RSIC Newsletter

RADIATION SHIELDING INFORMATION CENTER

OAK RIDGE NATIONAL LABORATORY

OPERATED BY UNION CARBIDE CORPORATION • FOR THE U.S. ATOMIC ENERGY COMMISSION

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No. 97 *December 1972*

There is a certain relief in change, even though it be from bad to worse; as I have found in traveling in a stagecoach, that it is often a comfort to shift one's position and be bruised in a new place.

...Irving, Tales of a Traveler

SPACE SHIELDING HANDBOOK NOW AVAILABLE

SHIELDING OF MANNED SPACE VEHICLES AGAINST PROTONS AND ALPHA PARTICLES, by R. G. Alsmiller, Jr., R. T. Santoro, J. Barish, and H. C. Claiborne, is now available as ORNL-RSIC-35. The emphasis in the report is on shielding against Van Allen belt protons and against solar-flare protons and alpha particles, but information on shielding against galactic cosmic rays is also presented.

This summary is primarily intended as a handbook for nonexperts in space shielding. For the most part, the approximation methods discussed are those that are standard in the space-shielding literature. However, a large amount of numerical data, not previously published, on the validity of the various approximation methods is presented. These data may be of interest to those who are familiar with space shielding.

The report is being mailed to those people who requested it through returning the reservation form published in the September 1972 issue of the RSIC Newsletter. A limited number of copies are still available and may be requested by those not having already done so.

CONCRETE FOR NUCLEAR REACTORS

The American Concrete Institute is announcing the availability of "Concrete for Nuclear Reactors," Special Publication Number 34, 3 volumes containing 75 papers totaling 1766 pages. An international endeavor, this report groups the individual papers under the following general subject categories: current use of concrete in nuclear reactors; what the designer needs to know; relation of concrete properties to design calculations; concrete strength under different states of stress; and effects of elevated temperatures on concrete strength and other properties. Other categories include: concrete creep related to

nuclear reactor applications, concrete behavior under long-term thermal influences; moisture migration in concrete; thermal properties, effects of neutron irradiation; special shielding concretes; chemical compatibility problems; prestressed concrete; air permeability; apparatus and instrumentation for measuring concrete properties; model tests and measurements on full-scale vessels; improving concrete properties; and future research and development. A 365-entry annotated bibliography on concrete for radiation shielding is included.

Edited by Clyde E. Kesler, this massive work is available from the AMERICAN CONCRETE INSTITUTE, Box 4754, Detroit, Mich. 48219 at the following prices:

6 x 9 in. format	$20.00 to ACI Members
3 volume set	27.50 to Non Members
Enameled paper cover	
Handling Charges:	$ .50 on orders of $10.00 or less
	1.00 on orders of $10.01 or more.
	(Michigan residents add 4% sales tax.)

ACTIVITIES OF THE ANS SHIELDING STANDARDS SUBCOMMITTEE

The Shielding Standards Subcommittee, ANS-6, following a meeting in Washington, November 14, in conjunction with the American Nuclear Society (ANS) report the following. The standards, ANSI N18.9-1972, "Program for Testing Biological Shielding in Nuclear Reactor Plants" and ANSI N101.6, "Concrete Radiation Shields," are now available from Society headquarters in Hinsdale, Illinois, at costs of $5.00 and $15.00 respectively.

Working Group 6.3, led by P. J. Persiani (ANL), will be encouraging the use of N18.9, accumulating feedback on its use, and preparing future revisions.

A subgroup led by B. A. Engholm (GGA) has drafted an outline for a concrete shielding analysis and design standard. They expect to have a draft by the time of the 1973 June ANS meeting.

A group of suppliers of lead were polled by D. K. Trubey, subcommittee chairman, in regard to their opinion of the need for shielding lead standards. The meager response obtained was negative. Further inquiries are planned.

The Benchmark Problems Group, led by G. L. Simmons (B&W) has several problems which should be ready for publication within a few months.

The Nomenclature group, led by H. E. Hungerford (Purdue), is working on a list of special terms which will be considered for a shielding glossary.

D. E. Bartine (ORNL) reported on work based on sensitivity analysis which might be used to form a reference set of coupled neutron-gamma-ray cross sections. All nuclides usually found in concrete are included. The fine-group set has energy boundaries which take account of all important minima in the total cross sections. Using sensitivity analysis for specific problems, the fine-group set can be collapsed to few-group sets.

IAEA DATA SYMPOSIUM

The International Atomic Energy Agency (IAEA) will convene a Symposium on Applications of Nuclear Data in Science and Technology, in Paris, March 12-16, 1973, with the Government of France as host. The aim of this Symposium is to serve as a forum for intercommunication between users, compilers, and evaluators of nuclear (including neutron) data for applications in science and technology. A list of proposed topics includes: nuclear data for fission reactors, nuclear data for activation analysis, status of compilations and evaluation of nuclear structure and reaction data, nuclear data in applications of radioisotopes, nuclear data for safeguards, nuclear data for thermonuclear fission reactors, nuclear data for space and accelerator shielding, nuclear data for astrophysics, and a summary panel. Names of participants must be presented by the government of an IAEA member state or by an international organization invited to participate. Proceedings of the meeting will be published.

MODIFICATIONS TO THE DNA WORKING CROSS SECTION LIBRARY

Two evaluations have recently been modified. The most recent versions for these are MAT 4151 MOD 2 Si and MAT 4136 MOD 4 Pb. The modifications are summarized as

1. Silicon - MAT 4151 - BNL (ORNL evaluating after MOD 2)
   MOD 2 October 1972

   Total cross section reevaluated by spline fitting to NBS data from 0.5 to 20 MeV. This caused corresponding changes to elastic, nonelastic, and inelastic; the inelastic discrete level and continuum cross sections based on ABACUS-2 calculations. The (n,α) was reevaluated from 8.4 to 20 MeV based on new data. Elastic scattering angular distributions were supplemented by new data. Legendre coefficients for the 1.779 level inelastic scattering were calculated from new data. Gamma-ray production data was recalculated to conform to the new cross sections. Continuum energy distribution was calculated by a statistical model.

2. Lead - MAT 4136 - ORNL
   MOD 4 November 1972

   Card punch errors were found at a few energies in the capture and total cross section. Due to summation and subtraction of various

cross sections, errors were also introduced in other cross sections. These errors are present in both MOD 2 and MOD 3. We recommend replacing with MOD 4.

ABSTRACTS OF NEW DATA PACKAGES

Appended to this copy of the RSIC Newsletter are abstracts of two data library packages assembled by RSIC. They are appropriately punched for inclusion in the ORNL-RSIC-30, Vol. 1, book of abstracts. The binders and a collection of abstracts DLC-1 through DLC-20 are available from RSIC upon request. The following packages are now available. Their contents are discussed in detail in the accompanying abstracts.(Abstract for DLC-21 not yet available.)

DLC-22/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, contributed by ORNL Neutron Physics Division.

DLC-23/CASK — 40-Group Coupled Neutron and Gamma-Ray Cross Section Data, contributed by ORNL Neutron Physics and Mathematics Divisions, Science Applications, Inc., Huntsville, Alabama, and the USAEC Division of Materials Licensing, Washington, D.C.

ADDITIONS TO THE CODE COLLECTION

Operable, tested with a sample problem, and available for distribution are the following code packages.

PSR-43/FLUSH — Spectral Unfolding Code - Stepwise Regression of System Response Functions, contributed by EG&G, Los Alamos, N. M. FORTRAN IV, CDC 6600. Reference: EGG 1183-5000.

PSR-44/BRMSTK — CSEWG Integral Data Testing Shielding Experiment Code Package, contributed by Neutron Physics Division, Oak Ridge National Laboratory (IBM 360 version - PSR-44A) and the Los Alamos Scientific Laboratory (CDC 6600 version - PSR-44B). References: ORNL-TM-3867, -3868, -3869, -3870, -3871, -3957, and -3974.

PSR-45/GAUSS V — Analysis Code for Gamma-Ray Spectra from Ge(Li) Spectrometers, contributed by Aerojet Nuclear Company, Idaho Falls. FORTRAN IV, IBM 360. Reference: ANCR-1043.

CHANGES TO CCC-181/DEMON CODE PACKAGE

Minor changes have been made in the CCC-181/DEMON code package to permit the use of logical unit numbers other than 1 and 3 for input and output units, respectively. The new version uses 5 and 6 (IBM standard). Current users of DEMON need not modify their version unless this feature must be implemented. Requests filled after November 22, 1972 will include the changes.

PERSONAL ITEMS

RSIC has been informed of changes of address by the following people: *Conrad Lennon* from Computer Science Corporation, El Segunda, to Holmes and Narver; *John R. Hendricks* from the University of Cincinnati to Westinghouse Bettis Atomic Power Laboratory; *Charles A. Goetz* from McDonnell Douglas at Huntington Beach to Bechtel Power Corporation in Los Angeles; *James J. Ritts* from WARD, Waltz Mill Site, Madison, Pa., to the TVA in Knoxville, Tennessee; *Paul S. Pickard* from the University of Arizona to the Nuclear Engineering Laboratory of the University of Illinois; *A. G. Bullard* from VPI, Blacksburg, Va., to Carolina Power and Light in Raleigh; *Fred T. Stetson, Jr.* from Ge-KAPL to Yankee Atomic Electric, Westborough, Mass.; *E. N. Shipley* from BELLCOMM, Washington, D.C. to Bell Telephone Laboratories in New Jersey; and *George Kear* from Lockheed-Sunnyvale to Lockheed-Palo Alto Research Laboratory.

Dr. Raymond Gold, formerly with Argonne National Laboratories, has been appointed Resident Director of the Joint Center for Graduate Study in Richland, Washington, and assumed his duties there on November 1. The Center is operated by Oregon State University, the University of Washington, and Washington State University and provides opportunity for graduate education in Nuclear Science, Engineering, and other selected fields.

Mary Ann Capo and *Richard N. Nassano* have transferred from the Astronuclear Laboratory in Pittsburgh to the Westinghouse operation in Jacksonville, Fla., known as Offshore Power Systems. They are performing radiation shielding and source calculations for the PWR which is located on an offshore barge.

W. E. (Bill) Kreger has recently joined the Radiological Assessment Branch of the AEC Directorate of Licensing in Washington. Bill is chairman of Section 3 of the ANS Standards Committee and was formerly with Physics International.

AVAILABLE RSIC REPORTS

We are again including a LIST OF REPORTS ISSUED BY RSIC, attached to the end of the Newsletter so that it may easily be detached and retained for reference. We will continue to supply copies to requesters until supplies are exhausted.

VISITORS TO RSIC

Visitors to RSIC during November were: W. H. Harless, Jr., General Electric, Sunnyvale, Calif.; P. J. Hendriksz, General Electric, San Jose, Calif.; Janet Lacetera, BRL, Aberdeen Proving Ground, Md.; D. O. Myatt, Science Communication, Inc., McLean, Va.; C. Papastergiou, Greek AEC, temporarily at ORNL; J. Ranft, Karl-Marx Universität, Leipzig, Germany; Ron Rittenberger, Westinghouse ARD, Madison, Pa.; J. Ritts, TVA, Knoxville, Tenn.

CREDIT CORRECTION

John W. Lucey, Associate Professor in the Department of Aerospace and Mechanical Engineering at the University of Notre Dame, has called our attention to a credit error in the literature accession list on page 16 of the November Newsletter. John Zink's thesis is listed as being done at the University of Oklahoma. Although John is now on the faculty there, he did his thesis research at Notre Dame.

WE AT RSIC
EXTEND TO ALL

Season's Greetings

And best wishes for the coming year

NOVEMBER ACCESSION OF LITERATURE

REACTOR AND WEAPONS SHIELDING

ACI-SPECIAL PUBLICATION NUMBER 34

Concrete for Nuclear Reactors
C. E. Kesler
1972
American Concrete Institute, Detroit, Mich. (3 vol.)

ANU-P-553

Exact Least Squares Fitting of Gamma-Ray Angular Distributions With Several Restricted Linear Parameters
R. A. I. Bell
1972
Australian National Univ., Canberra, Dept. of Nucl. Phys.

BNL- 16817

Monte Carlo Model for Multiparticle Production
D. E. Lyon, Jr.
November 1971
Brookhaven National Laboratory

BNL-tr-495

Neutron Cross Sections of Isotopes Used as Absorbers in Atomic Reactors
V. P. Vertebnyi, M. F. Vlasov, N. L. Gnidak, et al
(Akademiya Nauk Ukrainskoi SSR, Kiev, Institut Fiziki)
June 1970

CEA N 1526 (In French)

Library of Data for Fission Products (Third Edition)
J. Blachot and R. de Tourreil
March 1972
CEA, Grenoble France CEN

CONF-701138

Mathematical Methods for Energy-Dependent Radiation Transport, pp 49-68
D. V. Gopinath

Validity of the Empirical Formulae for Buildup Factors in Multiregion Systems, pp 111-18
D. V. Gopinath, K. Santhanan

Fast-Neutron Transport in Finite Slabs, pp 95-110
K. Santhanam, D. V. Gopinath

Studies for Bulk Shield Optimization for Apsara Reactor. Computer Code Shield and Applications to Other Studies, pp 119-31
S. Sankaranarayanan, R. Narain, S. N. Sen Gupta

Gamma Dose Rate at an Internal Point on X-Z Plane of Solid Radioactive Spheroid Source, pp 135-41
P. C. Gupta

1971
Proceedings of the National Symposium on Radiation Physics, Bombay: Bhabha Atomic Research Centre, Nov. 24, 1970

DNA-2890F

Automatic Computation of Importance Sampling Functions for Monte Carlo Transport Codes-Phase III (U). Final Report
M. H. Kalos, H. Steinberg, et al
June 1972
Avail: Mathematical Applications Group, Inc.

GULF-RT-A10859
(AD-746 870)
(DNEA-2779F)
(DASA01-71-C-0106)

Reanalysis of the Neutron Spectrum Measurements in an Iron Bulk,etc.
R. J. Cerbone
Gulf Radiation Technology, San Diego, Calif.
October 1971

HEDL-TME-71-27

FTR Fission Product Decay Heat
D. R. Marr, W. L. Bunch
February 1971
Hanford Engineering Development Lab., Richland, Wash.

HEDL-TME-72-42

Three Dimensional Neutronics Calculations for the Fast Test Reactor (FTR) and the FTR Engineering Mock Up Critical Assembly (EMC)
R. M. Fleishman, J. V. Nelson
1972
Hanford Engineering Development Lab.

HEDL-TME-72-71

Activated Corrosion Product Radiation Levels Near FFTF Reactor and Closed Loop Primary System Components
T. J. Kabele, W. F. Brehm, D. R. Marr
1972
Hanford Engineering Development Lab.

LA-tr-72-13

Treatment of the Space Dependence of Energy Resonance Self-Shielding at Boundaries of Homogeneous Zones in Reactors
H. Huschke
Kernforschungszentrum, Karlsruhe, Germany, Institut fuer Neutronenphysik

NAA-SR-Memo-8969

Fast Neutron Attenuation Analysis for a Snap Reactor Shadow Shield Using the Flexible Monte Carlo Code, FMC-N
C. Steichen
Aug. 1963
Dep., NTIS

ORNL-RSIC-34, Vol. I

Defense Nuclear Agency Working Cross Section Library: Description and Contents
Robert W. Roussin
October 1972
ORNL, RSIC

ORNL-TM-3732

Radiation Damage in Annealed Type 304 Stainless Steel
E. E. Bloom, J. O. Stiegler, et al
September 1972
Dep., NTIS

ORNL-TR-2584

Dependence of the Design Characteristics of Fast Power Reactors on the Variations of the Used Design Constants and Necessary Accuracy of...
S. M. Zaritskii, et al
February 1970
ORNL

ORO-3604-8

Determination of Densities of Alkali Metals by a Gamma Radiation Attenuation Technique
I. G. Dillon, F. E. LeVert, P. A. Loretan, et al
Tuskegee Inst., Ala., School of Engineering
March 1972
Dep., NTIS

ORP/CSD-72-1

Estimates of Ionizing Radiation Doses in the United States 1960-2000
Alfred W. Klement, Jr., Carl R. Miller, et al
Environmental Protection Agency
August 1972
Supt. of Documents, $1.50

RCN-169

Simple Method for the Construction of Splines with Piecewise Pre-Described Surfaces Over Given Intervals
H. A. van der Vorst
February 1972
(Reactor Centrum Nederland, Petten)

RISO-262

Sigma Master Tape, A Multi-Group Cross Section Library
A. M. H. Larsen
April 1972

RISO-M-1526

Benchmark Calculations on Homogeneous Spheres
H. Neltrup
August 1972
Dep., NTIS

RRA-M7202

Boundary Dose Rates Due to Gamma Rays at Power Reactor Sites
M. B. Wells, D. G. Collins, W. P. Neuendorf
November 1972
(Work supported by Bechtel Corp., San Francisco)

RT/FI(72)6

Fast Neutron Radiative Capture Cross Sections of Stable Nuclei With $29 \leq Z \leq 79$
V. Benzi, R. D'Orazi, G. Reffo, M. Vaccari
February 1972
Dep., NTIS (U.S. Sales Only)

SC-B-71-0886

A Bibliography on Invariant Imbedding and Related Topics
Melvin R. Scott
January 1972
Sandia Laboratories

SC-RR-72 0659

Analytical Approximations for Photon-Atom Differential Scattering Cross Sections Including Electron Binding Effects
Frank Biggs, Ruth Lighthill
October 1972
Sandia Laboratories, Weapons Effects Research Dept.

SCL-DR-720017

Finite Difference Algorithm for the Diffusion Equation in Spherical Coordinates
R. J. Kee
August 1972
Sandia Laboratory, Livermore, Calif.

STI/PUB-295 (Vol. 4)

Atlas of Radiation Dose Distributions, Volume IV. Brachytherapy Isodose Charts Sealed Radium Sources
M. Stovall, L. H. Lanzl, W. S. Moos
1972
IAEA $20.00

TID-25972
(CONF-720832-1)

Radiation Damage in Structural Materials
H. H. Frye, C. J. McHargue
ORNL
1971
Dep., NTIS
(3rd Inter-American Conference on Materials Technology, Rio de Janeiro, Aug. 14, 1972)

UCRL-51271

Analysis of Neutron Shipping Cask Model 0.5T
C. L. Hanson, M. S. Coops
March 1972
Dep., NTIS

WAPD-TM-1038

The Estimation of Acceleration Parameters for the Chebyshev Polynomial and the Successive Overrelaxation Iteration Methods
L. A. Hageman
June 1972
Dep., NTIS

Y-CDC-11

The S_n Method, K. D. Lathrop, Los Alamos Scientific Lab.
The Monte Carlo Method as Applied to Nuclear Criticality Safety,
G. E. Whitesides, ORNL
September 1972
Union Carbide Corp., Nuclear Div., Oak Ridge Y-12 Plant

At. Energ. (USSR) 30(6), 536-7 (June 1971) (In Russian)

Optimization of the Shape of a Shadow Shield Against Neutrons from Surface Source by the Monte Carlo Method
V. L. Generozov, V. A. Sakovich
(Full copy of paper held by USAEC-TIC)

At. Energy USSR 32, 155 (1972) (In Russian)

Approximate Method of Calculating Shielding Against High-Energy Neutrons
B. S. Sychev

At. Energ. (USSR) 32, 457 (1972) (In Russian)

Elementary Solutions of Neutron-Transport Equation Taking Into Account Anisotropic Scattering
N. V. Sultanov

At. Energ. (USSR) 32(6), 504-5 (June 1972) (In Russian)

Gamma Quanta Distribution at Large Distances from the Sources
S. S. Nikolaishvili, A. I. Gabrashvili, N. N. Dzhgarkava, E. A. Iordanishvili

Atomkernenergie 20, 19 (1972)

Transport Theoretical Calculation of Stationary Neutron Fields for Problems with Axial Symmetry
H. Biederbe

IBM J. RES. 16, 354 (1972)

Parallel Shooting Method for Boundary-Value Problems - Application to Neutron-Transport Equation
J. Canosa, H. R. Penafiel

J. Nucl. Energy 26(5) 231-6 (May 1972)

Asymptotic P_N AND PP_N Approximations
S. T. Huang, E. E. Lewis

Nuclear Data Tables 10, 539-566 (1972)

Compilation of Phenomenological Optical-Model Parameters 1969-1970
C. M. Perey, F. G. Perey

Nucl. Safety 13 (5), 353-362 (Sept. Oct. 1972)

Preliminary Observations on the Radiological Implications of Fusion Power
D. Steiner, A. P. Fraas

Nucl. Sci. Eng., 49(3) 349-357 (Nov. 1972

Evaluation of Gamma-Ray Shielding Calculations and Determination of Shielding Parameters with Bremsstrahlung Radiation
L. F. Rodriguez, A. Shapiro

Nucl. Sci. Eng., 49(3) 394-395 (Nov. 1972)

Specification and Testing of Nuclear Data Required for Monte Carlo Transport Calculations
E. D. Cashwell, E. H. Plechaty

Nucl. Tech. 15, 455-461 (Sept. 1972)

Nondestructive Assay of Power Reactor Fuel Assemblies
C. R. Weisbin, R. H. Augustson, J. S. Hendrick, A. E. Evans, G. D. Turner (LASL)
K. D. Bohnel, Gesellschaft fur Kernforschung, Karlsruhe, Germany

Radiology 105, 181 (1972)

Dose Distributions About CS-137 Sources in Tissue
V. Krishnas

Radioprotection 7(1), 3-12 (1972) (In French)

National Standards for Photon Dosimetry
J. P. Guiho

React. Tech. 15(2) 107-135 (Summer 1972)

Discrete-Ordinates Methods for the Numerical Solution of the Transport Equation
K. D. Lathrop

React. Tech. 15(2) 156-183 (Summer 1972)

Effects of Metal Swelling and Creep on Fast Reactor Design and Performance
P. R. Huebotter

Stud. Cercet. Fiz. 24, 791 (1972)

Behavior in Time and in a Radiation Field of Some Shielding Concrete Types for Gamma and Neutron Radiation Manufactured with Romanian-Made Aggregates and Binding Matters
M. Balanesc

BOOK

ATLAS OF RADIATION DOSE DISTRIBUTIONS V.4

International Atomic Energy Agency, Vienna 1972

HANDBOOK

TISSUE DOSE FROM NEUTRONS IN THE HUMAN BODY (In Russian)
V. G. Zolotukhin, I. B. Keirim-Marcus, O. A. Kochetkov, G. M. Obaturov, V. I. Tsevtkov
Atomizdat, Moscow, 1971

THESIS

Cf Dosimetry for Radiological Applications
V. Krishnaswamy
1971
University of Pennsylvania (Univ. Microfilms Order No. 72-6189 162p)

THESIS
FRNC-TH-229 (In French)

Simulation of Electron and Proton Transport Using the Monte Carlo Method
Jean-Paul Patau
1972
Dep., NTIS (U.S. Sales Only)

SPACE AND ACCELERATOR SHIELDING

CERN-71-16 (Vol. 1 and 2) 678-96 (Apr. 1971) (In French)
(CONF-710423 Vol. 1 and 2)678-96

Calculating Muon Flux in an Actual Configuration
E. Bertel, B. Sereville

CERN-71-16 (Vol. 1 and 2) 814-35 (1971)
(CONF 710423) 814-35

Comparison of Measurements and Calculations for a 29.4 GeV/c Steel Beamstop
A. Van Ginneken, M. Awschalom, T. Borak

CONF-701135 pp 71-94

Shielding of High-Energy Accelerators: A Review
G. Srikantiah
1971
(Proceedings of the National Symposium on Radiation Physics, Bombay: Bhabha Atomic Research Centre, Nov. 24, 1970)

ICRU-21

Radiation Dosimetry-Electrons with Initial Energies Between 1 and 50 MeV
ICRU, Washington, D.C.
May 1972

N72-25461
(TT-70-50155; AEC-TR-7175)

Radiation Transmission Through Inhomogeneities in Shields
V. G. Zolotukhin, V. A. Klimanov, O. I. Leipunskii, V. P. Mashkovich, V. K. Sakharov, B. I. Sinitsyn, S. G. Tsypin
1971
Dept., NTIS (Hard Copy $20.50)

N72-25770

Spacecraft Radiation Analysis from Significant Accomplishments in Technology (1970-72) p 67-70
D. W. Harris
1972
Dep., NTIS (HC $3.00)

ORNL-TM-3945

Photon Dose Rates from the Interactions of 200-GeV Protons in Iron and Iron-Lead Beam Stops
T. A. Gabriel, R. T. Santoro
October 1972

ORNL-TM-3961

Calculations of Neutron Flux Spectra Induced in the Earth's Atmosphere by Galactic Cosmic Rays
T. W. Armstrong, K. C. Chandler, J. Barish
October 1972

ORNL-TM-3985

Pion Dose Calculations
T. W. Armstrong
October 1972

ORNL-TR-2617
(Trans. from IFVE-ORZ-71-81)

Intranuclear Cascade in the Concrete Shield of a 70-GeV Proton Synchrotron
G. I. Britvich, V. B. Getmanov, V. N. Lebedev, V. V. Mal'kov, B. S. Sychev
Dep., NTIS

RLO-1388-639

Universal Curve for Meson-Nucleon Elastic Scattering
S. Blaha, W. H. Pardee, U. P. Sukhatme
1972
Dep., NTIS

Acta Physica Acad. Sci. Hung. 29(3), 435-8 (1970)

Three-Dimensional Monte Carlo Simulation of the Nuclear-Active Component of Extensive Air Showers
Yu. A. Fomin, G. B. Kristiansen

Acta Physica Acad. Sci. Hung. 29(4) 73-9 (1970)

Energy Losses and the Absorption Curve of Muons
Yu. D. Kotov, V. M. Logunov

Acta Physica Acad. Sci. Hung 29(4), 513-19 (1970)

Lateral Spread of Nuclear-Electromagnetic Cascades in Iron
W. V. Jones

Aerospace Med. 43(7), 782-4 (July 1972)

Radiobiological Problems Caused by Supersonic Transport (with a Survey of the First Results Established by Tests Performed on Board the Concorde Prototype)
R. P. Delahaye, R. Kaiser, A. Pfister

At. Energy. (USSR) 32(5), 430-3 (May 1972) (In Russian)

Nomograms for the Determination of the Energy Loss of a Charged Particle in Passing Through a Layer of Matter
G. N. Potetyunko

Brit. Med. J. 3 (5819), 130 (Jul. 1972)

Supersonic Radiation Risks
H. Ito, K. Hosaka, S. Kubo

ESRO/ELDO Sci. Tech. Rev. 4(1) (1972)

Solar Flare Mechanisms
M. L. Shaw
(European Space Research and Technology Centre, Noordwijk, The Netherlands)

Nucl. Sci. Eng., 49(3), 395-398 (Nov. 1972)

The Validity of Using Only Primary Protons in Van Allen Belt and Solar-Flare Proton Shielding Studies
R. T. Santoro, R. G. Alsmiller, Jr., J. Barish

Phy. Rev. C. 6, 631 (1972)

Nonelastic Interactions of Nucleons and Pi Mesons with Complex Nuclei at Energies Below 3 GeV
H. W. Bertini

Phy Rev. C. 6, 660 (1972)

Calculations of Spallation-Fission Competition in Reactions of Protons With Heavy Elements at Energies Less Than or Equal to 3 GeV
R. L. Hahn, H. W. Bertini

Soviet J. At. Energy (English Translation)31(3) 1002 (Sept. 1971)

Dose Distribution Nonequilibrium Electrons at the Interface Separating Media in γ-Irradiation
M. G. Antsilevich, V. M. Lenchenko, L. A. Sofienko
Avail: TIC

Soviet J. Nucl. Phys. 14(6) 1214-1218 (1971)

Measurement of Hadron Interaction Cross Sections in Cosmic Rays
G. L. Bashindzhagyan, V. M. Belokopytov, A. I. Dem'Yanov, V. S. Murzin, L. I. Sarycheva, N. B. Sinev

UMSCHAU 72(9) 284-7 (May 1972)

Radiation Hazards to Man in Space Flights
O. C. Allkofer, W. Heinrich, M. Simon

COMPUTER CODE LITERATURE

AAEC/TM-605 February 1972 IMPURE
IMPURE: A FORTRAN Program for the Analysis of the Gamma Spectrum of (super 99m)Tc Eluted from Fission Produced (super 99)Mo
Hetherington, E.L.R.; Wood, N.R.
Australian Atomic Energy Commission Research Establishment, Lucas Heights, Australia
FORTRAN IV
AVAIL: Dep., NTIS (U.S. Sales Only)

AECL-4130 May 1972 IONR
A Computer Program to Calculate Damage Distributions in Ion-Bombarded Targets
Caillibot, P.F.; Hunt, C.E.L.
Atomic Energy of Canada Limited, Chalk River, Ontario
FORTRAN IV; CDC 6600
AVAIL: AECL, Chalk River

AEEW-R-778 October 1971 TWOTRAN
Two Dimensional Transport Code TWOTRAN: A Users Guide to the Winfrith FORTRAN IV Version for Use On the IBM 360 Computer
Harris, D.
Atomic Energy Establishment, Winfrith, England
FORTRAN IV; IBM 360
AVAIL: Dep., NTIS (U.S. Sales Only)

ANCR-1042 July 1972 ACSAP
An Automated Cross Section Analysis Program (ACSAP)
Marshall, N.H.; Codding, J.W.; Simpson, O.D.; Smith, J.R.; Young, R.C.
Aerojet Nuclear Co., Idaho Falls, Idaho
FORTRAN IV; IBM 360
AVAIL: Argonne Code Center

ANL-7719 March 1972 ARC
The ARC System One-Dimensional Adjunct Calculation and Edits
Neal, D.E.; Daly, T.A.; Schoengold, D.A.; Main, G.J.; Kovalsky, E.A.; Leaf, G.K.
Argonne National Lab., Argonne, Illinois
FORTRAN IV; IBM 360
AVAIL: Dep., NTIS

AWRE-O-34/72 May 1972 2D RAY
Two-Dimensional Ray-Tracing Program
Curtis, A.R.
Atomic Weapons Research Establishment, Aldermaston, England
FORTRAN IV; IBM 7030
AVAIL: Dep., NTIS (U.S. Sales Only)

BMBW-FBK-72-6 May 1972 FLUBS
Computer Code for the Solution of the Three-Dimensional Multigroup Equations, Based on the Improved Synthesis Method
Schaeffler, H.; Schur, P.; Ruehle, R.
Technische Universitaet, Brunswick, West Germany
FORTRAN IV
AVAIL: NTIS

CEA-N-1532(E) March 1972 MAGALI;GENOA;KOUAC; ABACUS-2;JUPITOR;ECIS-70
Comparison of Spherical Optical Model Codes and Proposition of Standard Values for Testing a Code
Kikuchi, Y.
CEA-CEN-Saclay, France
FORTRAN IV; IBM 360
AVAIL: Dep., NTIS (U.S. Sales Only)

CONF-720607 n.d. MORSE
Use of the MORSE Monte Carlo Code to Solve Shielding Criticality Problems of Spent Fuel Casks
Morrison, G.W.; Odegaarden, R.H.
Oak Ridge National Lab., Oak Ridge, Tennessee; U.S. Atomic Energy Commission, Div. of Materials Licensing, Washington, D.C.
FORTRAN IV; IBM 360
AVAIL: NTIS

COO-204907 July 1971 FERDOR
Fast Neutron Spectroscopy in Aqueous Media Using an NE-213 Proton-Recoil Neutron Spectrometer System
Coolbaugh, M.J.; Faw, R.E.; Meyer, W.
Kansas State University, Manhattan, Kansas
AVAIL: NTIS

HEDL-TME-71-27 February 1971 RIBD
FTR Fission Product Decay Heat
Marr, D.R.; Bunch, W.L.
Hanford Engineering Development Lab., Richland, Washington
AVAIL: Dep., NTIS

J. Radioanal. Chem.,10(2),299-314(April 1972) GRS
Computer Program in ALGOL-60 for the Location and Evaluation of Peaks in Ge(Li) Gamma Ray Spectra
Verheijke, M.L.
Philips Research Labs., Eindhoven, Netherlands
ALGOL-60; Philips Electrologica X8

Kernenergie,15(9),311-317(1972) AKTIVIST III
The Properties of Fission Product Mixtures from Thermofission of U-235 and Pu-239
Kruger, F.W.
VEB Kernkraftwerksbau, Berlin, East Germany

KFK-1576 (In German) March 1972 NUSYS
Equivalent Approximation of the Step Function and its Use in Nuclear Calculations (Iterative REMO Procedure)
Boehnel, K.; Stein, E.; Thiem, D.; Willerding, G.
Kernforschungszentrum, Karlsruhe, West Germany
AVAIL: Dep., NTIS (U.S. Sales Only)

LA-4823 May 1972 ELECTRON-PLASMA
Numerical Solution of the Boltzmann Equation for Energy Distributions of Electrons with Inelastic Scattering on Molecules
Hancock, J.H.; Jones, R.C.; Mills, C.B.
Los Alamos Scientific Lab., Los Alamos, N.Mex.
FORTRAN IV; CDC 6600
AVAIL: Dep., NTIS

Minerva Fisiconucl.,15(3),97-104(July 1971) DOSE RAD
FORTRAN Program for Systematic Dosimetry Based on Periodic Determinations of Radioactivity Uptake
Guillot, P.
EURATOM-CCR, Ispra, Italy
FORTRAN IV

MLM-1907 August 1972 RSDP
Radioactive Series Decay Program
Campbell, A.R.
Mound Lab., Miamisburg, Ohio
HP 9100B
AVAIL: Dep., NTIS

Nucl. Instrum. Meth.,101(3),611-12(1972) GAM DISC
Monte Carlo Calculation of the Self-Absorption of Gamma Rays in a Disc Shaped Source
Peterman, B.F.
Univ. of Saskatchewan, Regina, Canada

NUS-786/1 May 1971 NUALGAM;BREMRAD
Final Report for Modification of Codes NUALGAM and BREMRAD
Vol. 1
Steyn, J.J.; Huang, R.; Firstenberg, H.
NUS Corp., Rockville, Md.
FORTRAN IV; IBM 360
AVAIL: NTIS

NUS-786/2 May 1971 NUALGAM;BREMRAD
Final Report for Modification of Codes NUALGAM and BREMRAD
Vol. 2: Code User Manual
Steyn, J.J.; Huang, R.
NUS Corp., Rockville, Md.
FORTRAN IV; IBM 360
AVAIL: NTIS

NUS-786/3 May 1971 NUALGAM;BREMRAD
Final Report for Modifications of Codes NUALGAM and BREMRAD
Vol. 3: Statistical Considerations of the Monte Carlo Method
Firstenberg, H.
NUS Corp., Rockville, Md.
FORTRAN IV; IBM 360
AVAIL: NTIS

Particle Accelerators,3,129-161(1972) MAGTRA;TASTAK; KASTRA;FLUTRA
Estimation of Radiation Problems Around High Energy Accelerators Using Calculations of the Hadronic Cascade in Matter
Ranft, J.
Karl-Marx Universitat, Leipzig, East Germany
FORTRAN IV; CDC 6600; IBM 360

LIST OF REPORTS ISSUED BY RSIC

ORNL-RSIC-1 - (Superseded by ORNL-RSIC-5)

ORNL-RSIC-2 - (Superseded by ORNL-RSIC-5)

ORNL-RSIC-3 - A Comparison of First- and Last-Flight Expectation Values Used in an O5R Monte Carlo Calculation of Neutron Distributions in Water - D. K. Trubey and M. B. Emmett (May 1965).

ORNL-RSIC-4 - Some Calculations of the Fast-Neutron Distribution in Ordinary Concrete from Point and Plane Isotropic Fission Sources - D. K. Trubey and M. B. Emmett (June 1965).

*ORNL-RSIC-5, Vol. I, II, and III - Bibliography, Subject Index, and Author Index of the Literature Examined by the Radiation Shielding Information Center (Reactor and Weapons Shielding).

ORNL-RSIC-6, Vol. I and II - Abstracts of the Literature Examined by the Radiation Shielding Information Center (Reactor and Weapons Shielding).

+ORNL-RSIC-7 - Tabulated Values of Scattered Gamma-Ray Fluxes in Iron Interpolated from Moments-Method Calculation - D. K. Trubey (May 1965).

ORNL-RSIC-8 - Survey of Methods for Calculating Gamma-Ray Heating - H. C. Claiborne (June 1965) .

ORNL-RSIC-9 - A Comparison of Three Methods Used to Calculate Gamma-Ray Transport in Iron - D. K. Trubey, S. K. Penny, and K. D. Lathrop. (October 1965).

ORNL-RSIC-10 - A Survey of Empirical Functions Used to Fit Gamma-Ray Buildup Factors - D. K. Trubey (February 1966).

ORNL-RSIC-11 - Bibliography, Subject Index, and Author Index of the Literature Examined by the Radiation Shielding Information Center (Space and Accelerator Shielding) (Rev. II, May 1970).

ORNL-RSIC-12 - Abstracts of the Literature Examined by the Radiation Shielding Information Center (Space and Accelerator Shielding).

ORNL-RSIC-13, Vol. I, II, and III - Abstracts of Digital Computer Codes Assembled by the Radiation Shielding Information Center - Betty F. Maskewitz.

ORNL-RSIC-14 - The Exponential Transform as an Importance-Sampling Device - A Review - Francis H. Clark (Jan. 1966).

ORNL-RSIC-15 - Bibliography of the Computer Codes Literature Examined by the Radiation Shielding Information Center - Betty F. Maskewitz, Vivian A. Jacobs, Jane Gurney (July 1967).

---

*ORNL-RSIC-5, Vol. I, is no longer available from RSIC. Requesters are referred to the National Technical Information Service, Department of Commerce, Springfield, Va. 22151.

+Available from RSIC in microfiche only.

ORNL-RSIC-16 - Use of ICRU-Defined Units in Shielding - D. K. Trubey (October 1968).

ORNL-RSIC-17 - Comparisons of Results Obtained with Several Proton Penetration Codes - W. Wayne Scott and R. G. Alsmiller, Jr. (July 1967).

ORNL-RSIC-18 - Estimates of Primary and Secondary Particle Doses Behind Aluminum and Polyethylene Slabs Due to Incident Solar-Flare and Van Allen Belt Protons - W. Wayne Scott (July 1967).

ORNL-RSIC-19 - A Review of the Discrete Ordinates S_n Method of Radiation Transport Calculations - D. K. Trubey and Betty F. Maskewitz (March 1968).

ORNL-RSIC-20 - Weapons Radiation Shielding Handbook - Chapter 5: Methods for Calculating Effects of Ducts, Access Ways, and Holes in Shields - Wade E. Selph and H. Clyde Claiborne (Jan. 1968).

ORNL-RSIC-21 - Weapons Radiation Shielding Handbook - Chapter 4: Neutron and Gamma-Ray Albedos - Wade E. Selph (Feb. 1968).

ORNL-RSIC-22 - Comparisons of Results Obtained with Several Proton Penetration Codes - Part II - W. Wayne Scott and R. G. Alsmiller, Jr. (June 1968).

ORNL-RSIC-23 - A Survey of Recent Soviet Radiation Shielding Work - J. Lewin, J. Gurney, D. K. Trubey (Sept. 1968).

ORNL-RSIC-24 - Compilation of Data on Experimental Shielding Facilities and Tests of Shields of Operating Reactors - Compiled by: European American Committee on Reactor Physics, European Nuclear Energy Agency (Nov. 1968).

ORNL-RSIC-25 - Shielding Benchmark Problems - A. E. Profio, Editor.

+ORNL-RSIC-26 - The Attenuation Properties of Concrete for Shielding of Neutrons of Energy Less than 15 MeV - F. A. R. Schmidt (Aug. 1970).

ORNL-RSIC-27 - A Review of Multigroup Nuclear Cross Section Preparation - Theory, Techniques,and Computer Codes - compiled by D. K. Trubey and J. Gurney (Jan. 1970).

ORNL-RSIC-28 - Comparisons of the Results Obtained with Several Electron-Penetration Codes - W. Wayne Scott (March 1970).

+ORNL-RSIC-29 - A Review of the Monte Carlo Method for Radiation Transport Calculations - compiled by Betty F. Maskewitz and Vivian Z. Jacobs (February 1971).

ORNL-RSIC-30 - Abstracts of the Data Library Packages Assembled by the Radiation Shielding Information Center - R. W. Roussin (Mar. 1972).

ORNL-RSIC-31 - (To be announced).

ORNL-RSIC-32 - Recent Developments in the Shielding of Neutron Sources - H. Clyde Claiborne (June 1971).

+Available from RSIC in microfiche only.

ORNL-RSIC-33 - A Review of Calculations of Radiation Transport in Air - Theory, Techniques, and Computer Codes - compiled by D. K. Trubey and H. E. Comolander (May 1972).

ORNL-RSIC-34, Vol. I - Defense Nuclear Agency Working Cross Section Library - Description and Contents - R. W. Roussin (October 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 NCDATA[2] 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 Collission 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 results[2] 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 ANISN[4] and DOT[5] as well as the three dimensional Monte Carlo code, MORSE.[6] 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 SUPERTOG[7] code was used to generate resonance corrected fine group cross sections for 104 energy groups[8] 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 POPOP4[9] code. Gamma-ray transport cross sections were calculated for an 18 group gamma energy structure by the MUG[10] 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 calculations[11] 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., "SUPERTOG: 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.