been produced by BSDCOM.

BSDCOM operates on the same HALLMARK Monte Carlo results as BSDPRINT. It produces results for an arbitrary source spectrum and punches them on cards for subsequent editing by BSDPRINT. The user specified the fraction of neutrons in each of the eight source energy intervals.

ANGLE8 is the edit program for the one file of HALLMARK eight angle Monte Carlo results in the format shown in Ref. 2. It will also edit results from BSDCOM8.

BSDCOM8 (also denoted as BSDCOM[8ANGLE] in Ref. 1) produces results for an arbitrary spectrum as specified by the user. It operates on the same HALLMARK data as ANGLE8 and punches results on cards for subsequent editing by the latter program.

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

EBCDIC card image; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

Times on the IBM 360/91 for compiling and running the packaged sample problems (m = minutes, cpu = central processing unit):

REPUT	1/2 m cpu,	2 m total
DOTCOM	1 m cpu,	6 1/2 m total
BSDPRINT	1/2 m cpu,	2 m total
BSDCOM	1/2 m cpu,	2 m total
ANGLE8	1/10 m cpu,	1/2 m total
BSDCOM8	1/5 m cpu,	1 m total

10. REFERENCES

a. Documentation available with library:

- (1) C. L. Thompson, I. J. Brown, and R. W. Roussin, "User's Manual for Programs to Edit and Combine DLC-5/HALLMARK Calculational Results of Neutron and Secondary Gamma-Ray Transport in Air-Over-Ground Geometry," ORNL-TM-3129 (September 1970).
- (2) E. A. Straker, "Time-Dependent Neutron and Secondary Gamma-Ray Transport in Air-Over-Ground Geometry, Vol. II: Tabulated Data," ORNL-4289, Vol. II (September 1968). Only the first 23 pages are supplied with the library.

b. Other documentation helpful in defining library:

- (3) D. C. Irving, R. M. Freestone, Jr., and F. B. K. Kam, "O5R, A General-Purpose Monte Carlo Neutron Transport Code," ORNL-3622 (February 1965).
- (4) F. B. K. Kam and K. D. Franz, "ACTIFK, A General Analysis Code for O5R," ORNL-3856 (September 1966).
- (5) D. K. Trubey and M. B. Emmett, "OGRE-G, An OGRE System Monte Carlo Code for the Calculation of Gamma-Ray Dose Rate at Arbitrary Points in an Arbitrary Geometry," ORNL-TM-1212 (January 1966).
- (6) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967).

11. CONTENTS OF LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above;
- b. depending on the user's needs, two or more reels of magnetic tape with contents as listed below:

(1) Using 7 track, 556 bpi (unblocked)

- 1 reel of tape containing 5 files of the discrete ordinates results,
- 1 reel of tape containing 4 files of the discrete ordinates results,
- 1 reel of tape containing 9 files of Monte Carlo results,
- 1 reel of tape containing the retrieval programs, sample input and output;

(2) Using 9 track, 800 bpi (blocked)

- 1 reel of tape containing 18 files of results, and
- 1 reel of tape containing the retrieval programs, sample input and output.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

September 1970.

DLC-5.

RSIC DATA LIBRARY DLC-6/GAMLIB

1. NAME AND TITLE OF DATA LIBRARY

GAMLIB: 99-Group Neutron Cross Sections for Use in the GAM
Portion of the GGC Multigroup Cross Section Code.

2. NAME AND TITLE OF THE DATA RETRIEVAL PROGRAMS

Two retrieval programs are supplied with DLC-6:

CONVERSION: A Program for Converting GAMLIB Cross Sections
from Binary to BCD or Vice Versa.

MERGE: A Program for Merging Two Existing GGC Library
Tapes Onto a New GGC Library Tape.

3. HISTORICAL BACKGROUND INFORMATION

The original GAM library was obtained from General Atomic in 1964. Since then, much of the data has been revised and improved by individuals at ORNL. In addition, ENDF/B³ data have been processed through SUPERTOG⁴ and the results added to the ORNL GAM library.⁵

The GAM II program⁶ has been replaced at ORNL as a principle reactor design tool by the program XSDRN.⁷ The GAM library is still maintained since needs for GAM processing occasionally arise, the library contains a great deal of data not yet converted to XSDRN format, and the production of an XSDRN data set from ENDF/B data now requires a GAM data set as an intermediate step. When these restrictions are overcome, it is anticipated that the library will be quietly retired. However, since much of the current ORNL GAM library is based on ENDF/B it was felt that it would be useful to make some of the ORNL GAM library generally available.

4. APPLICATIONS OF THE DATA

GAMLIB is intended to be a source of neutron multigroup data for the fast (GAM) portion of the GGC Multigroup Cross Section

Codes (refs. 8 through 11). It supplements the library available from RSIC in the PSR-12/GGC code package.

5. SOURCE AND SCOPE OF THE DATA

GAMLIB is a multigroup library, meaning, in this case, that detailed cross-section data has been averaged with "1/E" weighting to yield average cross sections over 99 energy bands covering the energy range from 14.92 MeV to 0.414 eV. In addition, the GAM program accepts resonance cross-section data in the form of single level Breit Wigner parameters to perform resonance self-shielding calculations. Some of the data is presented in this form. In general, where resonance data is available, two data sets will be present, one containing the resonance parameters and the other, the group averaged values of the unshielded resonance cross sections. Elastic and inelastic scattering are represented by group to group transfer matrices, the elastic data having P_3 scattering arrays.

GAMLIB I.D. numbers of nuclides on the tape are of the form Z.AAAS, where Z is the atomic number and AAA the atomic weight. For the naturally occurring element, AAA = 000. The parameter S is 8 or 9, depending on whether the cross sections are for the infinite dilution form or are given as resonance parameters, respectively. For example, the I.D. numbers for 63-Cu are 29.0638 for infinite dilution and 29.0639 for resonance.

The library contains data for 2-H, He, 6-Li, 7-Li, 9-Be, 10-B, 12-C, 14-N, 16-O, 23-Na*, Mg, 27-Al, Ti, V, Cr, 55-Mn*, Fe, Ni, Cu, 63-Cu*, 65-Cu*, 81-Br, 82-Kr, 83-Kr, 84-Kr, 85-Kr, 86-Kr, Rb, 88-Sr, 90-Sr, 93-Nb*, Mo, 100-Ru, 105-Rh, 104-Pd, 126-Te, 132-Xe, 133-Xe, 134-Xe, 135-Xe, 134-Cs, 134-Ba, 139-La, 140-Ce, 142-Ce, 144-Nd, 148-Sm, 149-Sm*, 151-Eu*, 153-Eu*, Gd, 164-Dy*, 175-Lu*, 176-Lu*, 181-Ta*, 182-W*, 183-W*, 184-W*, 186-W*, 185-Re*, 187-Re*, 197-Au*, 207-Pb, 232-Th*, 233-U**, 234-U*, 235-U*, 236-U*, 238-U*, 237-Np*, 238-Pu*, 239-Pu*, 240-Pu*, 241-Pu*, 242-Pu*, 241-Am*, 243-Am*, 244-Cm*, NSFP***, SSFP***.

*Two I.D. numbers, one for resonance, one for infinite dilution.

**Resonance nuclide only.

***NSFP = non saturating fission product pseudo element

SSFP = slowly saturating fission product pseudo element.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAMS

Two programs are provided for manipulating the DLC-6/GAMLIB data. These were written for RSIC by J. L. Lucius of the ORNL Mathematics Division.

The first code, CONVERSION, has two functions. It was used to copy the master tape (unformatted) onto several tapes (formatted) in order that the data may be easily transmitted between installations. CONVERSION can then be used at the receiving installation to re-create a single master tape (unformatted). The resulting tape can then be used with a GGC program.

The second code, MERGE, merges selected nuclides from two existing library tapes onto a new library tape which can be used with GGC.

7. CONTRIBUTORS

Oak Ridge National Laboratory, Oak Ridge, Tennessee.

General Atomic, San Diego, California.

8. DATA FORMAT AND COMPUTER

BCD card images; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

CONVERSION: To convert GAMLIB from a single unformatted tape to 9 formatted tapes required 10 minutes on the IBM 360/91.

MERGE: No running time estimate available.

10. REFERENCES

a. Documentation available with library:

(1) Pages 35-37 of Ref. 5 below.

(2) J. L. Lucius, "The Computer Programs CONVERSION and MERGE, Aids in Exchange and Use of ORNL GAM II Cross Section Libraries," informal notes (1971).

b. Other documentation Helpful in Defining Library:

- (3) M. K. Drake, Editor, "Data Formats and Procedures for the ENDF Neutron Cross Section Library," BNL-50274 (ENDF 102, Vol. 1) (1970).
- (4) R. Q. Wright, J. L. Lucius, N. M. Greene, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (1969). Available from RSIC as PSR-13/SUPERTOG.
- (5) J. L. Lucius, J. D. Jenkins, and R. Q. Wright, "The INDEX Data System: An Index of Nuclear Data Libraries Available at ORNL," ORNL-TM-3334 (1971).
- (6) G. D. Joanou and J. S. Dudek, "GAM-II: A B_3 Code for the Calculation of Fast-Neutron Spectra and Associated Multi-group Constants," GA-4265 (1963).
- (7) N. M. Greene and C. W. Craven, Jr., "XSDRN: A Discrete Ordinates Spectral Averaging Code," ORNL-TM-2500 (1969). Available from RSIC as CCC-123/XSDRN.
- (8) J. Adir and K. D. Lathrop, "Theory and Methods Used in the GGC-4 Multigroup Cross Section Code," GA-9021 (1968). Available from RSIC as PSR-12B/GGC-4.
- (9) J. Adir and K. D. Lathrop, "Theory of Methods Used in the GGC-3 Multigroup Cross Section Code," GA-7156 (1967). Available from RSIC as PSR-12A/GGC-3.
- (10) J. Adir, S. S. Clark, R. Froehlich, and L. J. Todt, "Users' and Programmers' Manual for the GGC-3 Multigroup Cross Section Code," GA-7157 (1967).
- (11) M. K. Drake, C. V. Smith, and L. J. Todt, "Description of Auxiliary Codes Used in the Preparation of Data for the GGC-3 Code," GA-7158 (1967).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. depending on the users' needs, one or more reels of magnetic tape with contents as listed below:
 - (1) 7-track, 556 bpi (9 tapes, unblocked), each tape containing about 13 data sets with the retrieval programs written on the 9th tape reel.
 - (2) 9-track, 800 bpi (blocked),
1 reel of tape for entire library plus retrieval programs.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN THE LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

December 1971, DLC-6.



RSIC DATA LIBRARY DLC-7/HPICE

1. NAME AND TITLE OF DATA LIBRARY

HPICE: Evaluated Photon Interaction Library, ENDF/B File
23 Format.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

EDIT-23: A Program to Edit File 23 ENDF/B Photon Interaction
Data.

3. HISTORICAL BACKGROUND INFORMATION

In 1969, Lawrence Radiation Laboratory, Livermore, California, placed the data of Refs. 3-4 (data of Ref. 3 below 1 MeV, data of Ref. 4 above 1 MeV) into ENDF/B format and sent it to RSIC. The data were examined by RSIC, reviewed by J. H. Hubbell of NBS, and made available by RSIC. In 1970, an *ad hoc* group of the Shielding Subcommittee, Cross Section Evaluating Working Group, reviewed the current evaluations and recommended that DLC-7 be regarded as the current reference data.

4. APPLICATIONS OF THE DATA

For use in general purpose gamma-ray transport codes.

5. SOURCE AND SCOPE OF THE DATA

The Lawrence Livermore Laboratory has a continuing program to evaluate photon cross sections. Recent data have been published in Refs. 3 and 4. DLC-7C data below 1 MeV coincides with Ref revisions will be made about twice a year.

The data are given in units of (barns/atom) for energies 1 keV to 100 MeV and for elements $Z = 1-83, 86, 90, 92,$ and 94 . The MAT numbers are equal to the atomic numbers (Z).

The following cross sections are tabulated:

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<u>MF</u>	<u>Cross Section Type</u>
501	Total
502	Coherent scattering
504	Incoherent scattering
516	Pair Production (includes triplet)
603	Photoelectric

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

A retrieval program called EDIT-23 is supplied for the purpose of editing the data and providing an example of data retrieval. This program is designed to edit photon interaction data in the ENDF/B file 23 format.

7. CONTRIBUTOR

Lawrence Livermore Laboratory, Livermore, California.

8. DATA FORMAT AND COMPUTER

BCD card image; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

To compile EDIT-23 and edit the entire library requires 1.5 minutes on the IBM 360/65.

10. REFERENCES

a. Documentation available with library:

(1) Informal note on Program EDIT-23.

b. Other documentation helpful in defining library:

(2) D. J. Dudziak, Compiler, "ENDF Formats and Procedures for Photon Production and Interaction Data," LA-4544 (ENDF-102, Rev., Vol. II) (July 1971).

(3) W. H. McMaster *et al.*, "Compilation of X-Ray Cross Sections," UCRL-50174, Sec. II, Rev. 1 (May 1969).

- (4) E. F. Plechaty and J. R. Terrall, "Photon Cross Sections 1 keV to 100 MeV," UCRL-50400, Vol. VI (1968).

11. CONTENTS OF LIBRARY

- a. The references listed in section 10a above.
- b. One reel of magnetic tape containing the library, program EDIT 23, and sample input and output.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

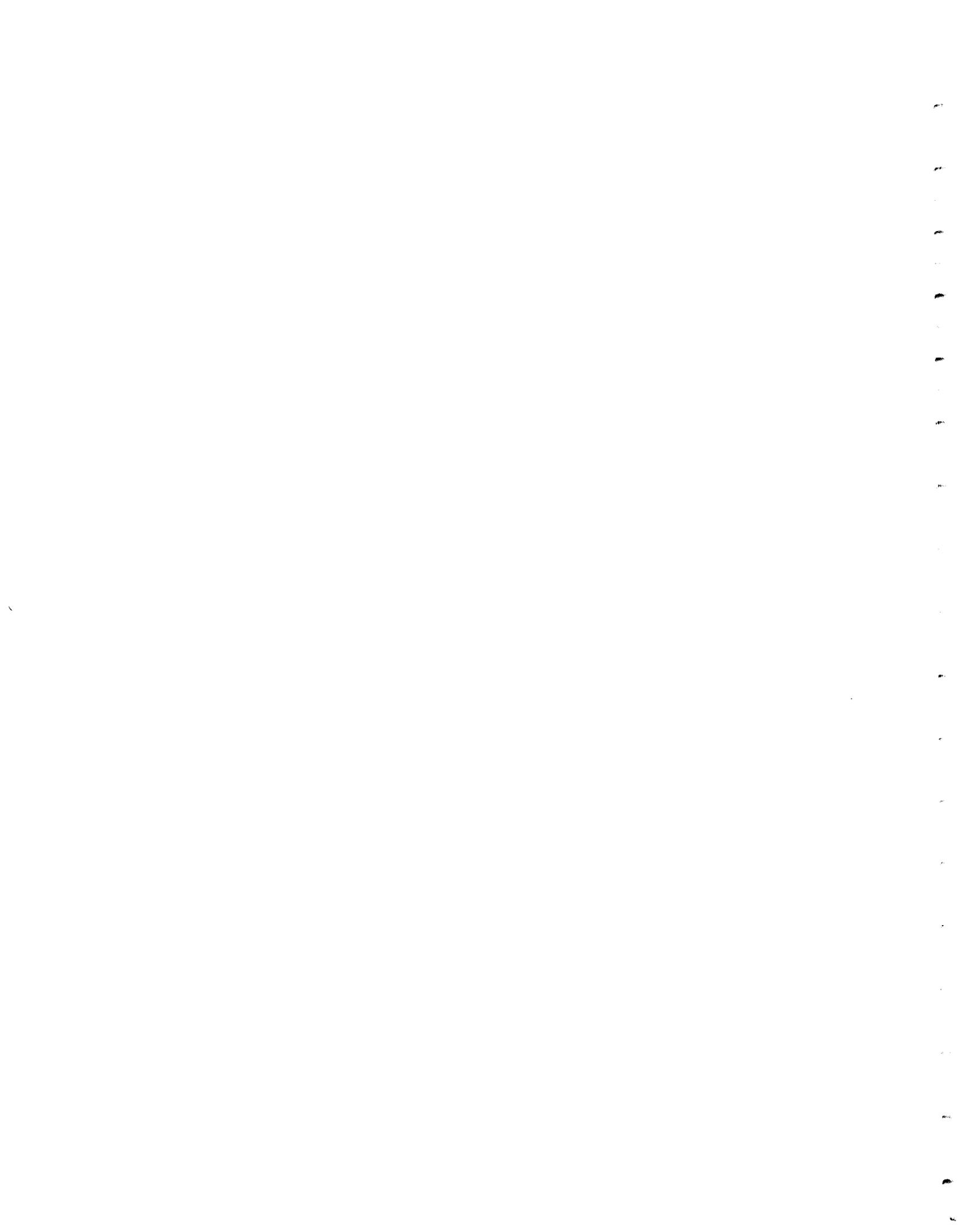
13. DATE OF ABSTRACT AND CURRENT VERSION

December 1969.

DLC-7C (below 1 MeV same as Ref. 4).

March 1971.

DLC-7D (values for Pair Production at 4 MeV were increased about 3-5%).



RSIC DATA LIBRARY DLC-8/BP-3

1. NAME AND TITLE OF DATA LIBRARY

BP-3: Data for Shielding Benchmark Problem 3.0: 22-Group Neutron Cross Sections for Air, Generated by CSP and ANISN for ENDF/B.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

No retrieval program required.

3. HISTORICAL BACKGROUND INFORMATION

The data are that used in CCC-81/ANISN² by E. A. Straker, Neutron Physics Division, ORNL, for Shielding Benchmark Problem 3.0,³ the calculation of neutron spectrum from point fission and 14-MeV source in infinite air.

4. APPLICATIONS OF THE DATA

The data can be used to repeat the Shielding Benchmark Problem 3.0 for testing against the results obtained with ANISN by E. A. Straker.

5. SOURCE AND SCOPE OF THE DATA

DLC-8/BP-3 data was first reduced from point data from ENDF/B⁴ to a 104 fine group structure by a modified version of PSR-9/CSP,⁵ assuming a 1/E weighting factor. These fine group cross sections were further reduced to 22 neutron groups (13 groups above 0.111 MeV) with ANISN using as weighting function the spectrum from a spatially uniform source of 14-MeV neutrons in an infinite medium of air. The resulting data are macroscopic multigroup, P-5 expansion cross sections punched on cards and suitable for input to the ANISN code. The data are described more fully in ORNL-RSIC-25.³

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

No retrieval program required.

7. CONTRIBUTORS

Computing Technology Center and Oak Ridge National Laboratory,
Union Carbide Corporation, Nuclear Division, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

EBCDIC card image; 360/65/75/91.

9. TYPICAL RUNNING TIME

Does not apply.

10. REFERENCES

a. Documentation available with library:

(1) I. J. Brown, "104 and 22-group energy structure tables and listings of cross section data," informal notes (1969).

b. Other documentation helpful in defining library:

(2) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967).

(3) A. E. Profio, Editor, "Shielding Benchmark Problems," ORNL-RSIC-25 (ANS-SD-9) (June 1969). Prepared by the Benchmark Problems Group of the ANS-6 Standards Committee, American Nuclear Society.

(4) H. C. Honeck, "ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (May 1966). Revised by S. Pearlstein, Brookhaven National Laboratory (July 1967).

(5) K. J. Yost and N. M. Greene, "CSP-1: A Neutron Cross-Section Averaging Package for Use with the O5R Data Tape," ORNL-4130 (December 1967).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

a. the documentation listed in section 10a above,

b. the cross-section data on cards (123 cards).

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

December 1969.

DLC-8/BP-3.



RSIC DATA LIBRARY DLC-9/FARS

1. NAME AND TITLE OF DATA LIBRARY

FARS: 122-Group Coupled Neutron and Gamma-Ray Transport Code
Cross-Section Data.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

SUPRET: A Program to Edit or Convert SUPERTO^G Output to
Forms Suitable for Input to ANISN or DTF-IV.

3. HISTORICAL BACKGROUND INFORMATION

The data in DLC-9 were compiled and used in a state-of-the-art report for RSIC by F. A. R. Schmidt (Ref. 8) on concrete. Since, at the time the work was done, the data represents the state-of-the-art of coupled cross sections, it was felt that it would be useful to preserve the data and make it available.

4. APPLICATIONS OF THE DATA

DLC-9 data is suitable for neutron, gamma-ray, or coupled neutron and gamma-ray transport calculations. It is intended for use in multigroup discrete-ordinates or Monte Carlo transport codes which treat anisotropic scattering by Legendre expansion up to order P_8 .

Specifically, the retrieval program manipulates DLC-9 so that it conforms to input requirements of the CCC-82/ANISN,⁵ CCC-89/DOT,⁶ or CCC-42/DTF-IV⁷ codes. The library was designed for use in calculating neutron and secondary gamma-ray transport in concrete.

5. SOURCE AND SCOPE OF THE DATA

DLC-9 is a coupled set of neutron and gamma-ray cross-section data for elements H, C, N, O, Mg, Al, Si, Ca, and Fe.

PSR-13/SUPERTO^G⁹ was used to generate the neutron multigroup data for all elements except Si, Fe, and Ca, which were generated

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using PSR-9/CSP.¹⁰ (For the thermal group it was assumed that scattering was isotropic in the lab system and group averaging was done by hand assuming a Maxwellian energy distribution as a weighting function.)

The source of nuclear data for all elements except Si, Fe, and Ca was ENDF/B.¹¹ The Si and Fe came from the O5R library¹² and the Ca from a recent evaluation by Drake.¹³ This data is averaged over each specified group width. The explicit assumption was made that the flux (weighting function) per unit lethargy was constant. When resonance data were available, resolved and unresolved resonance contributions were calculated and used. The neutron transfer data consists of fine group constants such as one-dimensional reaction arrays (absorption, fission, etc.), P_n elastic scattering matrices, and inelastic and (n,2n) scattering matrices. The units are barns rather than cm^2 .

The P_n scattering matrices for the gamma-ray groups and one-dimensional reaction arrays were computed from DLC-4/HPICO,¹⁴ using PSR-7/MUG.¹⁵

The neutron to gamma-ray group transfer matrices were generated using PSR-11/POPOP4¹⁶ with account being taken for the production of gamma rays from thermal and epithermal neutron capture, inelastic scattering, and other neutron reactions.

All the transfer matrices were then combined and written on tape as card images in the ANISN format.

DLC-9 represents a P_8 approximation to elastic (or Compton) scattering angular distributions. There are 104 neutron groups covering an energy range from 15 MeV to thermal. This group structure was designed by Straker¹⁷ to properly describe neutron transport in media containing a substantial proportion of oxygen. For gamma rays, 18 groups cover the energy range from 10 to 0.02 MeV.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

The retrieval program SUPRET is the same as that used for the DLC-2/99G package except that some array dimensions are increased to allow for 122 groups rather than 100.

SUPRET is also called the SUPERTOOG Data Retrieval Program and was written by the authors of the SUPERTOOG program.

This program will retrieve DLC-9 data and will then, by input option, edit the data, punch cards in either the ANISN or DTF-IV format, or write an unformatted tape for use by ANISN.

7. CONTRIBUTORS

Computing Technology Center and Oak Ridge National Laboratory, Union Carbide Corporation, Nuclear Division, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

EBCDIC card image; 360/65/75/91.

9. TYPICAL RUNNING TIME

Using the retrieval program to produce an unformatted tape, for use by ANISN, containing elements hydrogen and oxygen for P₈ expansion requires approximately 2 minutes on the IBM 360/65.

10. REFERENCES

a. Documentation available with library:

- (1) R. Q. Wright, "User's Manual for SUPERTOOG DATA RETRIEVAL Program," informal notes (June 1969).
- (2) R. W. Roussin, "Description of the DLC-9/FARS Data," informal notes (1969).
- (3) R. W. Roussin, "Using ANISN to Reduce the DLC-2 100 Group Cross-Section Data on a Smaller Number of Groups," ORNL-TM-3049 (May 1969).

9.4

- (4) R. W. Roussin, "Note on Collapsing Group Structure for Coupled Cross-Section Sets," informal notes (November 1969).
- b. Other documentation helpful in defining library:
- (5) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967).
- (6) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967).
- (7) K. D. Lathrop, "DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering," LA-3373 (November 1965).
- (8) F. A. R. Schmidt, "The Attenuation Properties of Concrete for Shielding of Neutrons of Energy Less than 15 MeV," ORNL-RSIC-26 (August 1970).
- (9) R. Q. Wright, N. M. Greene, J. L. Lucius, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (September 1969).
- (10) K. J. Yost and N. M. Greene, "CSP-I: A Neutron Cross-Section Averaging Package for Use with the O5R Data Tape," ORNL-4130 (1967).
- (11) H. C. Honeck, "ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (May 1966).
- (12) D. C. Irving, "O5R Memo No. 2," (1965).
- (13) M. K. Drake, "Neutron and Gamma-Ray Production Cross Sections for Sodium, Magnesium, Chlorine, Potassium, and Calcium," NDL-TR-89 I-VI (1967).
- (14) "OGRE Photon Interaction Library [based on UCRL-50400, Vol. VI (1968)]. Data available from RSIC as DLC-4.
- (15) J. R. Knight and F. R. Mynatt, "MUG - A Program for Generating Multigroup Photon Cross Sections," CTC-17 (January 1970).

- (16) W. E. Ford, III, and D. H. Wallace, "POPOP-4: A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Cross Sections," CTC-12 (1969).
- (17) E. A. Straker, "Time Dependent Neutron and Secondary Gamma-Ray Transport in Air-Over-Ground Geometry," ORNL-4289, Vol. II (1968).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in section 10a above,
- b. one reel of magnetic tape containing DLC-9 data and retrieval program.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

November 1969.

DLC-9.



RSIC DATA LIBRARY DLC-10/AVKER

1. NAME AND TITLE OF DATA LIBRARY

AVKER: Neutron Kerma Response Function Data Library.

2. NAME AND TITLE OF THE DATA RETRIEVAL PROGRAM

AVKER: A Program for Determining Neutron Kerma Factors for Use in Energy Deposition calculations.

3. HISTORICAL BACKGROUND INFORMATION

The neutron kerma response function library was generated for use by Ritts, Solomito, and Stevens for the calculation of neutron fluence-to-kerma factors for the human body (Ref. 4).

4. APPLICATIONS OF THE DATA

The original library was compiled for use in computing energy release in tissue and heating in various materials.

The quantity kerma (kinetic energy release in material) is defined in Refs. 2 and 3 and is evaluated by an integration over energy of the product of kerma factor and fluence density at any spatial position. The kerma factor for an element may be given by

$$K(E) = c \sum_j \sigma_j(E) \Delta E_j(E) \quad \text{erg-b/atom}$$

where σ_j = microscopic cross section for reaction j (b/atom),

ΔE_j = average energy imparted to the struck nuclei and
kinetic energy of charged particles emitted (MeV),

$$c = 1.602 \times 10^{-6} \text{ erg/MeV.}$$

The macroscopic kerma is determined by a multiplication of K (above) by input nuclear densities of the elements of a given composition. If the nuclear densities are in units of 10^{24} atoms/g, the output data are in units of (ergs/g)/(neutron/cm²). Other units, such as rads or watt-sec, may be obtained by altering the input nuclear densities.

5. SOURCE AND SCOPE OF THE DATA

The elements compiled for the first library are: H, 6-Li, 7-Li, Be, C, N, O, F, Na, Mg, Al, Si, P, S, Cl, K, Ca, Fe, and Nb.

The cross sections used were based on the O5R⁵ and ENDF/B⁶ libraries except for P, which the authors of Ref. 1 compiled, and F which came from GAM-II.⁷

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

The retrieval program called AVKER¹ will evaluate fluence-to-kerma factors for any desired composition that can be made from elements in the library. These data can be obtained either as kerma factors at 816 energy points within the energy range 0.023 eV to 19.2 MeV or as kerma factors for a specified group structure averaged with flat of 1/E weighting.

7. CONTRIBUTOR

Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD card image; IBM 360/75/75/91.

9. TYPICAL RUNNING TIME

To compile AVKER and generate 104 group kerma factors (flat weighting) required less than 2 minutes on the IBM-360/75.

10. REFERENCES

a. Available with library:

- (1) M. Solomito, J. J. Ritts, and H. C. Claiborne, "AVKER: A Program for Determining Neutron Kerma Factors for Use in Energy Deposition Calculations," ORNL-TM-2558 (1969).

b. Other documentation:

- (2) International Commission of Radiation Units and Measurements, "Radiation Quantities and Units," ICRU Report 11 (1968).

- (3) D. K. Trubey, "Use of ICRU-Defined Quantities and Units in Shielding," ORNL-RSIC-16 (1968).
- (4) J. J. Ritts, M. Solomito, and P. N. Stevens, "Calculation of Neutron Fluence-to-Kerma Factors for the Human Body," *Nucl. App. and Tech.* 7(1), 89-99 (July 1969).
- (5) D. C. Irving, "O5R Memo No. 2" (1965).
- (6) H. C. Honeck, "ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (May 1966). Revised by S. Pearlstein, Brookhaven National Laboratory (July 1967).
- (7) G. D. Joanou and J. S. Dudek, "GAM-II: A B₃ Code for the Calculation of Fast Neutron Spectra and Associated Multigroup Constants," GA-4265 (1963).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. one reel of magnetic tape containing the library, retrieval program, and sample input and output.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615, 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

November 1969.

DLC-10.

January 1970 (data for copper added to library, informal notes added).

DLC-10B.

RSIC DATA LIBRARY DLC-11/RITTS

1. NAME AND TITLE OF DATA LIBRARY

RITTS: 121 Group Coupled Neutron and Gamma-Ray Cross-Section Data for Transport Codes.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

JRMACRO: A Program for Converting Microscopic, Multigroup, P_n Expansion Cross-Section Data into Corresponding Macroscopic Data for Mixtures or Compounds.

3. HISTORICAL BACKGROUND INFORMATION

The library was developed during the course of investigations by J. J. Ritts and others at Oak Ridge National Laboratory. JRMACRO is a mixing code which was developed by Ritts with assistance from Computing Technology Center personnel. Further refinements were implemented by the RSIC staff.

4. APPLICATIONS OF THE DATA

DLC-11 data is suitable for neutron, gamma-ray, or coupled neutron and gamma-ray transport calculations. It is intended for use in multigroup discrete ordinates of Monte Carlo transport codes which treat anisotropic scattering by Legendre expansion up to order P_3 .

Specifically, the retrieval program JRMACRO manipulates DLC-11 such that it conforms to input requirements of the CCC-82/ANISN,⁵ CCC-89/DOT,⁶ CCC-42/DTF-IV,⁷ and CCC-127/MORSE⁸ codes.

5. SOURCE AND SCOPE OF THE DATA

DLC-11 is a collection of multigroup cross-section data which were compiled by J. J. Ritts* for use in depth-dose calculations in anthropomorphic phantoms and are further described in Ref. 9. For convenience the data are grouped as follows:

*Current address: Westinghouse Electric Corp., Advanced Reactors Division, Waltz Mill Road, Madison, Pennsylvania.

11.2

1. A coupled 121-group (100 neutrons, 21 gamma ray) set of data for the eleven elements H, C, O, N, Na, Mg, P, S, Cl, K, and Ca. This set includes P_3 coupled 121-group microscopic cross sections plus 121-group kerma factors for the eleven elements.
2. A 100-group set of neutron cross sections for the eleven elements.
3. A coupled 121-group set of macroscopic cross sections for nine organic materials including 11-element standard man, 4-element standard man, skin, bone, tissue, brain, lung, red marrow, and muscle.

The basic data sources for the neutron multigroup cross sections were ENDF/B¹⁰ for H, C, N, O, Na, and Mg, the O5R library¹¹ for Ca, S, and K, the GAM-II library¹² for Cl and an evaluation by Ritts⁹ for P. A "1/E" spectrum was assumed for averaging the top 99 groups and a Maxwellian for averaging the thermal group values.

The gamma-ray multigroup cross sections computed from photon interaction data from Ref. 13 using PSR-7/MUG.¹⁴

The neutron-to-gamma-ray group transfer cross sections were generated, using PSR-11/POPOP4,¹⁵ with account being taken for neutron capture, inelastic scattering, and other neutron reactions.⁹

The 100-group neutron kerma factors were generated by DLC-10/AVKER¹⁶ and the 21-group gamma-ray kerma factors by PSR-7/MUG.¹⁴

The DLC-11 cross sections represent a P_3 approximation to elastic (or Compton) scattering angular distributions. The 100 neutron groups cover an energy range from 14.92 to thermal. For gamma rays, 21 energy groups cover the range from 14.0 to 0.01 MeV. The group structures are given in Ref. 2.

6. DISCUSSION OF DATA RETRIEVAL PROGRAM

The retrieval program JRMACRO is used to read microscopic, multigroup, P_n expansion cross-section data, "mix" this data

11.3

into macroscopic cross-section data as needed, and write the resulting set in a suitable output format. The cross-section data considered here is of the general type used by particle transport computer codes such as DTF-IV, ANISN, DOT, and MORSE.

JRMACRO accepts input cross sections by means of cards, tape written in card image format, an unformatted tape (binary), or a combination of the above. Formatted input (cards or card image tape) is first read and stored on a tape or disk before any mixing of cross-section data is performed.

The output cross-section data may be in the form of a card image tape, an unformatted tape, or both.

JRMACRO was used to convert unformatted library tapes for ANISN into the card image format in which the DLC-11 is distributed.

7. CONTRIBUTORS

The Oak Ridge National Laboratory and Computing Technology Center, Union Carbide Corporation, Nuclear Division, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

EBCDIC card image; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

The sample problem runs approximately 45 seconds cpu time, 230 seconds total time on IBM 360/91. The problem involves reading the 100-group neutron data for C, Na, and K, multiplying all data by 1.0, and writing the result on an unformatted tape (a way, although inefficient, to convert from card image tape to unformatted tape).

10. REFERENCES

a. Documentation available with library:

11.4

- (1) J. J. Ritts, R. W. Roussin, and I. J. Brown, "User's Manual for JRMACRO," ORNL-TM-3052 (March 1970).
 - (2) J. J. Ritts and R. W. Roussin, "Description of the DLC-11/RITTS Data," informal notes (March 1970).
 - (3) R. W. Roussin, "Using ANISN to Reduce the DLC-2 100-Group Cross Section Data to a Smaller Number of Groups," ORNL-TM-3049 (May 1969).
 - (4) R. W. Roussin, "Note on Collapsing Group Structure for Coupled Cross-Section Sets," informal notes (November 1969).
- b. Other documentation helpful in defining library:
- (5) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967).
 - (6) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967).
 - (7) K. D. Lathrop, "DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering," LA-3373 (November 1965).
 - (8) E. A. Straker, P. N. Stevens, D. C. Irving, and V. R. Cain, "The MORSE Code - A Multigroup Neutron and Gamma-Ray Monte Carlo Transport Code," ORNL-4585 (February 1970).
 - (9) J. J. Ritts, "The Calculation of Doses in Human Tissue," M.S. Thesis, University of Tennessee, Knoxville, Tennessee (March 1970).
 - (10) H. C. Honeck, "ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (May 1966). Revised by S. Pealstein, Brookhaven National Laboratory (July 1967).
 - (11) D. C. Irving, "O5R Memo No. 2" (1965).
 - (12) G. D. Joanou and J. S. Dudek, "GAM-II: A B₃ Code for the Calculation of Fast-Neutron Spectra and Associated Multigroup Constants," GA-4265 (1963).

- (13) "OGRE Photon Interaction Cross-Section Library," based on UCRL-50174, Sec. II (1967) and NBS-8681, Sec. Ed. (1966).
- (14) J. R. Knight and F. R. Mynatt, "MUG: A Program for Generating Multigroup Photon Cross Sections," CTC-17 (1970), available from RSIC as PSR-7/MUG.
- (15) W. E. Ford, III and D. H. Wallace, "POPOP4: A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Cross Sections," CTC-12 (1969), available from RSIC as PSR-11/POPOP4.
- (16) M. Solomito, J. J. Ritts, and H. C. Claiborne, "AVKER: A Program for Determining Neutron Kerma Factors for Use in Energy Deposition Calculations," ORNL-TM-2558 (April 1969). Available from RSIC as DLC-10/AVKER.

11. CONTENTS OF LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. depending on the user's needs, one or more reels of magnetic tape with contents as listed below:
 - (1) Using 7 track, 556 bpi (unblocked),
 - 1 tape containing the 121-group coupled microscopic data for eleven elements, the 100-group neutron microscopic data for eleven elements, and the JRMACRO program and sample input and output,
 - 1 tape containing 121-group coupled macroscopic data for 11 element standard man, 4 element standard man, skin, bone, and tissue, and
 - 1 tape containing 121-group coupled macroscopic data for brain, lung, red marrow, and muscle.
 - (2) Using 9 track, 800 bpi (blocked),
 - 1 tape for entire library and retrieval program.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

April 1970.

DLC-11.

RSIC DATA LIBRARY DLC-12/POPLIB

1. NAME AND TITLE OF DATA LIBRARY

POPLIB: A Compendium of Neutron-Induced Secondary Gamma-Ray Yield and Cross Section Data.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

POPOP4 Library Tape Maker: A Program for Making or Updating Either a Binary or a BCD Formatted Library Tape of Neutron-Induced Secondary Gamma-Ray Yield and Cross Section Data Sets.

3. HISTORICAL BACKGROUND INFORMATION

The library was compiled by W. E. Ford, III and others at the Computing Technology Center in conjunction with the development of the POPOP4 computer code, which converts such data into multigroup transfer cross sections for use in transport codes.

4. APPLICATIONS OF THE DATA

The library may be used with POPOP4³ to prepare neutron to gamma-ray group transfer matrices. These can then be merged with multigroup neutron cross section sets (from GAM-II,⁴ XSDRN,⁵ SUPERTOG,⁶ etc.) and multigroup gamma-ray cross section sets (from MUG,⁷ GAMLEG,⁸ etc. to give a cross section set which can be used for coupled neutron and secondary gamma-ray calculations in multigroup transport codes such as ANISN,⁹ DOT,¹⁰ DTF-IV,¹¹ and MORSE¹².

5. SOURCE AND SCOPE OF THE DATA

Data in the library is either:

- (1) the intensities of secondary gamma rays resulting from neutron-nucleus interactions (yields), or
- (2) the secondary gamma-ray production cross sections for neutron-nucleus interactions (cross sections).

The format of the data is described in Ref. 3, pages 33-37.

The library was compiled from the literature and from private files of contributors. No claim is made for the validity of the data. However, a program of "testing" the data sets for use in shielding calculations is in progress. The initial efforts are described in Ref. 2.

The initial library contains data for H, D, Li, Be, 10-B, C, N, O, F, Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Zr, Nb, Mo, Cd, Ba, Eu, Gd, Ta, W, Hg, Pb, 235-U, 238-U, and Np. Some reactions for which data appear are radiative capture, fission, inelastic scattering (n, α), and (n,p). For many nuclides there are several data sets for a particular reaction.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

The retrieval program is referred to as POPOP4 Library Tape Maker. The use of this program is described in Ref. 2, Appendix E. This program will read a BCD formatted POPOP4 library tape and make a binary POPOP4 tape for use with POPOP4. In addition, the program includes the capability of:

- a. making or updating a BCD formatted library tape,
- b. making or updating a binary library tape for use with POPOP4,
- c. listing any or all the data sets on a library tape, and
- d. punching any or all the data sets on a library tape in the format for use with POPOP4. (This capability is usually used to retrieve data sets in order to modify the data prior to use with POPOP4.)

7. CONTRIBUTOR

Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD card image; IBM 360/65/75/91

9. TYPICAL RUNNING TIMES

Typical running time of POPOP4 Library Tape Maker is less than two minutes on the IBM 360/65.

10. REFERENCES

a. Documentation available with library:

(1) W. E. Ford, III, "The POPOP4 Library of Neutron-Induced Secondary Gamma-Ray Yield and Cross-Section Data," CTC-42 (1970).

(2) W. E. Ford, III and D. H. Wallace, "The Use and 'Testing' of Al, Fe, Ni, Cu, and Pb Secondary Gamma-Ray Production Data Sets from the POPOP4 Library," CTC-20 (July 1970).

b. Other documentation helpful in defining library:

(3) W. E. Ford, III and D. H. Wallace, "POPOP4 - A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Production Cross Sections," CTC-12 (May 1969).

(4) G. D. Joanou and J. S. Dudek, "GAM-II - A B₃ Code for the Calculation of Fast Neutron Spectra and Associated Multigroup Constants," GA-4265 (1963).

(5) N. M. Greene and C. W. Craven, Jr., "XSDRN: A Discrete Ordinates Spectral Averaging Code," ORNL-TM-2500 (July 1969). The code package is available from RSIC as CCC-123/XSDRN.

(6) R. Q. Wright, N. M. Greene, J. L. Lucius, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (September 1969). The code package is available from RSIC as PSR-13/SUPERTOG.

(7) J. R. Knight and F. R. Mynatt, "MUG - A Program for Generating Multigroup Photon Cross Sections," CTC-17 (January 1970). The code package is available from RSIC as PSR-7/MUG.

- (8) K. D. Lathrop, "GAMLEG - A FORTRAN Code to Produce Multigroup Cross Sections for Photon Transport Calculations," LA-3267 (April 1965). The code package is available from RSIC as CCC-42/DTF-IV.
- (9) W. W. Engle, Jr., "A User's Manual for ANISN - A One-Dimensional Discrete Ordinates Transport Code with Anisotropic Scattering," K-1693 (March 1967). The code package is available from RSIC as CCC-82/ANISN.
- (10) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967). The code package is available from RSIC as CCC-89/DOT.
- (11) K. D. Lathrop, "DTF-IV, A FORTRAN IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering," LA-3373 (November 1965). The code package is available from RSIC as CCC-42/DTF-IV.
- (12) E. A. Straker, P. N. Stevens, D. C. Irving, and V. R. Cain, "The MORSE Code - A Multigroup Neutron and Secondary Gamma-Ray Monte Carlo Transport Code," ORNL-4585. The code package is available from RSIC as CCC-127/MORSE.

11. CONTENTS OF LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. one reel of magnetic tape on which is written in several files: the retrieval program, POPOP4 library, input cards for a sample problem and an output listing from running the problem.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

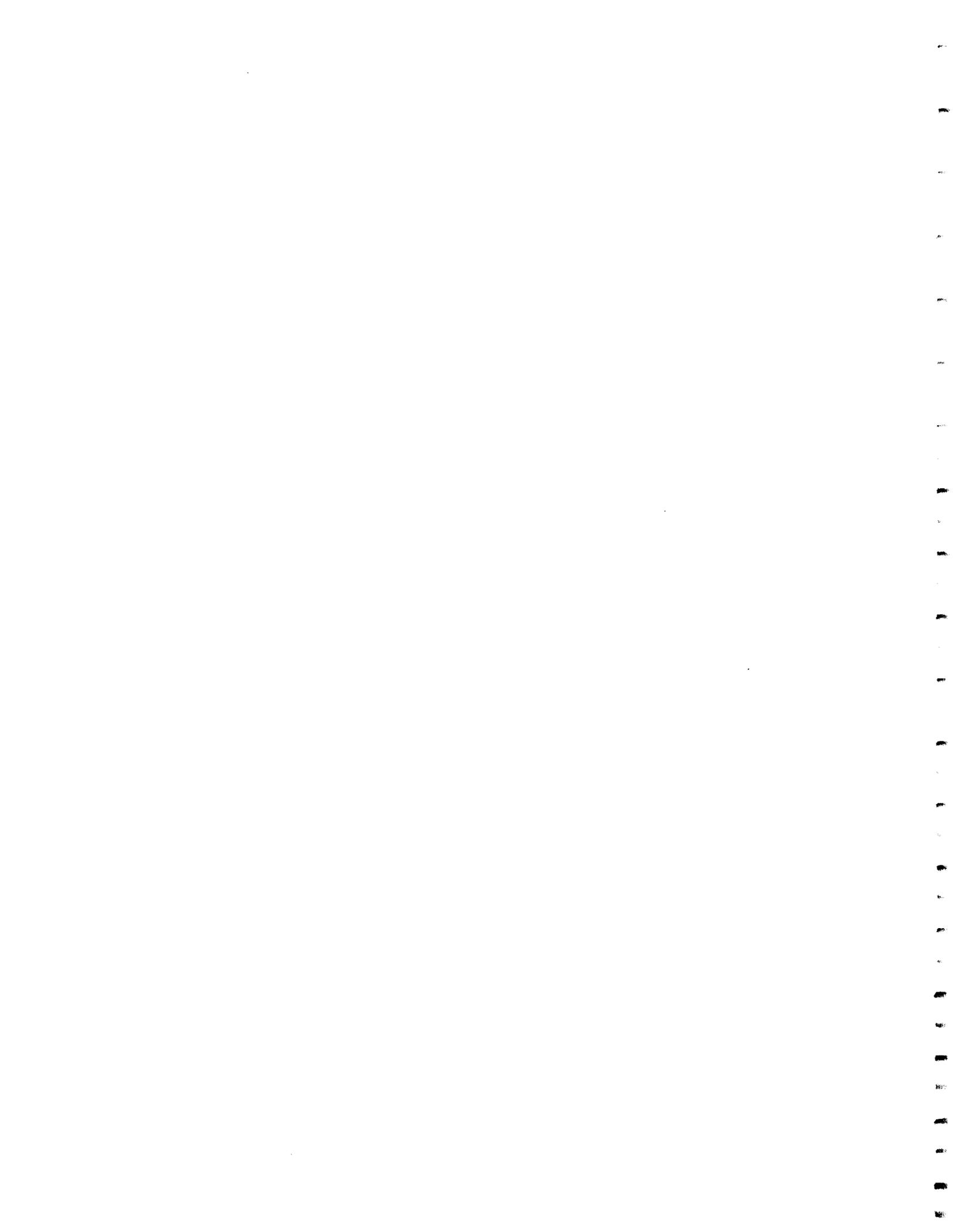
Initial Library - September 1970. Contained 139 data sets.

First Update - December 1970. Two sets deleted, 86 added.

DLC-12B - May 1971. One set voided, three corrected, 10 added.

Report added to the documentation: W. E. Ford, III, "The POPOP4
Library and Codes for Preparing Secondary Gamma-Ray Production Cross
Sections," ORNL-TM-3367 (April 1971).

DLC-12C - August 1971. One data set voided, ten sets added,
title changed on one set.



RSIC DATA LIBRARY DLC-13/GARLIB

1. NAME AND TITLE OF DATA LIBRARY

GARLIB: Multigroup Resonance-Region Cross Sections for Use in Shielding Calculations.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAMS

GARW: A Program to Manipulate GAROL Resonance Cross Sections for Fully Dense Natural Tungsten.

GARU: A Program to Manipulate GAROL Resonance Cross Sections for Fully Dense Depleted Uranium.

3. HISTORICAL BACKGROUND INFORMATION

The GARLIB data is produced by program GAROL (packaged by RSIC as PSR-33). Because other libraries of updated input data (i.e., resonance parameters and optimum energy point distributions) are required for GAROL, and the code is not widely used, the GARLIB data were generated for use by those designing space power reactor shields.

4. APPLICATIONS OF THE DATA

The 32-group, 0.4 to 1234 eV, capture and scattering cross sections contained in the library may be used as is for multigroup neutron transport calculations for the tabulated thicknesses of resonance absorber slabs (or cylindrical or spherical shells of the same thickness). They must, of course, be merged with a high energy (1 keV to 15 MeV) cross section set as calculated by GAM-II,² for example. If the slab is not of the thickness listed, interpolated values may be used. Extrapolation, especially to thinner absorbers, is not advised because of the rapidly rising average cross sections. On the basis of conclusions reported in Refs. 3 and 4, total capture rates in the absorber will be preserved when these cross sections are used.

It is often inconvenient to perform a neutron transport calculation with the 32 energy groups in the 0.4 to 1234 eV region. For

this reason, the relative group fluxes which were calculated by GAROL are also contained in the library to permit group collapsing according to the following equation:

$$\sigma_c = \frac{\sum \phi_i \sigma_i}{\sum \phi_i} ,$$

where i refers to energy group, and the summations are taken over the desired groups. This group collapsing may be done by hand calculations or with the retrieval programs included with the data library.

5. SOURCE AND SCOPE OF THE DATA

Multigroup capture and scatter cross sections for the resolved resonance region were calculated for tungsten and depleted uranium slabs. The computer code used to generate the cross sections, GAROL,⁵ was previously observed to preserve the total capture rate in detailed multigroup neutron transport calculations. The cross sections are intended for use in shielding calculations of neutron transport and capture distribution in slabs or cylindrical or spherical shells of thick resonance absorbers.

Capture and scatter cross sections were obtained for fully dense tungsten and depleted uranium slabs of thickness 1, 2, 2.54, 4, and 8 centimeters; the slabs were surrounded by either hydrogen or lithium hydride. Group cross sections were calculated for a group split of 0.25 lethargy units extending from 0.414 to 1234.1 eV. This group structure is identical to that of the last 32 groups in the GAM-II 99-group structure; thus, the presently reported group cross section sets may be readily merged with 1 keV to 15 MeV cross-section data of GAM-II. All cross sections are microscopic and in units of barns. Because it may not be generally convenient to run with 32 energy groups in the 1 eV to 1 keV region, the group fluxes which were calculated with GAROL are also presented; further group collapsing either by hand calculations or with included computer codes is thus permitted.

Cross sections are included for W-180, W-182, W-184, and W-186, as well as U-235 and U-238.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAMS

The retrieval programs read multigroup region-averaged fluxes, capture cross sections, and scattering cross sections calculated and punched out by GAROL.

Separate codes are included for the tungsten and uranium cases. The codes, when executed, will print out the information presented in Ref. 1. The final section of each code outlines a procedure for further group-collapsing the cross sections.

The first code, called GARW, manipulates isotopic tungsten cross sections. Tungsten is fully dense and isotope fractions are those occurring naturally.

The second code, called GARU, manipulates cross sections of uranium-238 and uranium-235 as calculated for fully dense depleted uranium (0.23% uranium-235).

Versions of the library and retrieval programs are available for both the IBM 7090 and IBM 360/65/75/91.

7. CONTRIBUTOR

National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

8. DATA FORMAT AND COMPUTER

- a. BCD card image; IBM 7090.
- b. EBCDIC card image; IBM 360/75/91.

9. TYPICAL RUNNING TIME

- a. IBM 7090, approximately 1 minute to run either GARU or GARW.
- b. IBM 360/91, approximately 21 seconds for GARW, 18 seconds for GARU.

10. REFERENCES

a. Documentation available with the library:

- (1) G. P. Lahti and R. M. Westfall, "Multigroup Resonance-Region Cross Sections of Tungsten and Depleted Uranium for Use in Shielding Calculations," NASA TM X-1909 (January 1970).

b. Other documentation helpful in defining library:

- (2) G. D. Joanou and J. S. Dudek, "GAM-II: A B₃ Code for the Calculation of Fast Neutron Spectra and Associated Multigroup Constants," GA-4265, General Atomics Division, General Dynamics Corporation (September 1963).
- (3) Gerald P. Lahti, "Resonance Neutron Capture in a Thick Slab of Depleted Uranium," *Trans. Am. Nucl. Soc.* 12(1), 389-390 (June 1969).
- (4) Gerald P. Lahti, "Multigroup Calculations of Resonance Neutron Capture in a Thick Slab of Depleted Uranium," NASA TM X-1878 (1969).
- (5) C. A. Stevens and C. V. Smith, "GAROL - A Computer Program for Evaluating Resonance Absorption Including Resonance Overlap," GA-6637, General Atomics Division, General Dynamics Corporation (August 1965).

11. CONTENTS OF THE LIBRARY

The library contains the following items:

- a. the documentation listed in 10a above, and
- b. one reel of magnetic tape on which is written in 2 separate files: the source card decks for the retrieval programs, the data libraries, and output listings from sample edits of the data libraries for each hardware version.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

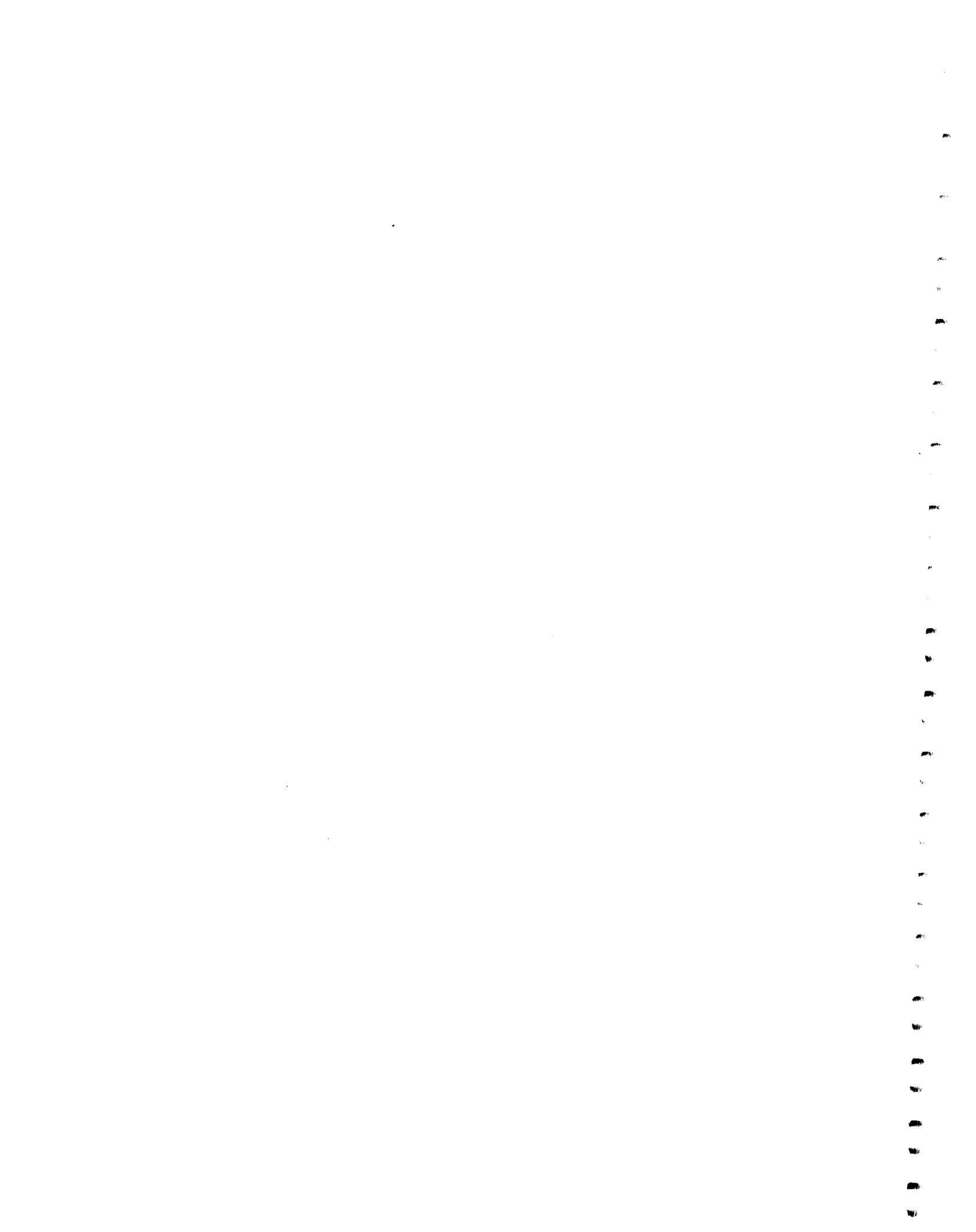
or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

July 1970.

DLC-13A for IBM 7090/94, DLC-13B for IBM 360/65/75/91.



RSIC DATA LIBRARY DLC-14/AIR

1. NAME AND TITLE OF DATA LIBRARY

AIR: Sample Input to ANISN for Calculation of Neutron and Secondary Gamma-Ray Transport in Air

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

No retrieval program required.

3. HISTORICAL BACKGROUND INFORMATION

The ANISN input data (including the air cross section data) were developed for use by E. A. Straker and M. L. Gritzner of the Oak Ridge National Laboratory, Oak Ridge, Tennessee, for the calculation of neutron and secondary gamma-ray transport in infinite homogeneous air. Their results are reported in Ref. 1.

4. APPLICATIONS OF THE DATA

The basic idea behind the distribution of this ANISN³ input data is to allow potential users to repeat the ANISN calculations reported in Ref. 1. It is felt that it will be more economical to repeat the calculations rather than to distribute the results of the Straker-Gritzner¹ calculations.

However, the cross section part of the data can actually be used in DOT⁴ or MORSE⁵ or any transport code which will accept input cross section data in the FIDO³ format.

5. SOURCE AND SCOPE OF THE DATA

The sample input data for ANISN are for a P₅, S₁₆ calculation of the transport of neutrons and secondary gamma rays from a 12.2 to 15 MeV point neutron source in an infinite air medium. The source is actually uniformly distributed in the first interval (500 cm radius) of a spherical medium of air with radius 3005 meters.

The problem is set up for calculating various "detector responses" by means of the "activity" option available with ANISN. This is

accomplished by providing a cross section table for a "material" which has detector responses in certain table positions. Then the inclusion of appropriate input data for 22\$ and 23\$ arrays causes the group fluxes to be multiplied by the group response function values to give the desired answer. The neutron detector responses calculated by this sample problem are Henderson tissue dose, Snyder-Neufeld dose, tissue kerma, and air kerma. The gamma-ray response functions calculated are Henderson tissue dose and air kerma.

The neutron cross sections were first reduced from point data from ENDF/B⁶ to a 104 fine group structure with a modified version of CSP,⁷ assuming a 1/E weighting factor. The gamma-ray data were reduced from point data from DLC-4/HPICO⁸ to an 18 group structure using MUG.⁹ The POPOP4¹⁰ code was used to convert secondary gamma-ray production data from DLC-12/POPLIB¹¹ to neutron-to-gamma-ray group transfer cross sections. The coupled set (104 neutron, 18 gamma-ray groups) was then collapsed to 22 neutron and 18 gamma-ray groups with ANISN, using as the weighting function the spectrum from a spatially uniform source of 14 MeV neutrons in an infinite air medium with a density of 11.11 mg/cc. The resulting data are coupled macroscopic multigroup, P₅ expansion cross sections for air punched on cards and suitable for input to the ANISN code.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

No retrieval program required.

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

EBCDIC card image; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

Using CCC-82C/ANISN, one problem ran approximately 2 minutes on the IBM 360/91 at ORNL.

10. REFERENCES

a. Documentation available with library:

(1) E. A. Straker and M. L. Gritzner, "Neutron and Secondary Gamma-Ray Transport in Infinite Homogeneous Air," ORNL-4464 (December 1969). Only the first 21 pages are supplied with the library.

(2) Informal notes.

b. Other documentation helpful in defining library:

(3) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967). The code package is available from RSIC as CCC-82/ANISN.

(4) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967). The code package is available from RSIC as CCC-89/DOT.

(5) E. A. Straker, P. N. Stevens, D. C. Irving, and V. R. Cain, "The MORSE Code - A Multigroup Neutron and Gamma-Ray Monte Carlo Transport Code," ORNL-4585 (September 1970). The code package is available from RSIC as CCC-127/MORSE.

(6) H. C. Honeck, "ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (May 1966). Revised by S. Pearlstein, Brookhaven National Laboratory (July 1967). Version I, released 1968.

(7) K. J. Yost and N. M. Greene, "CSP-1: A Neutron Cross-Section Averaging Package for Use with the O5R Data Tape," ORNL-4130 (December 1967). The code package is available from RSIC as PSR-9/CSP.

(8) DLC-4/HPIC, Photon Interaction Cross Sections in OGRE format; available from RSIC.

(9) J. R. Knight and F. R. Mynatt, "MUG: A Program for Generating Multigroup Photon Cross Sections," CTC-17 (1970). The code package is available from RSIC as PSR-7/MUG.

(10) W. E. Ford, III and D. H. Wallace, "POPOP4: A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Cross Sections," CTC-12 (1969). The code package is available from RSIC as PSR-11/POPOP4.

(11) DLC-12/POPLIB, A Compendium of Neutron-Induced Secondary Gamma Ray Yield and Cross Section Data; available from RSIC.

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in section 10a above,
- b. one reel of magnetic tape containing necessary input data and also output from running the problem.

Persons requesting the library should send a full (2400 ft) reel of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to:

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to:

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

June 1971.

RSIC DATA LIBRARY DLC-15/STORM-ISRAEL

1. NAME AND TITLE OF DATA LIBRARY

STORM-ISRAEL: Evaluated Photon Interaction Library in ENDF/B File 23 Format.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

EDIT-23: A Program for Editing ENDF/B File 23 Photon Interaction Data.

3. HISTORICAL BACKGROUND INFORMATION

It should be noted that a similar evaluation, performed by W. H. McMaster *et al.*, Lawrence Livermore Laboratory, is available from RSIC as DLC-7. These data are reported in UCRL-50174, Sec. II, Rev. 1 (May 1969), for energies less than 1 MeV and for elements $Z = 1-83, 86, 90, 92,$ and 94 and give $\sigma(\text{tot}), \sigma(\text{incoh}), \sigma(\text{coh}), \sigma(\text{pair}),$ and $\sigma(\text{photo})$. The data cover the energy range 1 keV to 100 MeV.

A group (acting for the Cross Section Evaluation Working Group Shielding Subcommittee and headed by J. H. Hubbell, National Bureau of Standards Photon Cross Section Center) examined both the LASL and Livermore compilations and found them to be in substantial agreement. The Livermore data, having passed substantial Phase I testing at the time the group reported (May 1970), were recommended as the ENDF/B reference data. Nevertheless, we feel it is of value to make the Storm-Israel compilation available as an alternate evaluation.

4. APPLICATIONS OF THE DATA

For use in general purpose gamma-ray transport codes.

5. SOURCE AND SCOPE OF THE DATA

A discussion of the evaluation and much of the data were published in Ref. 1. The data are given in barns/atom for energies 1 keV to

100 MeV and for elementz Z = 1 to 100. The material (MAT) numbers are equal to the atomic numbers (Z).

D. J. Dudziak, LASL, placed the data in ENDF/B BCD format.

The reaction type (MT) numbers used by Dudziak are consistent with those recommended in ENDF publications where possible, although several had to be assigned for the purpose. The ones used are summarized in Table I.

In the newer nomenclature $\sigma_a(\text{tot})$ and $\sigma_h(\text{tot})$ may be regarded as kerma factors which should be applied to the spectral flux density in a fashion consistent with the transport calculation which determined the flux density. That is, if the transport model assumes bound-electron incoherent scattering and treats secondary photons from pair production and photoelectric reactions, $\sigma_a(\text{tot})$ should be used to calculate kerma. If the model assumes free-electron incoherent scattering and treats pair production and photoelectric reactions as absorption, $\sigma_h(\text{tot})$ should be used.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

EDIT-23 is a program developed especially for the purpose of editing photon interaction data that is in ENDF/B file 23 BCD format.³ The program was designed by John R. Knight of ORNL who used selected portions of the PLOTFB⁵ edit capability. The current version was modified by RSIC so that it would recognize the new MT numbers used in the DLC-15 data.

7. CONTRIBUTOR

Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

8. DATA FORMAT AND COMPUTER

BCD card image; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

One minute CPU time on IBM-360/91 is required to compile and execute the sample problem (editing data for 2 elements).

Table I. PHOTON CROSS SECTION REACTION TYPES

Reaction	Symbol	MT
INCOHERENT FREE ELECTRON		
*Total	$\sigma(\text{Klein-Nishina})$	540
*Absorption	$\sigma_{\alpha}(\text{Klein-Nishina})$	552
*Scattering	$\sigma_{\text{s}}(\text{Klein-Nishina})$	541
INCOHERENT BOUND ELECTRON		
Total	$\sigma(\text{incoh})$	504
Absorption	$\sigma_{\alpha}(\text{incoh})$	553
*Scattering	$\sigma_{\text{s}}(\text{incoh}) = \sigma_{\text{t}}(\text{incoh}) - \sigma_{\alpha}(\text{incoh})$	542
COHERENT SCATTERING		
	$\sigma(\text{coh})$	502
PAIR PRODUCTION		
Nucleus	$\sigma(\text{pair n})$	517
Electron	$\sigma(\text{pair e})$	515
*Total	$\sigma(\text{pair}) = \sigma(\text{pair n}) + \sigma(\text{pair e})$	516
Absorption	$\sigma_{\alpha}(\text{pair})$	554
PHOTOELECTRIC		
Total	$\sigma(\text{photo})$	602
Absorption	$\sigma_{\alpha}(\text{photo})$	555
TOTAL		
Narrow beam	$\sigma(\text{tot})$	501
	$\sigma(\text{tot}) = \sigma(\text{incoh}) + \sigma(\text{coh}) + \sigma(\text{pair}) + \sigma(\text{photo})$	
Narrow beam minus coherent	$\sigma(\text{tot-coh})$	503
	$\sigma(\text{tot-coh}) = \sigma(\text{tot}) - \sigma(\text{coh})$	
Absorption	$\sigma_{\text{h}}(\text{tot})$	550
	$\sigma_{\text{h}}(\text{tot}) = \sigma_{\alpha}(\text{Klein-Nishina}) + \sigma_{\alpha}(\text{pair}) + \sigma_{\alpha}(\text{photo})$	
Energy Absorption	$\sigma_{\alpha}(\text{tot})$	551
	$\sigma_{\alpha}(\text{tot}) = \sigma_{\alpha}(\text{incoh}) + \sigma_{\alpha}(\text{pair}) + \sigma_{\alpha}(\text{photo})$	

*Not included in published tables but available on tape.

10. REFERENCES

a. Documentation available with library:

- (1) Ellery Storm and Harvy I. Israel, "Photon Cross Sections from 1 keV to 100 MeV for Elements Z=1 to Z=100," *Nucl. Data Tables* A7, 565-681 (1970), selected pages only.
- (2) Informal notes in EDIT 23 program.

b. Other relevant documentation:

- (3) D. J. Dudziak, "ENDF/B Format Requirements for Shielding Applications," LA-3801 (ENDF 111) (1967).
- (4) Ellery Storm and Harvey I. Israel, "Photon Cross Sections from 0.001 to 100 MeV for Elements 1 Through 100," LA-3753 (1967).
- (5) D. E. Cullen, "PLOTFB: A Code to List and Plot ENDF/B Data," section appearing in "Description of the ENDF/B Processing Codes CHECKER, CRECT, DAMMET, PLOTFB, and Retrieval Sub-routines," ENDF-110 (BNL 13582) September 1967 (Revised April 1969).

11. CONTENTS OF THE LIBRARY

a. The documentation listed in 10a above,

b. Depending on the user's needs, one or more full reels of magnetic tape with contents as listed below.

- (1) Using 7 track, 556 bpi (two reels of tape)

One tape with one file containing data for elements 1-50, and one tape with four files containing data for elements 51-100, program EDIT 23, sample input and output.

- (2) Using 9 track, 800 bpi

One reel of tape containing 2 files of data (elements 1-50 and 51-100) and 3 files of data for program EDIT-23, sample input data, and output.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

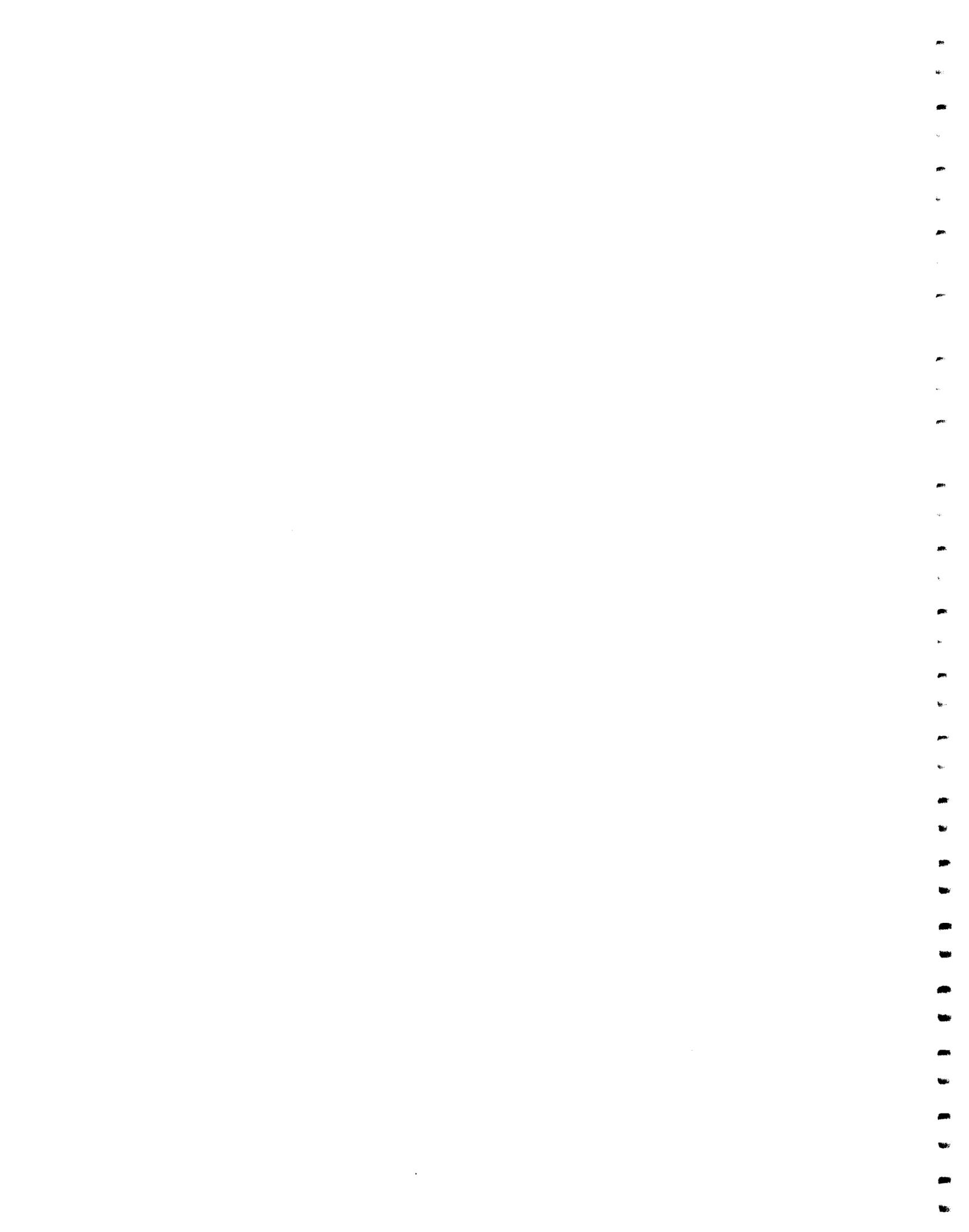
or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

January 1971.

DLC-15.



RSIC DATA LIBRARY DLC-16/COBB

1. NAME AND TITLE OF DATA LIBRARY

COBB: 123-Group Neutron Cross Section Data Generated from ENDF/B-II Data for Use in the XSDRN Discrete Ordinates Spectral Averaging Code.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

Three retrieval programs are supplied with DLC-16.

JUANITA: A Program to Convert from Formatted to Unformatted XSDRN Master Library Tapes and Vice Versa.

SUP: A Program to Update an Unformatted XSDRN Master Library Tape.

SECS: A Program to Edit an Unformatted XSDRN Master Library Tape.

3. HISTORICAL BACKGROUND INFORMATION

This library was compiled during the course of investigations by W. R. Cobb of the ORNL Reactor Division. Portions of the data included were prepared by R. Q. Wright of the ORNL Mathematics Division.

4. APPLICATIONS OF THE DATA

It is intended to be a source of evaluated data for the cross-section preparation code CCC-123/XSDRN.³ It supplements, rather than replaces, the existing XSDRN master library which is distributed with the code package.

5. SOURCE AND SCOPE OF THE DATA

The library contains ENDF/B version II cross sections processed through several steps (primarily by PSR-13/SUPER TOG⁴) into the standard XSDRN 123-group energy structure. These steps are:

a. Process fast cross sections with SUPERTOG into standard 99-group GAM-II⁵ energy structure (14 MeV - 0.414 eV), using a "1/E" weighting function, and produce a GAM-II tape. (This step performed by R. Q. Wright.)

b. Process thermal cross sections with SUPERTOG into standard 30-group THERMOS⁶ energy group structure (1.86 eV - 0.0047 eV), using a Maxwell-Boltzmann distribution with temperature 293°K as a weighting function for $E < 0.125$ eV coupled to a "1/E" weighting function for $0.125 \text{ eV} < E < 1.86 \text{ eV}$.

c. Compute room temperature free-gas kernels, using THERMOS tape-making program, and combine with results of step b into a THERMOS tape.

d. Combine the GAM-II and THERMOS tapes into a 123-group XSDRN tape using an unpublished ORNL code written specifically for this purpose.

This library contains data for a P_3 approximation to the angular scattering for all ENDF/B version II nuclides except hydrogen; however, an older set of cross sections for hydrogen in water were included for completeness. Nuclides whose cross sections are not given by ENDF/B in elemental form have been processed both as resonance and infinite dilute cross sections.

The XSDRN ID numbers of nuclides on this tape are of the form

$$10,000 * Z + 10 * A + S$$

where Z is the atomic number of the element, A is the atomic weight of the isotope, and S is 0 or 1, depending on whether the cross sections are in the form of resonance parameters or are given at infinite dilution. An ID number for which A=0 implies that the cross sections are for the naturally occurring element.

The library contains data for H, D, He, 9-Be, 10-B, 12-C, 16-O, 23-Na*, Mg, 27-Al, Ti, V, Cr, 55-Mn*, Fe, Ni, Cu, 63-Cu*, 65-Cu*,

*Two XSDRN ID numbers given, one for resonance nuclide treatment and one for infinite dilution treatment.

93-Nb*, Mo, 135-Xe, 149-Sm*, 151-Eu*, 153-Eu*, Gd, 164-Dy*, 175-Lu*, 176-Lu*, 182-W*, 183-W**, 184-W**, 186-W**, 185-Re*, 187-Re*, 197-Au*, 233-U, 234-U*, 235-U*, 238-U*, 237-Np*, 238-Pu*, 239-Pu*, 240-Pu*, 241-Pu*, 242-Pu*, 241-Am*, 243-Am*, and 244-Cm*.

5. DISCUSSION OF DATA RETRIEVAL PROGRAMS

Three programs are provided for manipulating DLC-16/COBB data. These were written by N. M. Greene of ORNL for use with data for the XSDRN discrete ordinates spectral averaging code.

The first code, JUANITA, will convert an unformatted XSDRN master library tape to a formatted one, or vice versa. XSDRN requires an unformatted (binary) tape for input but DLC-16/COBB has been put in formatted (BCD card images) form for easy transmittal between installations.

The second code, SUP, can be used to update and the third code SECS, to edit an unformatted XSDRN master library tape.

7. CONTRIBUTOR

Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

JUANITA: Compilation and execution time for converting the entire DLC-16 library from an unformatted to a formatted tape, 2 minutes on the IBM 360/91.

SUP,SECS: No running time information available for these programs.

*Two XSDRN ID numbers given, one for resonance nuclide treatment and one for infinite dilution treatment.

**Resonance nuclide treatment only.

10. REFERENCES

- a. Documentation available with library:
- (1) Intra-Laboratory Memo describing library, W. R. Cobb.
 - (2) Instructions for Retrieval Programs, JUANITA, SUP, and SECS, by N. M. Greene, informal notes.
- b. Other documentation helpful in defining library:
- (3) N. M. Greene and C. W. Craven, Jr., "XSDRN - A Discrete Ordinates Spectral Averaging Code," ORNL-TM-2500 (1969).
 - (4) R. Q. Wright, N. M. Greene, J. L. Lucius, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (1969).
 - (5) G. D. Joanou and J. S. Dudek, "GAM-II: A B_3 Code for the Calculation of Fast-Neutron Spectra and Associated Multi-group Constants," GA-4265 (1965).
 - (6) H. C. Honeck, "THERMOS: A Thermalization Transport Theory Code for Reactor Lattice Calculations," BNL-5826 (1961).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. depending on the user's needs, one or more reels of magnetic tape with contents as listed below:
 - (1) 7-track, 556 bpi (4 tapes, unblocked)
 - 1 tape for 21 nuclides
 - 1 tape for 22 nuclides
 - 1 tape for 20 nuclides and
the retrieval programs JUANITA, SUP, and SECS.
 - (2) 9-track, 800 bpi (blocked)
 - 1 reel of tape for entire library plus retrieval programs.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

January 1971.

DLC-16.



RSIC DATA LIBRARY DLC-17/NOX

1. NAME AND TITLE OF DATA LIBRARY

NOX: 119-Group, P₅, Coupled Neutron and Secondary Gamma-Ray Cross Section Data for Nitrogen and Oxygen.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

LIBGEN: A Computer Program to Generate an Unformatted Cross-Section Tape for Input to ANISN.

3. HISTORICAL BACKGROUND INFORMATION

The cross-section data in DLC-17 were compiled at ORNL to be used for studies of neutron and secondary gamma-ray transport in nitrogen and air. The data library was preserved since it was based on new evaluations for N and O and since results using the data have been reported. The nitrogen data were used in a calculation study of gamma-ray production and transport in liquid nitrogen,¹ which compared results with experiments in liquid nitrogen.^{3,4} Results of several ORNL studies using the nitrogen and oxygen data were presented⁵ to assess the adequacy of the nitrogen cross sections.

4. APPLICATION OF THE DATA

DLC-17 is suitable for multigroup neutron, gamma-ray, or coupled neutron and gamma-ray transport calculations in nitrogen, oxygen, or air. The retrieval program manipulates the data so that it can be used in codes such as CCC-82/ANISN,⁶ CCC-89/DOT,⁷ or CCC-127/MORSE.⁸

5. SOURCE AND SCOPE OF THE DATA

The coupled 86 neutron and 33 gamma-ray energy group cross sections were produced with PSR-13/SUPERTOG,⁹ the neutron to gamma-ray group transfer matrices with a modified version of NUSECT, and the gamma-ray multigroup data with PSR-7/MUG.¹⁰ NUSECT is the cross section generator for CCC-128/06R,¹¹ but modifications had to be

made to the version in the RSIC code package to generate the desired gamma-ray production matrices.

This data represents a P_5 Legendre expansion approximation for neutron elastic scattering and gamma-ray Compton scattering. Inelastic neutron scatter and gamma-ray production are treated as isotropic.

Cross section values for the neutron thermal group (86) were determined by assuming a Maxwellian weighting function with a constant scattering cross section and a " $1/v$ " absorption cross section.

The 86 neutron groups cover the energy range from 15 MeV to thermal and the group structure was chosen to represent the variation in the nitrogen total cross section. The 33 gamma-ray groups span the energy range from 10 to 0.01 MeV. The gamma-ray group structure was chosen with one group of width 0.02 MeV containing each nitrogen resolved line and one group of varying energy width between adjacent resolved lines.

The neutron interaction secondary gamma-ray production and gamma-ray interaction multigroup data were generated from recent evaluations by Young and Foster.^{12,13} The evaluations are part of the DNA Working Cross Section Library,¹⁴ and the identification designations are DNA MAT 4133, MOD 1 for nitrogen and DNA MAT 4134, MOD 0 for oxygen. These are available from RSIC upon request.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

LIBGEN is a modified version of the Library Generation Routine which is available in the CCC-82/ANISN code package. This version will read data from a card image tape, the mode by which NOX is distributed, and write an unformatted tape for direct use with ANISN.

7. CONTRIBUTORS

Neutron Physics and Mathematics Divisions, Oak Ridge National Laboratory

8. DATA FORMAT AND COMPUTER

BCD card images; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

To read the NØX data from a card image tape and rewrite it on an unformatted tape requires 14 seconds on the IBM 360/91.

10. REFERENCES

a. Documentation available with library:

- (1) E. A. Straker and B. J. McGregor, "A Calculation of Gamma-Ray Production and Transport in Liquid Nitrogen," ORNL-TM-3635 (Dec. 1971).
- (2) L. R. Williams, "Input Description for LIBGEN," informal notes (1972).
- (3) G. M. Reynolds and S. M. Sperling, "A Re-analysis of Secondary Gamma-Ray Spectra Produced in Liquid Nitrogen by 14 MeV Neutrons," DNA 2831F or SAI-71-550-LJ (March 1972).

b. Other documentation useful in defining library:

- (4) G. M. Reynolds, "Gamma-Ray Transport in Liquid Nitrogen," GA-9429 or DASA 2331 (1969).
- (5) E. A. Straker et al., "Investigation of the Adequacy of Nitrogen Cross Section Sets: Comparison of Neutron and Secondary Gamma-Ray Transport Calculations with Integral Experiments," ORNL-TM-3768 (July 1972).
- (6) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967).
- (7) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967).
- (8) E. A. Straker, P. N. Stevens, D. C. Irving, and V. R. Cain, "The MORSE Code - A Multigroup Neutron and Gamma-Ray Monte Carlo Transport Code," ORNL-4585 (September 1970).
- (9) R. Q. Wright, N. M. Greene, J. L. Lucius, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (Sept. 1969).
- (10) J. R. Knight and F. R. Mynatt, "MUG - A Program for Generating Multigroup Photon Cross Sections," CTC-17 (January 1970).
- (11) C. L. Thompson and E. A. Straker, "06R-ACTIFK, Monte Carlo Neutron Transport Code," ORNL-TM-3050 (August 1969).

- (12) P. G. Young and D. G. Foster, Jr., "An Evaluation of the Neutron and Secondary Gamma-Ray Production Cross Sections for Nitrogen," LA-4725 (1972).
- (13) P. G. Young and D. G. Foster, Jr., "An Evaluation of the Neutron and Secondary Gamma-Ray Production Cross Sections for Oxygen," LA-4780 (1972).
- (14) R. W. Roussin, "The Defense Nuclear Agency Working Cross Section Library: Description and Contents," ORNL-RSIC-34 (1972).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in section 10a above,
- b. one reel of magnetic tape containing the cross section data and retrieval program.

Persons requesting the package should send a reel of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the code package may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT

August 1972.

RSIC DATA LIBRARY DLC-18/NAB

1. NAME AND TITLE OF DATA LIBRARY

NAB: 100-Group, P₃ Neutron Cross Section Data for Sodium and Aluminum.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

LIBGEN: Library Generation Routine to Produce Unformatted Cross-Section Tape for Input to ANISN.

3. HISTORICAL BACKGROUND INFORMATION

The cross-section data were compiled at ORNL to be used for studies of neutron transport through sodium, particularly in conjunction with the calculations with the MORSE Monte Carlo code of the ORNL-LMFBR Sodium Benchmark Experiment. This experimental program involves the measurements of neutron transport through up to fifteen feet of sodium. The NAB data were judged to be satisfactory for most practical applications to problems involving deep penetration of neutrons.¹

4. APPLICATIONS OF THE DATA

DLC-18 is suitable for multigroup neutron transport calculations in sodium or sodium contained in aluminum tanks, such as the ORNL-LMFBR Sodium Benchmark Experiment.² The retrieval program manipulates such that it can be used in codes such as CCC-82/ANISN,⁴ CCC-89/DOT,⁵ and CCC-127/MORSE.⁶

5. SOURCE AND SCOPE OF THE DATA

The 100 neutron group data were produced by PSR-13/SUPERTOG⁷ using a "1/E" weighting spectrum for non-thermal energies. The energy group structure is that used for the GAM-II⁸ which covers the energy range from 14.92 MeV to thermal. The thermal group cross sections were determined by assuming a Maxwellian weighting function and a constant scattering cross section and a "1/v" absorption cross section.

18.2

This data represents a P_3 Legendre expansion approximation for neutron elastic scattering. Inelastic neutron scattering was treated as isotropic in the lab system.

The multigroup cross sections were generated from a preliminary version of the ENDF/B-III MAT 1156 sodium and MAT 1135 aluminum. Subsequent changes to the evaluated data prior to its official release as part of ENDF/B Version III would affect the data in DLC-18/NAB somewhat, but probably not significantly.

Because the materials used in the experiment were not free from impurities, these were included as follows:

Calcium	400 ppm
Oxygen	200 ppm
Potassium	150 ppm
Hydrogen	50 ppm

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

LIBGEN is a modified version of the Library Generation Routine which is available in the CCC-82/ANISN code package. This version will read data from a card image tape, the mode by which NAB is distributed, and write an unformatted tape for direct use with ANISN.

7. CONTRIBUTORS

Neutron Physics and Mathematics Divisions, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

RCD or EBCDIC card images; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

To read the NAB data from a card image tape and rewrite it on an unformatted tape requires 15 seconds on the IBM 360/91.

10. REFERENCES

- a. Documentation available with library:
- (1) F. R. Mynatt, M. J. Gritzner, R. E. Maerker, and B. J. McGregor, "Fast Reactor Shielding Monthly Progress Report for March 1972, 189a No. 10028, Activity No. 40 01 61," ORNL-TM-3800 (May 1972), pages 30 through 35.
 - (2) L. R. Williams, "Input Description for LIBGEN," informal notes (1972).
- b. Other documentation useful in defining library:
- (3) F. R. Mynatt, et al., "Fast Reactor Shielding Monthly Progress Reports," during the period August 1971 to March 1972. ORNL-TM-3573, - 3606, - 3639, - 3666, - 3695, -3746, -3786, and -3800.
 - (4) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (March 1967).
 - (5) F. R. Mynatt, "A User's Manual for DOT," K-1694 (January 1967).
 - (6) E. A. Straker, P. N. Stevens, D. C. Irving, and V. R. Cain, "The MORSE Code - A Multigroup Neutron and Gamma-Ray Monte Carlo Transport Code," ORNL-4585 (September 1970).
 - (7) R. Q. Wright, N. M. Greene, J. L. Lucius, and C. W. Craven, Jr., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (Sept. 1969).
 - (8) G. D. Joanou and J. S. Dudek, "GAM-II: A B_3 Code for the Calculation of Fast-Neutron Spectra and Associated Multigroup Constants," GA-4265 (1963).
 - (9) M. K. Drake, Editor, "Data Formats and Procedures for the ENDF Neutron Cross Section Library," BNL-50274 (T-601) (ENDF-102, Vol. 1) (October 1970).

11 CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in section 10a above,
- b. one reel of magnetic tape containing the cross section data and retrieval program.

Persons requesting the package should send a reel of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the code package may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT

August 1972.

RSIC DATA LIBRARY DLC-19/DECAYGAM

1. NAME AND TITLE OF DATA LIBRARY

DECAYGAM: Radioactive Decay Gamma-Ray Spectra Compilation.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

PRINTGAM: Edit Routine for Radioactive Decay Gamma-Ray Spectra.

3. HISTORICAL BACKGROUND INFORMATION

There was a need at the Oak Ridge National Laboratory for an up-to-date compilation of radioactive decay gamma-ray spectra with an emphasis on fission products. A data library using punched cards grew over a period of time and underwent many revisions. The present version available on tape represents a collection from many sources and includes some unpublished compilations of the Oak Ridge National Laboratory Nuclear Data Project.

4. APPLICATION OF THE DATA

Gamma-ray decay spectra have many applications. It is particularly useful for activation analysis. Shield designers need photon spectra for shield thickness and gamma-ray heating calculations. Environmental dose calculations also depend on these data.

5. SOURCE AND SCOPE OF THE DATA

The source of the data are given in the printout with each table of photon energy and intensity. There is a total of 514 tables for isotopes of nearly all elements.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

The data retrieval routine reads the tape and prints the data in tabular form.

7. CONTRIBUTOR

Analytical Chemistry Division, Oak Ridge National Laboratory.

8. DATA FORMAT AND COMPUTER

BCD or EBCDIC card images, IBM 360.

9. TYPICAL RUNNING TIME

A printout by the retrieval program takes a few seconds on the IBM 360/91.

10. REFERENCE

Source of data is cited as records preceding each data set on the reel of magnetic tape containing the library.

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation cited above,
- b. the data on magnetic tape, either:
 - (1) 7-track, 556 bpi (unblocked)
 - or (2) 9-track, 800 bpi (blocked)

Persons requesting the library should send a full (2400 ft) reel of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to:

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area Code 615; 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

October 1972.

RSIC DATA LIBRARY DLC-20/TRANSMIT

1. NAME AND TITLE OF DATA LIBRARY

TRANSMIT: Experimental Neutron Transmission Data Used to Test Total Cross Sections.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

XTRSIC: A Program to Print Experimental Transmission Data by Element.

3. HISTORICAL BACKGROUND INFORMATION

Since evaluated cross section data are ultimately used to predict neutron transmission through shields comparatively thicker than the samples normally used to make cross section measurements, the Defense Nuclear Agency sponsored experiments to test the data with samples of realistic thicknesses.

These transmission checks are necessary because the total cross-section evaluations are based on measurements from various sources using different techniques covering different energy regions and often with inadequate energy resolution to resolve all of the structure in the cross sections. This situation results in two major sources of errors in the file affecting the cross-section magnitude and its energy scale. The energy scale differences in the data may often be solved, for a given element, at the time the evaluation is made when there is sufficient energy overlap between the various data sets. However, for practical shielding applications involving several elements, it is difficult to insure that the energy scale of the different evaluations is consistent unless a high degree of absolute accuracy is achieved in each evaluation. The finite energy resolution of the transmission data, upon which the total cross section's evaluation is based, may cause very serious errors when all of the structure is not resolved. This is so because the average transmission obtained at a given energy for a specific sample thickness cannot be converted to an average cross section which would be valid for other energy resolutions and/or sample thickness. Above 0.5 MeV neutron energy, total cross sections

are usually obtained from transmission measurements using time-of-flight with a "white neutron source" and recoil proton detectors for sample thicknesses between 0.2 and 0.3 atoms per barn. Our measurements which were obtained with similar techniques will, therefore, test the adequacy of these data with sample thicknesses 3 to 4 times larger. From 0.2 to 0.5 MeV the data situation varies very much from nuclei to nuclei, and often the evaluations are based on very fragmentary data from diverse sources. It is very difficult to estimate a priori the adequacy of the evaluations in this energy region, but typically we may expect errors to be as large as 30 to 40%.

4. APPLICATION OF THE DATA

The data may be compared with the uncollided flux transmission probabilities based on any newly evaluated or newly acquired total cross section file.

5. SOURCE AND SCOPE OF THE DATA

Neutron transmission measurements, from 0.2 to 20.0 MeV, have been made for the shielding materials carbon, oxygen, aluminum, silicon, calcium, iron and the compound silicon dioxide. The measurements were performed at the ORELA Shield Test Station with a resolution of about 0.12 nsec/meter on sample thicknesses varying from 0.65 to 0.9 atoms/barn. The transmission measurements were compared with the predictions obtained from the Defense Nuclear Agency evaluated cross-section library as of October 1972. Since the total cross-section files for these elements are also the ones present in the ENDF/B-III library, we also checked its total cross-section files for all of these elements with the exception of oxygen. There are serious discrepancies between our data and the predictions based on the evaluated files. These discrepancies are often large in the energy region from 0.2 to 0.6 MeV.

The experimental technique and the data reduction method are described in Sec. II of Ref. 1. The experimental results and the comparison with the predictions of the evaluations are shown in Sec. III of Ref. 1.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

The transmission data is formatted to provide a list of the transmission for each energy and estimated error. The retrieval program simply locates the desired element(s) and prints the data.

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD or EBCDIC card image; IBM 360.

9. TYPICAL RUNNING TIME

A complete printout required 28 seconds CPU time on the IBM 360/75.

10. REFERENCE

F. G. Perey, T. A. Love, and W. E. Kinney, "A Test of Neutron Total Cross-Section Evaluations from 0.2 to 20 MeV for C, O, Al, Si, Ca, Fe, and SiO₂," ORNL-4823 (ENDF-178) (1972).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the referenced document, and
- b. a reel of magnetic tape on which is written in separate files: the transmission data for 7 materials, the retrieval program, XTRSIC, and input and output from running a sample edit.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to be written as indicated below.

- (1) 7-track, 556 bpi (unblocked) - 2 reels
- (2) 9-track, 800 bpi (blocked) - 1 reel

12. HOW TO OBTAIN THE LIBRARY

Inquiries or requests for the data package may be mailed to

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to

Area code 615; 483-8611, extension 3-6944 or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT AND CURRENT VERSION

October 1972.

RSIC DATA LIBRARY DLC-21/KXRAY

1. NAME AND TITLE OF DATA LIBRARY

KXRAY: Evaluated X-Ray Cross Section Library.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

RDXRAY: A Program for Printing the KXRAY Data.

3. HISTORICAL BACKGROUND INFORMATION

This set of evaluated data for X-ray interactions is described in Refs. 1-3 and replaces an earlier compilation, also by Kaman.⁴ Two other photon interaction libraries, DLC-7 and DLC-15, are also packaged as part of the RSIC Data Library Collection, but their energy range extends only to 1-keV. The emphasis of DLC-21 is toward lower energies, its range extending from 0.1 keV to 1 MeV, and the library provides data in an energy region not covered by the others.

4. APPLICATIONS OF THE DATA

For use in general purpose X-ray transport codes.

5. SOURCE AND SCOPE OF THE DATA

The procedure used in the evaluation and compilation of the X-ray library are described in Ref. 1. The first 34 pages of that report are supplied in the documentation provided with DLC-21. Additional useful information is given in Refs. 2 and 3.

Experimental X-ray attenuation cross sections for 94 elements for energies between 0.1 keV and 1 MeV were obtained for the period from 1920 through 1970. Exact photoelectric absorption values also were calculated for hydrogen. Scattering cross sections were calculated by relativistic SCF methods. These were subtracted from total attenuation data, and the resulting photoelectric and measured photoelectric absorption cross sections from 1 keV to 1 MeV were fit by a least squares procedure to obtain best values. Interpolations were made for elements and energy ranges for which there were no experimental data. In addition, from 0.1 keV to between 1 keV and 10 keV non-relativistic,

self-consistent, independent electron theory was used to calculate photoelectric absorption cross sections. Thus, for this energy range, values based on least squares fits and on calculations are given, with the calculated values recommended. Scattering values were added to all photoelectric cross sections to obtain a best set of attenuation cross sections.

Values are tabulated in units of barns/atom as a function of energy (keV). Data are given for photoelectric, coherent scattering, incoherent scattering, incoherent scattering (absorption component), and total attenuation.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

RDXRAY is a program to read and list the contents of a tape containing DLC-21/KXRAY.

7. CONTRIBUTOR

Kaman Sciences Corporation, Colorado Springs, Colorado.

8. DATA FORMAT AND COMPUTER

BCD or EBCDIC card image, IBM 360/75/91.

9. TYPICAL RUNNING TIME

To list the entire library using RDXRAY requires approximately 5 minutes on the 360/75.

10. REFERENCES

a. Documentation available with library

- (1) Wm. J. Veigele, E. Briggs, L. Bates, E. M. Henry, and B. Bracewell, "X-Ray Cross Section Compilation from 0.1 keV to 1 MeV, Vol. 1, Rev. 1, Discussion and Results," DNA 2433F, (KN-71-431(R)), July 1971. The first 34 pages are packaged with DLC-21.

- (b) Other documentation helpful in defining library
- (2) Wm. J. Veigele et al., "X-Ray Cross Section Compilation from 0.1 keV to 1 MeV, Vol. II, Rev. 1, Input Data and Supplemental Results," DNA 2433F (KN-71-431(R)), July 1971.
 - (3) E. Briggs and Wm. J. Veigele, "Supplementary Report to X-Ray Cross Section Compilation from 0.1 keV to 1 MeV," DNA 2433F (K-72-431(SR)), August 1972.
 - (4) Wm. J. Veigele, E. Briggs, B. Bracewell, and M. Donaldson, "X-Ray Cross Section Compilation," KN-798-69-2(R) October 1969: B. Bracewell and Wm. J. Vergele, Bull. Am. Phys. Soc. 15, 72 (1970).

11. CONTENTS OF LIBRARY

The library package contains the following items:

- a. the reference listed in section 10a above.
- b. a reel of magnetic tape containing the library, program RDXRAY and sample input and output.

Persons requesting the library should send a full (2400 ft) reel of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to:

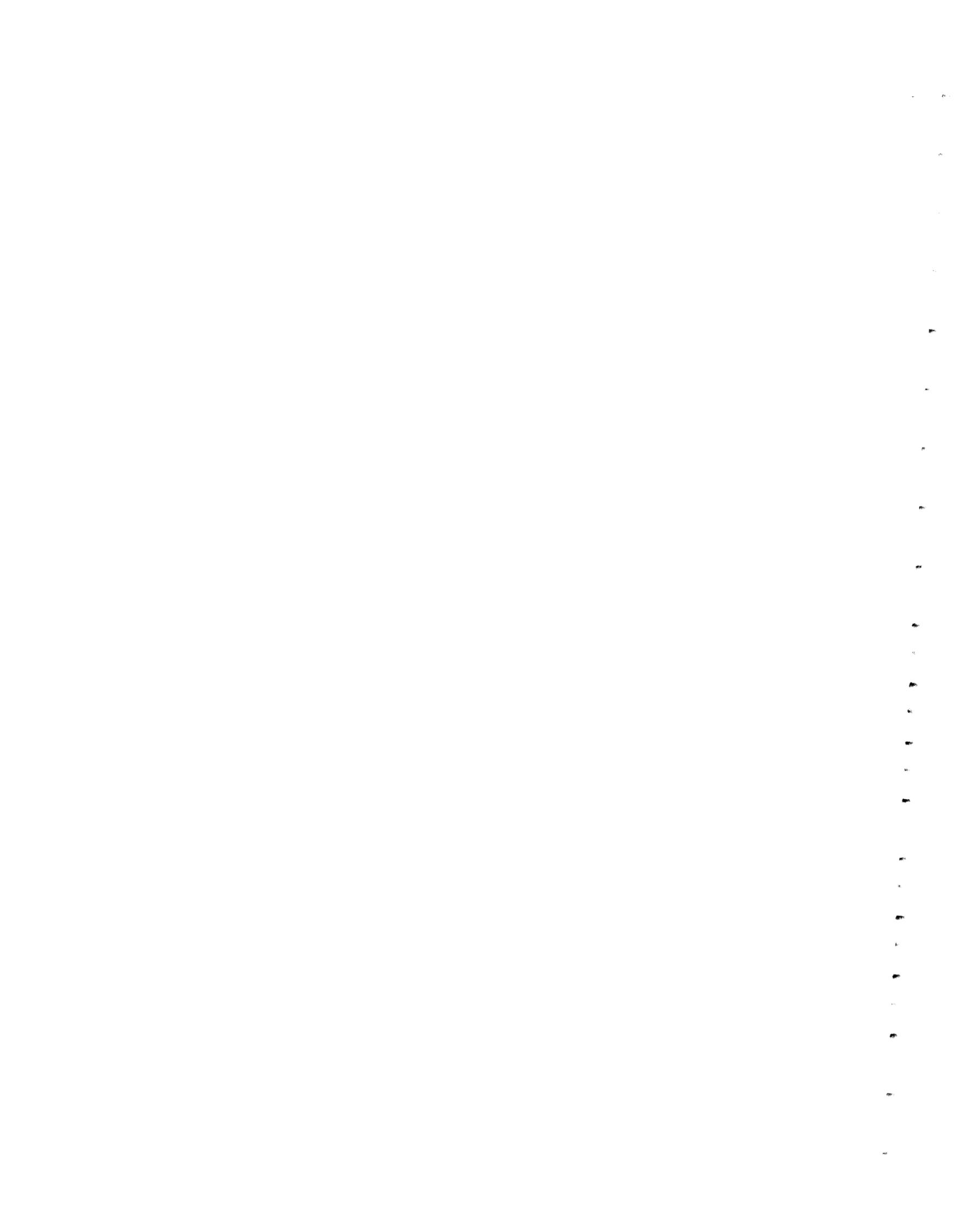
DATA COORDINATOR
 Radiation Shielding Information Center
 Oak Ridge National Laboratory
 P. O. Box X
 Oak Ridge, Tennessee 37830

or telephoned to:

Area Code 615, 483-8611, extension 3-6944, or to
 FTS xx-615-483-6944.

13. DATE OF ABSTRACT

November 1972.



RSIC DATA LIBRARY DLC-22/FLEP

1. NAME AND TITLE OF DATA LIBRARY

FLEP: Coefficients for the Analytic Representation of Nonelastic Cross Sections and Particle-Emission Spectra from Various Nucleon-Nucleus Collisions in the Energy Range 25 to 400 MeV.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

NCDATA: A Program for Interpolating Between the Energies and Nuclei Specified in the FLEP Data Library.

3. HISTORICAL BACKGROUND INFORMATION

The Low-Energy Intranuclear Cascade Code System, packaged as CCC-47/LEP, has been used to generate particle-production spectra from a variety of nucleon-nucleus collisions in the energy range of 25 to 400 MeV. In order to make these data more accessible, analytic representations of the data have been obtained by a linear least-squares fitting procedure. The NCDATA computer program was written to provide a means of interpolating the FLEP library to obtain data for incident nucleon energies and target nuclei not specifically included.

4. APPLICATIONS OF THE DATA

The analytic representations are intended for use as input cross-section data to transport codes. They have been used most extensively in transport codes that utilize the method of discrete ordinates.

5. SOURCE AND SCOPE OF THE DATA

The fitting procedure is described in detail in Ref. 1. Analytic fits are given for both protons and neutrons incident on the elements C, O, Al, Cr, Cu, Ru, Ce, W, Pb, and U for:

- a. the nonelastic cross section as a function of energy;
- b. the cascade neutron- and proton-emission spectra in the angular intervals 0-30°, 30-60°, 60-90°, and 90-180°;

- c. the evaporation neutron- and proton-emission spectra (assumed isotropic); and
- d. the cascade neutron- and proton-emission spectra integrated over all angles.

Plots are available (on microfiche) which compare the original data generated by CCC-47/LEP with the analytic representation resulting from the fitting procedure.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

The NCDATA² code, by means of interpolation, will provide an analytic representation of the particle-emission spectra for neutrons and protons having energies between 25 and 400 MeV incident on any element with atomic weight between 12 and 238.

7. CONTRIBUTOR

Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

8. DATA FORMAT AND COMPUTER

BCD card image, IBM 360/75/91.

9. TYPICAL RUNNING TIME

To generate data for protons incident on iron requires 47 seconds on the IBM 360/75.

10. REFERENCES

a. Documentation available with library:

- (1) R. G. Alsmiller, Jr., M. Leimdorfer, and J. Barish, "Analytic Representation of Nonelastic Cross Sections and Particle-Emission Spectra from Nucleon-Nucleus Collisions in the Energy Range 25 to 400 MeV," ORNL-4046 (April 1967). Selected pages are supplied with the library.
- (2) R. G. Alsmiller, Jr. and J. Barish, "NCDATA - Nuclear Collision Data for Nucleon-Nucleus Collisions in the Energy

Range 25 to 400 MeV," ORNL-4220 (February 1968).

(3) Description of the Contents of the Microfiche - Comparison Plots, Informal Notes.

b. Other documentation helpful in defining library:

(4) Hugo W. Bertini, Phys. Rev. 131, 1801 (1963), with erratum, Phys. Rev. 138, AB2 (1965).

(5) Hugo W. Bertini, Nucl. Phys. 87, 138 (1966).

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

a. the documentation listed in 10a above,

b. a reel of magnetic tape containing FLEP, NCDATA and sample input and output, and, if specifically requested, plots on microfiche comparing the original LEP results and the analytical representation from the fitting procedures.

Persons requesting the library should send a full (2400 ft) reel of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to:

DATA COORDINATOR
Radiation Shielding Information Center
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

or telephoned to:

Area Code 615, 483-8611, extension 3-6944, or to
FTS xx-615-483-6944.

13. DATE OF ABSTRACT

November 1972.

RSIC DATA LIBRARY DLC-23/CASK

1. NAME AND TITLE OF DATA LIBRARY

CASK: 40 Group Coupled Neutron and Gamma-Ray Cross-Section Data.

2. NAME AND TITLE OF DATA RETRIEVAL PROGRAM

LIBGEN: A Computer Program to Generate an Unformatted Cross Section Tape for Input to ANISN.

3. HISTORICAL BACKGROUND INFORMATION

The cross section data in DLC-23 were compiled for the purpose of performing calculations of spent fuel shipping casks. The data were described at the 1972 annual ANS meeting in Las Vegas and results² using the data were also presented. Since the library is based on relatively recent point cross-section data, it was felt that it would be useful to make it available.

4. APPLICATIONS OF THE DATA

The data were designed for use in shielding analysis of PWR depleted uranium shipping casks. Results of such an analysis are given in Ref. 2. The data were collapsed from a fine group structure using a weighting function representative of a water-uranium mixture.³ Thus, the application of this data for problems not similar to the shipping cask type should be done with caution.

5. SOURCE AND SCOPE OF THE DATA

This library of coupled neutron and gamma-ray cross sections was compiled for several elements that are commonly used for shielding calculations. The coupled, P_3 , cross sections are given in the ANISN format which permits their usage in the discrete ordinates codes ANISN⁴ and DOT⁵ as well as the three dimensional Monte Carlo code, MORSE⁶. The data sets from which DLC-23 was derived are listed in Ref. 3.

The library contains data for H, Be, 10-B, C, N, O, Na, Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Mo, Ta, W, Pb, 235-U, 238-U, 239-Pu, and 240-Pu.

The source for the neutron cross sections was primarily the ENDF/B-II library, although some data were taken from other sources when necessary, as indicated in Ref. 3. The SUPERTOG⁷ code was used to generate resonance corrected fine group cross sections for 104 energy groups⁸ from the ENDF/B library. Single level Breit-Wigner or multi-level Breit-Wigner resonance parameters were used by SUPERTOG to generate point cross sections for the resonance nuclides. Approximately 100 points per resolved resonance were used to integrate the point cross sections for the fine groups. In the unresolved resonance region 81 points per fine group were used for the integration. A 1/E spectral weighting function was used.

The multigroup neutron cross sections in a 22 energy group structure were obtained from the 104 group cross sections by averaging the various elemental cross sections across a fine group flux calculated by ANISN for a uranium-water mixture using fine group cross sections. This weighting function is given in Ref. 3.

The secondary gamma-ray production cross sections were calculated by the POPOP4⁹ code. Gamma-ray transport cross sections were calculated for an 18 group gamma energy structure by the MUG¹⁰ code. The multigroup neutron cross sections, the secondary gamma production cross sections, and the gamma ray transport cross sections were coupled to form a 40 group set. This is the same 40 group structure as used by Straker for various shielding calculations¹¹ and it is tabulated in Ref. 3.

Calculations of the neutron and gamma-ray fluence from several shielding problems have been performed and some results of these calculations are discussed in Ref. 2.

6. DISCUSSION OF THE DATA RETRIEVAL PROGRAM

LIBGEN is a modified version of the Library Generation Routine which is available in the CCC-82/ANISN code package. This version

will read data from a card image tape, the mode by which CASK is distributed, and write an unformatted tape for direct use with ANISN.

7. CONTRIBUTORS

Neutron Physics and Mathematics Divisions, Oak Ridge National Laboratory.

Science Applications, Inc. Huntsville, Alabama.

Division of Material Licensing, U.S. Atomic Energy Commission, Washington, D. C.

8. DATA FORMAT AND COMPUTER

BCD card images; IBM 360/65/75/91.

9. TYPICAL RUNNING TIME

To read the CASK data from a card image tape and rewrite it on an unformatted tape requires 23 seconds on the IBM 360/91.

10. REFERENCES

a. Documentation available with library:

- (1) G. W. Morrison, E. A. Straker, and R. H. Odegaarden, "A Coupled Neutron and Gamma-Ray Multigroup Cross Section Library for Use in Shielding Calculations," Trans. Am. Nucl. Soc., 15, 535 (1972).
- (2) G. W. Morrison, E. A. Straker, and R. H. Odegaarden, "The Use of the MORSE Monte Carlo Code to Solve Shielding and Criticality Problems of Spent Fuel Casks," Trans. Am. Nucl. Soc., 15, 547 (1972).
- (3) R. W. Roussin and J. B. Wright, "Contents, Energy Group Structure, and Weighting Function Used for DLC-23/CASK," informal notes (1972).

b. Other documentation helpful in defining library:

- (4) W. W. Engle, Jr., "A User's Manual for ANISN," K-1693 (1967).
- (5) F. R. Mynatt, et al., "A User's Manual for DOT," K-1694 (1967).

- (6) E. A. Straker, et al., "The MORSE Code, A Multigroup Neutron and Gamma-Ray Monte Carlo Transport Code," ORNL-4585 (1970).
- (7) R. Q. Wright, et al., "SUPERTO: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679 (1969).
- (8) A. E. Profio, Ed., "Shielding Benchmark Problems," ORNL-RSIC-25 (1970).
- (9) W. E. Ford, III and D. H. Wallace, "POPOP4: A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Production Cross Sections," CTC-12 (1969).
- (10) J. R. Knight and F. R. Mynatt, "MUG - A Program for Generating Multigroup Photon Cross Sections," CTC-17 (1970).
- (11) E. A. Straker and M. L. Gritzner, "Neutron and Secondary Gamma-Ray Transport in Infinite Homogeneous Air," ORNL-4464 (1969)

11. CONTENTS OF THE LIBRARY

The library package contains the following items:

- a. the documentation listed in 10a above,
- b. one reel of magnetic tape containing DLC-23 data, retrieval program, and sample input and output.

Persons requesting the library should send the appropriate number of full (2400 ft) reels of magnetic tape to the address listed below.

12. HOW TO OBTAIN LIBRARY

Inquiries or requests for the library may be mailed to

DATA COORDINATOR
 Radiation Shielding Information Center
 Oak Ridge National Laboratory
 P. O. Box X
 Oak Ridge, Tennessee 37830

or telephoned to:

Area code 615; 483-8611, extension 3-6944, or to:
 FTS xx-615-483-6944.

13. DATE OF ABSTRACT

December 1972.