# RSIC Newsletter

RADIATION SHIELDING INFORMATION CENTER

**OAK RIDGE NATIONAL LABORATORY**

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

POST OFFICE BOX X •
OAK RIDGE, TENNESSEE 37831

No. 27 February 15, 1967

## CURRENT WORK AND PROBLEMS

The Japan Atomic Energy Research Institute has summarized recent work in shielding in Japan in the report "Progress Report of Shielding Investigations in Japan," M. Shindo (Editor), (JAERI-4038).

A special purpose Monte Carlo program called BREV1 calculates gamma ray penetration of double layer slab geometries for point or plane sources, isotropic, monodirectional, or cosine distributed.

EOS-1 is a Legendre polynomial expansion solution of the Boltzmann equation for gamma rays in a slab geometry. It is said to resemble NIOBE in some features.

SELENE is a program which solves the gamma ray problem using the $S_n$ method. It is particularly recommended in cases where there are sharp peaks in the fluxes. (That is, it is believed this program will perform better than EOS-1 in such cases.) Examples would be monoenergetic or monodirectional source cases.

All three of the above programs were written for the NEAC-2206 computer.

Exploratory studies of invariant imbedding applied to gamma ray transport are being made. Also investigations are being made of empirical forms suitable for representing multilayer gamma ray buildup factors and of leakage from simple geometric shapes (after Rockwell).

Experimental studies of buildup factors have been made in multilayer iron, water, lead shields using a 60-Co source. Gamma ray energy spectra penetrating iron-polyethylene shields from a 60-Co source were measured also. Gamma ray energy albedos for polyethylene and for aluminum have been measured with the use of 137-Cs and 60-Co sources. The backscattered flux density was found to consist principally of singly scattered radiation.

A system of programs called RAC has been devised to do neutron removal-diffusion problems. RAC is programmed for a 7044 computer.

EOS-2 is a Legendre polynomial expansion for neutrons as EOS-1 is for gamma rays.

A computation has been made to determine the photoneutron flux density at deep penetrations of a water shield around a reactor.

Experimental studies of neutron penetrations of iron-water laminations have been made using as a source a fission plate driven by a TRIGA reactor in a lid tank arrangement. Other neutron measurements in iron-water shields have been made with the Hitachi Training Reactor.

Removal cross sections were measured in a slab shield of iron, aluminum, and concrete using as a source 2.5 MeV (D-D) and 14 MeV (D-T) neutrons from an accelerator. No energy dependence of the removal cross section was noted.

Shield optimization studies for the ship reactor shield are being made at the JRR. Mockup shield tests are also being made with special attention to the streaming problem.

An experimental program has been carried on to study streaming through ducts in polyethylene, vinyl-chloride, iron, and lead. These measurements were carried on at the TRIGA lid tank facility at St. Paul's University. Various calculational methods for analyzing ducts are also under study.

## REACTOR-WEAPONS SHIELDING ABSTRACTS UPDATED

Inserts for ORNL-RSIC-6, Abstracts of the Literature Examinated by the Radiation Shielding Information Center, Vol. I, have recently been mailed to persons on the reactor-weapons shielding distribution. These inserts provide revisions and additions to the abstracts previously issued. A total of 1135 abstracts have now been issued for Vol. I.

## RECENT VISITORS TO RSIC

The following people visited RSIC during the month of January 1967: N. R. Byrn, Brown Engineering Company, Huntsville, Alabama; Joseph J. Droher, Liquid Metals Information Center, Atomics International, Canoga Park, California; K. O. Johnson, Jr., Water Desalination Information Center, ORNL; W. E. Dreeszeu, Ames Laboratory, Ames, Iowa; Hans I. Holm, AB Atomenergi, Studsvik, Sweden; Wm. A. Hirschi and Wm. Atwell, General Electric, Daytona Beach, Florida.

## JANUARY 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 of (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 literature in our file 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 yet available for the codes literature.

## Reactor and Weapons Shielding

Health Phys., 12(10), 1503 (Oct. 1966)

Shielding for Small Neutron Generators
J. S. Bevan

Health Phys., 12, 1327 (1966)

Some Factors for Calculation of Infinite-Plane Exposure Rates from Gamma Radiation
G. R. Crocker, M. A. Connors and D. T. K. Wong

Health Phys., 12(9), 1311 (Sept. 1966)

A Review of Aperture and Ceiling-shine Effects in Fallout Shielding Technology
Arthur B. Chilton

Sov. J. Atomic Energy, 18(5), 685 (May 1965)

Attenuation of Neutron Tissue Dose by Thin Layers of Hydrogenous Materials
G. V. Miroshnikov

Sov. J. Atomic Energy, 18(5), 681 (May 1965)

Attenuation by Iron and Polyethylene of Tissue Dose of Neutrons Incident Obliquely on the Shielding
G. V. Miroshnikov

Sov. J. Atomic Energy, 18(5), 669 (May 1965)

Parabolic Approximation of the Total Attenuation Coefficients of $\gamma$-Quanta in the Energy Range from 0.03 to 10 MeV
O. S. Marenkov and R. S. Derzhimanov

Sov. J. Atomic Energy, 21(3), 203 (Sept. 1966)

Dose Buildup Factors of Low-Energy Gamma-Rays for Homogeneous and Heterogeneous Barriers
D. B. Pozdneev

Sov. J. Atomic Energy, 21(3), (Sept. 1966)

Reflection of Low-Energy Gamma Radiation by Finite Homogeneous Barriers
D. B. Pozdneev

Sov. J. Atomic Energy, 18(5), 608 (May 1965)

Propagation of Neutrons in Iron
V. I. Golubev, A. V. Zvonarev, M. N. Nikolaev, M. Yu. Orlov, V. V. Penenko, and O. P. Uznadze

Z. Phys., 195, 252 (1966)

Elastic Scattering of 0.5 MeV Gamma Rays by Heavy Elements
U. Hauser and B. Mussgnug

Sov. J. Atomic Energy, 21(3), 205 (Sept. 1966)

Gamma-Ray Absorption from Point Monodirectional Gamma Source by Plane Geometry
F. A. Mahlis, L. A. Sugak, E. A. Plandin, I. K. Shmyrev

Nucl. Instr., 44, 160 (1966)

Monte Carlo Calculations of Source-to-Detector Geometry
I. R. Williams

Radiation Research, 29(2), 166 (1966)

A Method of Gamma-Ray Transport Simulation in Inhomogeneous Media
G. K. Bahr, D. R. Jones, H. Perry, and J. G. Kereiakes

Mag. Concr. R., 18, 95 (1966)

A Radioactive Method for Measuring Variations in Density in Concrete Cores, Cubes, and Beams
D. G. Harland

Phys. Rev., 148, 1206 (1966)

X-Rays and Electrons Emitted in Coincidence with Fission of Cf-252
R. A. Atneosen, T. D. Thomas, W. M. Gibson and M. L. Perlman

BNL-324, Vol. IIB, Supplement No. 2

Neutron Cross Sections, Volume II B, Z = 41 to 60
M. D. Goldberg, S. F. Mughabghab, S. N. Purohit, B. A. Magurno, and V. M. May - May 1966

ORNL-tr-1499 (Translated from Kernenergie 9(5), 165-168 (1966)

Optimization of a Shield for Mixed Radiation
F. W. Krueger

NDL-TR-68 (AD-643538)

Scattered Radiation (Skyshine) Contribution to an Open Basement Located in a Simulated Fallout Field (Final Report)
M. J. Schumchyk, M. A. Schmoke, W. O. Egerland, and E. L. Schulman - Dec. 1966

AD-634455

Control-Cab Design for ML-1A Nuclear Power Plant: Human Engineering Considerations
October 1965

AD 634653

Neutron Transport Calculations on Air Force Nuclear Engineering Test Reactor
D. R. Floyd - March 1966

AD 629607 (AFWL-TR-65-224)

Simulation Devices for Use in Studies of Protective Constructive
J. A. Mahoney - Feb. 1966

Sov. J. Atomic Energy, 18(4), 519 (April 1965)

Spectra of Fast Neutrons in Heavy Media and Water
D. L. Broder, A. S. Zhilkin, and A. A. Kutuzov

TID-23369

Measurement of Radioactive Fallout by Field Total Absorption Gamma Ray Spectroscopy Report No. 5
R. S. Foote - Nov. 26, 1965

Sov. J. Atomic Energy, 18(4), 524 (April 1965)

The Weight-Effectiveness Index of Two-Component Materials Used for Shielding Against Neutrons and Gamma Rays
G. A. Lisochkin and F. A. Predovskii

Sov. J. Atomic Energy, 18(4), 533 (April 1965)

Numerical Calculations on the Penetration of $\gamma$-Quanta through Matter
V. S. Galishev

Sov. J. Atomic Energy, 18(4), 534 (April 1965)

Spatial Energy Distribution and Dose Rate of $\gamma$-Radiation from Unidirectional and Isotropic Co-60 Sources at the Ground-Air Interface
S. M. Ermakov, B. A. Efimenko, V. G. Zolotukhin, Y. A. Kolevatov, and V. I. Kukhtevich

Sov. J. Atomic Energy, 18(4), 538 (April 1965)

Induced $\gamma$-Activity in Polyethylene as a Result of Neutron Irradiation
N. A. Dubinskaya, A. Y. Lyul', and L. L. Pelekis

Sov. J. Atomic Energy, 18(5), 594 (May 1965)

An Exact General Solution in Spherical Harmonics of the Boltzmann Equation
G. Ya. Rumuantsev

Sov. J. Atomic Energy, 18(5), 672 (May 1965)

The Effect of Boron-Containing Blocking on the Yield of Capture $\gamma$-Radiation
S. A. Kozlovskii, V. S. Kyz'yurov, K. K. Popkov, and D. N. Lebedev

Sov. J. Atomic Energy, 19(6), 1498 (December 1965)

Use of Concretes for High-Temperature Shielding of Nuclear Reactors
V. B. Dubrovskii, N. V. Krasnoyarov, M. Ya. Kulakovskii, B. K. Pergamenshchik, M. S. Pinkhasik, and V. I. Savitskii

Sov. J. Atomic Energy, 19(6), 1507 (Dec. 1965)

Applicability of Various Approximations of the Method of Spherical Harmonics for Calculating the Transmission of Neutrons through Shields
N. A. Artem-eva, K. K. Popkov, S. M. Rubanov, and L. S. Shkorbatova

Sov. J. Atomic Energy, 19(6), 1509 (Dec. 1965)

Determination of the Surface Relief of Materials by Means of Reflected Gamma Radiation
P. L. Gruzin, V. N. Afanas'ev, and V. O. Gaiduchik

ORNL-3967 (Vol. 2-6)

Differential Neutron Current Albedos for Concrete in the Incident Energy Range 0.5 eV to 200 keV. Results of Monte Carlo Calculations for an Incident Angle of 0 deg. (Vol. 2), 45 deg. (Vol. 3), 60 deg. (Vol. 4), 75 deg. (Vol. 5), 85 deg. (Vol. 6).
W. A. Coleman and R. E. Maerker - November 1966

FZK-311

Analysis of Slant-Incident Radiation Through Ducts and Voids in Shields
J. B. Eggen and F. O. Leopard - Dec. 20, 1966

APDA-NTS-8

Flux Mapping Measurements to Determine the Location of the Permanent Detectors in the Enrico Fermi Reactor
E. M. Page, R. E. Horne - September 1966

WAPD-TM-609

A Simple Method to Improve the Efficiency of the $\text{Sigma}_t$ Estimator in Certain Monte Carlo Programs
N. M. Steen - Oct. 1966

WAPD-Trans-40

Moderation of Neutrons Emitted by a Pulsed Source, and Neutron Spectrometry Based on Slowing-Down Time
A. A. Bergman, A. I. Isakov, M. V. Kazarnovskii, Yu. P. Popov, and F. L. Shapiro

Betonstein Zt., 30, 642-6 (1964) GERMAN

Concrete as a Radiation Shielding
R. Vinkeloe

BOOK

Soviet Progress in Neutron Physics
P. A. Krupchitskii (Editor), Consultant Bureau (Publisher)

Stud. Cercet. Fiz., 18, 445-6 (1966) RUMANIAN

The Build-up Factor B in Attenuation Calculations of $\gamma$ Radiation
Silvia Dumitrescu, V. Marghitu

Vop. Dudn. Geofiz, Min. Geol. Okhrany Nedr. SSSR, No. 5, 52-62 (1965) RUSSIAN

Energy Spectrograms of Point Sources of $\gamma$ Rays
V. A. Artsybashev and G. A. Ivanyukovich

Nippon Genshiryoku Gakkaishi, 8(6), 304-8 (June 1966)

Measurements of Dose Buildup Factors in Slab Materials for 60-Co Isotropic Source
Yoshihiko Kanemori

At. Energy (USSR), 20, 76 (January 1966) RUSSIAN

Optimum Ratio of Neutron and Gamma Dose Behind Reactor Shielding
L. N. Veselovskii, V. G. Kuznetsov, and V. A. Sakovich

At. Energy (USSR), 20, 78-80 (January 1966) Russian

Shielding Calculations for Cylindrical Sources
E. E. Kovalev, D. P. Osanov

At. Energy (USSR), 20 (January 1966) Russian

Shielding Properties of Iron-Serpentine Concrete
A. P. Veselkin, Ya. A. Egorov, V. A. Kucheryaev

Nippon Genshiryoku Gakkaishi, 7, 496-8 (Sept. 1965)

Some Considerations of Buildup Factors in Gamma-Ray Penetration for Multiple Layers
M. Kitazume

Kerntechnik, 8: 82-5 (1966)

Methods of Calculation in Neutron Shielding
D. Nachtigall

Atomkernenergie, 11, 247-50 (May-June 1966)

Radiation Field of a Disk Source in a Homogeneous Absorbing Half-Space
H. Schultz, C.-D. Wueneke

Atomkernenergie, 10: 432-5 (Nov.-Dec. 1965)

Double $P_1$-Approximation for Gamma-Rays
S. A. W. Gerstl

Nippon Genshiryoku Gakkaishi, 7: 634-44 (Nov. 1965)

Gamma-Ray Transmission Through Multiple Layers
Iwao Kataoka

At. Energ. (USSR), 19:460-2 (Nov. 1965)

Changes of Spectra of Fast Neutrons after Their Passage through Aluminum, Paraffin, and Aqueous Media
G. G. Doroshenko, V. A. Fedorov, E. S. Leonov

AECL-2626

Neutron Spectrum Measurements in Non-Multiplying and Multiplying Media
R. A. Jong and K. J. Serdula - August 1966

USNRDL-TR-1045

Experimental and Calculated Estimates of the Shielding Effectiveness of Compartmented Structures Exposed to Fallout
B. W. Shumway - July 19, 1966

N66-27941 (NASA-CR-75629; FZK-176-1)

Monte Carlo Calculations of Energy Depositions and Radiation Transport
Vol. 1 Validation of Cohort Codes
D. G. Collins, T. W. DeVries - Dec. 21, 1963

DL-72

The Intense Neutron Generator
W. B. Lewis - October 1966

AECL-2635

Some Neutron Measurements with Simulated Ing Targets
J. Walker
June 1966

CEX-65.5

Experimental Evaluation of Techniques for Improving Fallout Protection in Home Basements
R. L. Summers and Z. G. Burson - Dec. 1966

REIC Report No. 44

The Effect of Nuclear Radiation on Capacitors
C. L. Hanks and D. J. Hamman - Dec. 30, 1966

ORNL-3926

Monte Carlo Calculations of the Penetration of Normally Incident Neutron Beams through Concrete
F. H. Clark, N. A. Betz, J. Brown - January 1967

NBS-Rept. 9071

Dose Albedo and Transmission Coefficients for Cobalt-60 and Cesium-137 Gamma Rays Incident on Concrete Slabs
M. J. Berger and E. E. Morris - July 5, 1966

NBS Report 8681

Photon Attenuation and Energy Absorption Coefficients Tabulations and Discussion (Second Edition)
J. H. Hubbell and M. J. Berger - September 28, 1966

ORNL-4002

A Method of Representing Two-Dimensional Distributions for Use in Monte Carlo Calculations
M. Leimdorfer and J. Barish - January 1967

PSDC-TR-16

An Experimental Evaluation of Roof Reduction Factors
C. McDonnell and J. Velletri - May 1, 1966

ORNL-TM-1744

Fission Spectrum Neutron Dose Rate Attenuation and Gamma Ray Exposure Dose Buildup Factors for Lithium Hydride
F. B. K. Kam and F. H. S. Clark - January 13, 1967

Nucl. Sci. Eng., 11, 324-327 (1961)

Irradiated Ra:Be Neutron Sources
D. J. Dudziak and L. B. Freeman

LA-3606-MS

Gamma-Ray Energy Deposition in the Molten Plutonium Burnup Experiment (MPBE) Reactor Structure
D. J. Dudziak and M. E. Battat - January 12, 1967

ORNL-TR-1508

Determination of the Characteristics of Propagation of Fast Neutrons in Concrete by Measurement of the Scattering Field of a Collimated Neutron Beam
Hilmar Bindewald

ORNL-TR-1509

Circular Plane Radiation Source Before an Absorbing Half-Space
H. Schultz and C. D. Wuneke

LA-3577 (Confidential)

Monte Carlo Calculation of Gamma-Ray Heating Rates and Fluxes in Phoebus 1 from Core Sources
C. W. Watson - Dec. 6, 1966

RPP/R-3

Neutron Studies in Shields and Tunnels at the Rutherford Laboratory
K. B. Shaw

RPI-328-69

Gamma-Ray Spectra from Radiative Capture of Thermal and Resonance Neutrons in Mercury and Tungsten
E. R. Rae, W. Moyer, R. R. Fullwood, J. L. Andrews - 1966

NP-tr-1415

Anisotropy of the Atomic Scattering Factor for X-Rays in Aluminum and Diamond Crystals
S. T. Konobeevskii, K. P. Mamedov

LA-DC-8148

The Nuclear Explosion as a Single Burst Neutron Source
B. C. Diven

AD-642319 (USNRDL-TR-1076)

Gamma-Ray Spectra of the Products of Fast Neutron Fission of 235-U and 238-U at Selected Times after Fission
L. R. Bunney, and D. Sam - September 13, 1966

AECD-EP-13

Statistical Method of Neutron Transport in Absorbing Media
M. Ahsan - June 1966

UCRL-70172

The Monte Carlo Method
H. Sahlin - Oct. 1966

BNL-tr-103

Theory of X-Ray Scattering by Multicomponent Ordered Solutions
M. A. Krivoglaz, and E. A. Tikhonova

ORNL-TM-1557

Monte Carlo Calculations, Using the Albedo Concept, of the Fast-Neutron Dose Rates Along the Center Lines of One- and Two-Legged Square Concrete Open Ducts and Comparison with Experiment
R. E. Maerker and F. J. Muckenthaler - Sept. 21, 1966

AE-252

Nomogram for Determining Shield Thickness for Point and Line Sources of Gamma Rays
C. Joenemalm and K. Malen - Oct. 1966

WAPD-T-1932

Energy Buildup Factors in Water for Very Deep Penetrations for a 6 MeV Plane Isotropic Gamma Source
L. Lois - August 1966

AD-623557 (N66-11853; ATD-B-65-76)

Nuclear Safety - Annotated Bibliography
A. Baliunas, B. Poplawski

ORNL-TM-1554

Calculation of Doubly Differential Current Albedos for Monodirectional Beams of Epicadmium Neutrons Incident on Concrete and Comparison of the Reflected Subcadmium Component with Experimental Results
W. A. Coleman, R. E. Maerker, F. J. Muckenthaler, and P. N. Stevens
September 27, 1966

NYO-901-65

Evaluation of Gamma Ray Spectrometers
Egilda de Amicis Witherell, and R. F. Cowing - Oct. 10, 1966

## Shielding Computer Codes

CEA-N 575 (ORNL-tr-1372) December 1965 STOCK-CAR

Development of STOCK-CAR Computer Program for Flux and Dose Due to a Solid or Toric Cylindrical Source
by Bernadette Daversin
FERRANTI-MERCURY

CEA-N 583 (ORNL-tr-1378) January 1966 NIOBE

NIOBE Computer Program Description and Use
by Gilles Brandicourt and Jacques Culambourg
IBM 7094

GA-6511 April 1966 GADOSE and DOSET

GADOSE and DOSET - Programs to Calculate Environmental Consequences of Radioactivity Release
by E. Lee, R. J. Mack and D. B. Sedgley
FORTRAN for IBM 7044

ORNL-TM-1699 December 1966 RAFFLE

RAFFLE - A Monte Carlo Code for Calculations of First Flight Collision Probabilities
by O. W. Hermann and R. S. Carlsmith
FORTRAN for IBM 7090 and IBM 360

BRL MR 1790 September 1966 UNPH

A Machine Code for the Unfolding of Pulse Height Spectra
by Juergen K. Bock and John V. Lanahan
FORAST for BRLESC

LA-3530-MS July 1966 PROMCET

Programs Designed for Processing Monte Carlo Events Tapes
by J. Robert Streetman
FORTRAN for IBM 7094

UCRL-11647 Rev. September 1966 RANGE

FORTRAN Subroutine RANGE: Calculating the Range-Energy Relation for Charged Particles in Chemical Elements
by W. Peter Trower

GA-7417 September 1966 GASKET

GASKET - A Unified Code for Thermal Neutron Scattering
by J. U. Koppel, J. R. Triplett and Y. D. Naliboff

AERE-R-5172 September 1966 INELB

A Monte Carlo Treatment of the Interaction of an Electron Beam with a Heavy Target
by M. P. Ruffle
FORTRAN S2 for IBM 7030