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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Perseverance is more prevailing than violence;
and many things which cannot be overcome
when they are together
yield themselves up when taken little by little.

\- *Plutarch (A.D. 46-120)*

REVIEW OF CONCRETE AS A NEUTRON SHIELD published by RSIC

The report by Fritz A. R. Schmidt, "The Attenuation Properties of Concrete for Shielding of Neutrons of Energy Less than 15 MeV," ORNL-RSIC-26 (August 1970) has recently been issued and is available upon request from RSIC or from CFSTI.

In addition to an extensive review of previous work, cross sections were compiled and a coupled neutron-secondary-gamma-ray discrete ordinates calculation was carried out to determine dose transmission for 22 energy groups, 8 incidence angles, and 7 slab thicknesses. The results show that the secondary gamma-ray dose is very important for the greater slab thicknesses and lower energies.

BENCHMARK PROBLEMS EXTENDED

Supplement 1 of "Shielding Benchmark Problems" ORNL-RSIC-25 (ANS-SD-9), A. E. Profio, editor, has recently been issued. Compiling and publishing shielding benchmark problems is a joint project of the American Nuclear Society Shielding Standards Subcommittee (ANS-6), the ANS Shielding and Dosimetry Division, and RSIC. The supplement was distributed to Division members and is available upon request from RSIC or CFSTI.

Supplement 1 provides an additional Monte Carlo solution to a problem issued previously, "Fast Neutron Spectrum from a Point Fission Source in Infinite Graphite." The solution was contributed by S. N. Cramer, Computing Technology Center, Union Carbide Corporation, V. R. Cain and E. A. Straker, Oak Ridge National Laboratory. The supplement also presents a new problem, "The Nucleon-Meson Cascade in Iron Induced by 1- and 3-GeV Protons," contributed by T. W. Armstrong and R. G. Alsmiller, Jr., Oak Ridge National Laboratory.

TABLE I (Cont.)

Tape No. 204

MAT NO.	Material	MAT NO.	Material	MAT NO.	Material
1007	Be-9	1037	Au-197	1063	W-186
1026	Xe-135	1042	U-233 FP*	1066	U-233 FP
1027	Sm-149	1045	U-235 FP	1067	U-233 FP
1028	Eu-151	1048	Np-237	1068	U-235 FP
1029	Eu-153	1052	Pu-239 FP	1069	U-235 FP
1030	Gd	1056	Am-241	1070	Pu-239 FP
1031	Dy-164	1057	Am-243	1071	Pu-239 FP
1032	Lu-175	1058	Cm-244	1083	Re-185
1033	Lu-176	1060	W-182	1084	Re-187
1035	Ta-181	1061	W-183	1088	He
		1062	W-184	1120	D

*FP - Fission Products

STORM - ISRAEL PHOTON INTERACTION DATA
Available from RSIC

The photon cross section evaluation recently published by Ellery Storm and Harvey I. Israel, Los Alamos Scientific Laboratory, *Photon Cross Sections from 1 keV to 100 MeV for Elements Z = 1 to Z = 100*, Nuclear Data Tables, A7, 565-681 (June 1970), is now available from RSIC on tape as DLC-15. The reaction types are given in Table II. Please note that much more data are available on tape than were published (i.e., the starred reaction types were not included in the published tables).

We wish to express our gratitude to Israel and Storm for making their data available and to D. J. Dudziak (also of LASL) who placed the data in ENDF BCD format so that the data could be readily exchanged between laboratories. The reaction type numbers used by Dudziak are consistent with those recommended in ENDF publications where possible although several had to be assigned for the purpose.

It should be noted that a similar evaluation, performed by W. H. McMaster, et al., Lawrence Radiation Laboratory, Livermore, is available from RSIC on tape as DLC-7. These data are reported in UCRL-50174, Sec. II, Rev. 1 (May 1969), for energies less than 1 MeV and are for elements Z = 1-83, 86, 90, 92, and 94 and give σ(tot), σ(incoh), σ(coh), σ(pair), and σ(photo). The data on tape 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, available on tape and having passed substantial Phase I testing at the time the group reported

NUCLEAR ENGINEERING AND DESIGN
Publishing Shielding Issues

The journal *Nuclear Engineering and Design* is publishing a series of issues devoted to radiation shielding. The first one, Vol. 13, No. 1 (July 1970), contains the articles "The Use of Lead as a Shielding Material" by G. L. Stukenbroeker, C. F. Bonilla, and R. W. Peterson, and "The Use of Uranium as a Shielding Material" by E. B. Blasch, G. L. Stukenbroeker, R. J. Lusky, C. F. Bonilla, and H. Berger.

These articles were prepared and contributed by the National Lead Company for the third edition of the AEC Reactor Materials Handbook. The project to publish the third edition has been terminated but completed chapters are being published by *Nuclear Engineering and Design*.

The editors of *Nuclear Engineering and Design*, Thomas A. Jaeger and Charles F. Bonilla, are assisted in the shielding area by Editorial Board members E. Aalto, J. Butler, A. H. Foderaro, and D. K. Trubey.

CHAPTER 10 of IAEA ENGINEERING COMPENDIUM
to be Published in the Autumn

Dr. Thomas A. Jaeger, Bundesanstalt für Materialprüfung, Berlin, reports that Chapter 10 of the IAEA *Engineering Compendium on Radiation Shielding*, "Shield Design and Engineering," is now being printed and will be available in the autumn of 1970. The chapter will be published as Volume III.

CONTENTS

10.10 Shielding of Stationary Power Reactors (activation, gas-cooled, light-water cooled, heavy-water pressure tube, sodium-cooled graphite moderated, sodium-cooled fast, molten-salt).

10.11 Shielding of Ship Propulsion Reactors (shield optimization, N. S. Savannah, icebreaker Lenin, N. S. Otto Hahn, Japanese experimental nuclear ship).

Tom also reports that Chapter 9 (Vol. II), "Shielding Materials," is in preparation and should be available in 1971.

ADDITIONS AND UPDATES TO COMPUTER CODE PACKAGES

CCC-82/ANISN — A new version of ANISN, CCC-82F, has been added to the code package by the Technical Division, Savannah River Laboratory, Aiken, S. C. Input and output has been modified, Hansen-Roach cross sections have been added and a 22-group coupled neutron-gamma nuclide cross section library has been generated to allow analysis of complex shield compositions with restricted computer core volumes, less than 400K. Memorandum DPST-70-233 has been added to describe the changes. The code is operable on the IBM 360. One reel of tape is required for transmittal. Reminder: CCC-82A, FORTRAN IV, IBM 7090; CCC-82B, FORTRAN 63, CDC 1604; CCC-82C, FORTRAN IV, IBM 360 version in use at ORNL; CCC-82D, FORTRAN IV, CDC 6600 WANL version; and CCC-82E, Burroughs B-5500 version.

CCC-89/DOT — The C version (IBM 360) of DOT has been updated to include two auxiliary codes, DASH and UNCL. DASH - FORTRAN IV VOID TRACING AND S_n-MONTE CARLO BRIDGING CODE described in SRT-TRM01-W393-4C, was contributed to RSIC by the NERVA Engine Department, Aerojet Nuclear Systems Company, Sacramento, California. UNCL, a FORTRAN program which calculates the first collision source, was contributed by the Oak Ridge Computing Technology Center. These routines may be requested independently of the CCC-89C package by those who have other versions of DOT. A reel of tape is required for transmittal.

CCC-110/AIRTRANS — Code package now contains an IBM 360 version contributed by the USAF Aerospace Technologies Division, Production Directorate, Headquarters Foreign Technology Division, Wright-Patterson Air Force Base, Ohio. AIRTRANS, a time-dependent, 3-dimensional, Monte Carlo system for radiation transport in a variable density atmosphere is now packaged as a CDC 1604 version, received from United Nuclear Corporation, White Plains, N. Y., to be requested as CCC-110A; a UNIVAC 1108

version contributed by Lockheed Missiles and Space Company, Sunnyvale, Calif., CCC-110B; and the above 360 version, CCC-110C.
References: UNC-5179, LMSC-5234. One reel of tape is required for either of three versions.

CCC-124/KDLIBE — Codes in the KDLIBE, KERNEL-DIFFUSION CODE SYSTEM contributed by the Nuclear Systems Programs, General Electric Missile and Space Div., Cincinnati, O., have been converted by RSIC to run on the IBM 360 computer. Originally packaged (CCC-124A) were operable versions for the GE 635 computer. The 360 versions may be requested as CCC-124B. One reel of tape is required for each version. The system includes QADRD, QADRR, SURF, RAMP, GAMMIX, ZIP III, REORG, UPDONC, and GEORGE (C-VII and F-N)
Primary reference is GESP-226.

CCC-129/TWOTRAN — K. D. Lathrop of LASL has recently added to the TWOTRAN Code Package his CDC 6600 GENERAL GEOMETRY EXTENDED CORE STORAGE MULTIGROUP DISCRETE ORDINATES TRANSPORT CODE. It may be requested as CCC-129 C. A reel of tape should be sent for transmittal.
Reference LA-4432.

CCC-143/GREAT-GRASS — MONTE CARLO RADIATION TRANSPORT FOR FALLOUT SHIELDING, contributed by Radiation Research Associates, Fort Worth, Texas. Written in FORTRAN for the IBM 1130 computer, the code is also operable on the IBM 360.
References: RRA-T78, RRA-T79, and RRA-M84. The IBM 1130 version is packaged as CCC-143A; the IBM 360 version as CCC-143B. One reel of tape is required for transmittal.

CCC-144/TIMOC — MONTE CARLO THREE-DIMENSIONAL NEUTRON TRANSPORT CODE, contributed by CCR EURATOM through the ENEA Computer Programme Library, Ispra, Italy. One reel of tape is required for transmittal. Code is written in FORTRAN and FAP for the IBM 7090/94.

CCC-145/SORS — MONTE CARLO PHOTON AND NEUTRON TRANSPORT CODES, contributed by Lawrence Radiation Laboratory, Livermore, California. The packaged versions are operable on the CDC 6600 computer. Two reels of tape are required for the complete code package - one reel for CCC-145A, the photon part, and one reel for CCC-145B, the neutron part.
References: UCRL-50358 and UCRL-50532.

PSR-7/MUG

A new version of MUG has been packaged as PSR-7C and is now available. Two changes have been made: a new way of computing the energy-dependent absorption cross sections and a revision allowing data for photoelectric and pair production absorption cross sections to be read from ENDF/B file 23 data tape, in addition to the other data options previously available. Minor changes have been made in the main program, resulting in the reduction of core requirement to 300K bytes. Changes in the documentation will reflect the above revisions and modifications. For current MUG users who may wish to take advantage of the above changes, it is recommended that they send a reel of tape for the entire new package.

PSR-11/POPOP4

Changes have been made in the PSR-11 code package. The Computing Technology Center has contributed their SIMPLE SAMPLE COUPLING CODE, and have made minor changes in the source programs, TAPEMAKER and in POPOP4. The library of data is now packaged independently as DLC-12 for ease in updating. The sample problem packaged in PSR-11 will not be changed with each update of DLC-12.

PSR-23/SPECTER

CALCULATION OF ENERGY DISTRIBUTION OF NUCLEAR REACTION PRODUCTS, contributed by Teledyne Brown Engineering Company, Inc., Huntsville, Alabama. PSR-23A is operable on the IBM 360, and B is operable on the IBM 7090.
References: SMSD-SSL-1100.

PERSONAL ITEMS

Ramon Ashley, previously with Atomics International, is now on the staff of the manager of engineering at the Washington, D. C. office of Bechtel Corporation.

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Wilbur Bunch has transferred from Battelle-Northwest to Westinghouse (WADCO), Richland, Washington.

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Arnold Futterer has returned to the Ballistics Research Laboratory, Aberdeen Proving Grounds, Maryland, from the University of Virginia.

VISITORS TO RSIC

Visitors to RSIC during the month of August were: O. J. Hahn, University of Kentucky, Lexington, Ky.; Capt. Dean Kaul, DASA, Washington, D. C.; Nancy H. Morgan and Robert P. Morgan, Washington University, St. Louis, Mo.; Henry A. Quinn, AEC, Oak Ridge, Tenn.

AUGUST ACCESSION LIST OF LITERATURE

The RSIC is now aware of the literature cited in the following list. This literature has either been obtained by RSIC or has been placed on order. When received, this material will be examined and assigned to various files if suitable for our information system. The accession list is divided into three fields (1) reactor and weapons shielding, (2) space and accelerator shielding, and (3) shielding computer codes. These titles are announced before processing and indexing so that there will be no delay and can serve as a prompt announcement of current literature.

RSIC is not a documentation center. Copies of the literature cited must generally be obtained from the author or from a documentation center such as the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

RSIC maintains a microfiche file of literature entered into its information system. Computer searches of this system (which produces a special bibliography) and duplicate microfiche copies of the literature in our files are available upon request. Naturally, we cannot supply copies of literature which is copyrighted (such as books or journal articles) or whose distribution is restricted. Neither service is available for the codes literature.

REACTOR AND WEAPONS SHIELDING

AEEW-R-685 — November 1969

A Review of Thermal Neutron Diffusion Data for Heavy Water and Its Consequences for Neutron Scattering Law Models
A. T. D. Butland, C. T. Chudley
Available: HMSO, Five Shillings Net

BNL-400, Third Edition Vol. 1 (EANDC(US)-138"U") — January 1970

Angular Distributions in Neutron-Induced Reactions, Volume 1, Z = 1 to 20
D. I. Garber, L. G. Stromberg, M. D. Goldberg, D. E. Cullen, V. M. May
Available: CFSTI

BNL-14468 — 1970

Epithermal Neutron Capture Gamma Rays
R. E. Chrien

GA-8133-Add — March 28, 1969

Neutron Cross Sections for Niobium
M. S. Allen, M. K. Drake
Available: CFSTI as N70-25348

GA-8774 December 16, 1968

Reference Manual for ENDF Thermal Neutron Scattering Data
J. U. Koppel, D. H. Houston
Available: Dep., CFSTI

JPRS-51083 (translation date) August 4, 1970

Problems in the Physics of Reactor Shielding, Vol. 4, 1969
D. L. Broder, A. P. Veselkin, Yu. A. Yegorov, A. P. Suvorov, S. G. Tsypin
Available: CFSTI

NASA-TM-X-2038 July 1970

Preliminary Designs of Space Power Nuclear Reactor Shields
L. J. Kaszubinski, H. F. Kacher

ORNL-TR-2330 (Kernenergie, 13, 47-54 (1970 - In German))

The Calculation of the Radiation Field of a Directionally Radiating Point Source of γ-Quanta with the Method of Moments
R. W. Krueger

ORNL-TR-2348 (KFK-666 - In German) November 1969

Shipping of Irradiated Fuel Elements from Fast Breeder Reactors
G. Boehme, K. Gast, D. Gupta, A. Hagen, R. Kraemer, W. Schikarski, W. Schmidt, G. Sebold, H. W. Wiese, H. Zimmerman
Available: Dep. CFSTI

ORNL-TR-2354 (CEA-N-1253 in French) February 1970

Calculation of the Flux in a Sodium Reservoir
S. Katz, J. C. Nimal, T. Vergnaud
(Translated August 1970)

SC-RR-70-96 March 1970

A Comparison of Two Unfold Codes: UNSPEC and SPECTRA
M. Berman
Available: Dep., CFSTI

STI/PUB-238 (CONF-691008) March 1970
(In several languages)

Radiation Safety in Hot Facilities. Proceedings Series.
IAEA (Vienna, Austria)
IAEA $21.00
(Proceedings of a Symposium on Radiation Safety Problems in the Design and Operation of Hot Facilities, Saclay, France, 13-17 October 1969)

UCRL-18978 (N70-25493) August 1969

High-Resolution Gamma and X-Ray Spectroscopy on Unseparated Fission Products
Jerry B. Wilhelmy (Ph.D. Thesis)

Health Phys., 18(2), 158- (February 1970)

A Nomogram for Calculating the Energy Relations in Compton Scattering (Notes)
H. L. Andrews

Health Phys., 18(3), 207- (March 1970)

Assessment of Gamma-Exposure Due to a Radioactive Cloud Released from a Point Source
K. Imai, T. Iijima

Nucl. Eng. Design, 10(3), 373- (July 1969)

A Monte Carlo Simulation of the Surface-Type Neutron Moisture Gauge
W. J. Lippold, A. Carnesale, R. P. Gardner

Nucl. Eng. Design, 10(3), 388- (July 1969)

Information. Lead Shielding and Nuclear Safety Conference.

Nucl. Eng. Design, 13(1), 3-145 (July, 1970)

The Use of Lead as a Shielding Material
G. L. Stukenbroeker, C. F. Bonilla, R. W. Peterson

Nucl. Eng. Design, 13(1), 146-182 (July 1970)

The Use of Uranium as a Shielding Material
F. B. Blasch, G. L. Stukenbroeker, R. J. Luskey

Phys. Med. Biol., 15(3), 529- (1970)

Determination of X-Ray Spectra Using Attenuation Measurements and a Computer Program
J. W. Twidell

Phys. Med. Biol. 15(3), 541- (1970)

Use of Effective Energy to Calculate Absorbed Dose
E. J. K. Cowdre, C. Galand, D. E. Charlton

Soviet J. At. Energy (English Transl.), 25(5) 1238- (Nov. 1968)

Matrix Method Calculation of Spectral and Angular Characteristics of Gamma Radiation Inside Slab Shields. (Abstract)
S. A. Churin

Soviet J. At. Energy (English Transl.), 25(5)
1259- (Nov. 1968)

Passage of Gamma Rays Through an Inhomogeneous Barrier
(Letter to the Editor)
A. M. Kol'chuzhkin, V. V. Uchaikin

Soviet J. At. Energy (English Transl.), 25(6)
1345- (Dec. 1968)

Radiation Stability of Serpentine Concrete. (Abstract)
A. Ya. Ladygin, M. Ya. Kulakovskii, B. K. Pergamenshchik

Soviet J. At. Energy (English Transl.), 25(6)
1346- (Dec. 1968)

Investigation of the Accuracy of the P_2-Approximation in Describing Neutron Diffusion in a Medium with a Duct. (Abstract)
G. Ya. Rumyantsev, V. S. Dmitrieva

Soviet J. At. Energy (English Transl.), 25(6)
1348- (Dec. 1968)

Transmission of Fast Neutrons and Gamma Rays Through Rectangular Slots. (Abstract)
D. L. Broder, S. A. Kozlovskii, V. S. Kyz'yurov, K. K. Popkov, A. A. Smetanin

Soviet J. At. Energy (English Transl.) 25(6)
1350- (Dec. 1968)

Energy and Space Distribution of Backscattered Gamma-Radiation (Abstract)
P. P. Zol'nikov, K. A. Sukhanova, B. L. Dvinyaninov

Soviet J. At. Energy (English Transl.), 27(3)
955- (Sept. 1969)

Application of the Carlson Method to Calculations of Gamma-Ray Transmission Through Shielding. (Abstract)
L. L. Broder, I. N. Kulikova, S. M. Rubanova, I. N. Trofimov

Soviet Phys. J.
(Izv. Vuz. Fiz. (USSR), 11, 105-12 (1969) (In Russian)

Evaluation of the Perturbation of Gamma-Radiation Beyond a Barrier with a Cylindrical Cavity
A. A. Vorob'yev, V. A. Vorob'yev, G. P. Tarasov

SPACE AND ACCELERATOR SHIELDING

CONF-691101 November 1969

Second International Conference on Accelerator Dosimetry and Experience, Stanford Linear Accelerator Center, California, November 5-7, 1969 (Division of Operational Safety (AEC), Washington, D. C. Stanford Linear Accelerator Center, Calif.)
Available: Dep., CFSTI

HASL-234 August 1970

Measurements of Cosmic-Ray Ionization in the Atmosphere, 1968-70
P. D. Raft, W. M. Lowder, H. L. Beck
Available: CFSTI

NASA-CR-102661 (GA-9907) January 23, 1970

Electron Shielding Studies: Experimental Program
Tech. Summary Report, August 1, 1968 - Dec. 31, 1969
D. G. Costello, H. Weber, J. A. Lonergan
Available: CFSTI as N70-28160

NASA-CR-108385 (RR-69-1) October 1969

Penetration and Interaction of Protons with Matter.
Part 2: Experimental Studies Using Semiconductor Detectors
G. W. Crawford, ed.
Available: CFSTI as N70-26853

ORNL-TM-3033 August 12, 1970

Calculation of the Long-Lived Induced Activity in the Soil Around High-Energy Accelerator Target Areas
T. A. Gabriel

RISO-M-1241 April 1970

Estimate of Doses at the CERN Proton Synchrotron
E. Bjergbakke, C. Carlsson

TR-0066 (5260-20)-2 (SAMSO-TR-70-32; AD-701380) December 1969

Thick-Target Bremsstrahlung from Electrons with an Energy Spectrum and an Angular Distribution (Technical Report, Oct. 1963-June 1969)
G. Ialongo
Available: CFSTI as N70-27864

Atompraxis, 16(3), 186- (1970) (In German)

Radiation Doses in Altitude of Supersonic Transport Flights
O. C. Allkofer, M. Simon

Biophysik, 6, 113-122 (1969)

Radiation Exposure in Supersonic Transport by Solar Flares
O. C. Allkofer, M. Simon

Nucl. Sci. Eng., 37(2), 304-306 (August 1969)

Calculation of the Energy Deposited by Nucleons in a Spherical Phantom and Comparison with Experiment
D. C. Irving, R. G. Alsmiller, Jr., H. S. Moran

Soviet J. At. Energy (English Transl.), 25(6) 1307- (December 1968)

Neutron Yields and Thermal Neutron Fluxes in a Lead-Water System Bombarded by High Energy Protons
R. G. Vasil'kov, V. I. Gol'danski, Ya. V. Grishkevich, O. S. Lupandin, B. A. Pimenov

Soviet J. At. Energy (English Transl.), 26(1) 66- (January 1969)

Principle of Local Shielding of Radiation Sources in Accelerators (Abstract)
L. N. Zaitsev

Soviet J. At. Energy (English Transl.), 26(3) 317- (March 1969)

Effectiveness of Boron-Loaded Additives in Shielding Against Scattered Accelerator Radiation. (Abstract)
L. N. Zaitsev, L. R. Kimel', M. M. Komochkov, V. P. Sidorin, B. S. Sychev, O. A. Ulitin

Soviet J. At. Energy (English Transl.), 26(6) 624- (June 1969)

Shielding Tests at the 10-GeV Proton-Synchrotron Neutron Beam. (Abstract)
V. E. Aleinkov, L. N. Zaitsev, M. M. Komochkov, V. N. Lebedev, V. V. Mal'kov, M. V. Nenast'ev, M. I. Salatskaya, B. S. Sychev

COMPUTER CODES LITERATURE

APEX-543 *October 1959* GEORGE

General Reactor Analysis Computer Program for the IBM 704, Program GEORGE
by T. A. Hoffman and W. B. Henderson
IBM 704

APEX-601 *May 1961* *ZIP*

Program ZIP, A Generalized Reactor (Nuclear Analysis) Sequence (IBM 7090)
by W. L. Orr
FORTRAN II for the IBM 7090

CEA-N-1255 *February 1970* *ELF-NEUTRON*

The Program ELF-NEUTRON
by Francois Gervaise
FORTRAN IV for IBM 360

Comput. Programs Biomed. *January 1970* *EXTDOS*
1: No. 1, 47-57

Computer Program for 3-D Planning in External Beam Radiation Therapy, EXTDOS
by J. van de Geijn (The Hague)

NASA TM X-2048 *July 1970* *UNAMIT*

UNAMIT - A One-Dimensional 4-Pi Spherical Multilayer Reactor-Shield-Weight Optimization Code
by Eugene S. Troubetzkoy, Columbia University, and Millard L. Wohl, NASA Lewis Research Center
FORTRAN IV and FORTRAN 63

Nucl. Instrum. Methods *1970* *G-SPEC*
81: 217-19

Computer Program for Automatic Analysis of Gamma-Ray Spectra
by S. J. Mills (Commonwealth Scientific and Industrial Research, Pretoria)
FORTRAN IV(G) for IBM 360

ORNL-TM-3031 *August 1970* *06R-D*

06R-D, A Discrete Scattering Version of 06R with Importance Sampling of the Angle of Scatter
by C. E. Burgart
FORTRAN IV for IBM 360

ORNL-tr-2304 (UJV-2125-R) *February 1969* *SUNSPHER/SUNCYL*

S_n Approximation of the Transport Equation for Shielding a Nuclear Reactor
by J. Burian
ALGOL for GIER