RSIC Newsletter

RADIATION SHIELDING INFORMATION CENTER

OAK RIDGE NATIONAL LABORATORY

OPERATED BY UNION CARBIDE CORPORATION FOR THE DEPARTMENT OF ENERGY

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There is no science without fancy, and no art without facts—Vladimir Nabokov

PLANNING FOR 6TH ICRS

The tempo has accelerated in the planning and organization of the Sixth International Conference on Radiation Shielding (ICRS) to be held in Tokyo, Japan, May 16–20, 1983. (See CALL FOR PAPERS in the April issue of the *RSIC Newsletter).* *Takumi Asaoka,* director of the Reactor Physics Department of the Japan Atomic Energy Research Institute (JAERI) and Technical Program Chairman of the conference, has just completed a round of visits and discussions with sponsoring agencies and committees in Western Europe and the USA.

Asaoka conferred with members of the EURATOM Shielding Information Service (ESIS) at the Ispra, Italy, EURATOM Establishment, the OECD Nuclear Energy Agency (NEA) Committee on Reactor Physics (CRP), the Radiation Shielding Information Center, (RSIC) and the American Nuclear Society (ANS) Radiation Protection & Shielding (RP&S) Division *Ad Hoc* Committee for Promotion of the 6th ICRS.

An all day working session of the ANS Committee was held with Dr. Asaoka on April 30 in RSIC facilities at the Oak Ridge National Laboratory. The meeting was attended by: *Betty F. Maskewitz* (RSIC) Chairman; *Michael Kolar* (EPRI), ANS RP&S Division Chairman; *Gerald P. Lahti* (Sargent & Lundy), immediate past chairman; *David E. Bartine* (ORNL), incoming chairman; *David K. Trubey* (RSIC), convenor of the 5th ICRS; and members-at-large *Robert W. Peelle* (ORNL), *Robert T. Santoro* (ORNL), *G. Lee Simmons* (SAI).

The General Chairman of the Sixth ICRS, *Hiroshi Ishikawa* (JAERI Director), has announced the following appointments to the Technical Program Committee:

Chairman: *Takumi Asaoka* (JAERI)

Co-Chairman: *Tomonori Hyodo* (Kyoto University)

John Butler (UKAEA/Winfrith, England)

Gerhardt Hehn (IKE/Stuttgart, Fed. Rep. Germany)

Herbert Rief (ESIS/EURATOM/NEACRP, Ispra, Italy)

Max Salvatores (CEA/Cadarache, France)

A. Gandini (CNEN/Casaccia, Italy)

Robert W. Peelle (ORNL, Oak Ridge, Tennessee)

Gerald P. Lahti (Sargent & Lundy, Chicago, Illinois)

G. Lee Simmons (SAI, La Jolla, California)

The Technical Program Review will be held on September 20–21, 1982 in Karlsruhe, Federal Republic of Germany (FRG).

The April 1982 (No. 208) issue of the *RSIC Newsletter* carried the Call for Papers for the 6th ICRS. It is important that persons wishing to present papers in this conference give immediate at-

tention to the preparation and transmission of a summary. The deadline for submission of summaries is *September 6, 1982.* For additional details see the April newsletter. Additional copies are available from RSIC.

RSIC will be a clearinghouse to its user community for information about the conference which will be periodically furnished by the organizing committee, and available news will be published in the monthly newsletter.

PENKUHN REPRINT

The December 1981 *RSIC Newsletter* announced the availability of a reprint of "Gamma Shielding Estimates on the Back of an Envelope," Hans Penkuhn, *ESIS Newsletter* 38–39 (July–October). Due to the heavy requests for the reprint, Part II (A Supplement) of "Gamma Shielding Estimates on the Back of an Envelope," by Hans Penkuhn is printed at the end of this issue of the *RSIC Newsletter.*

RSIC AND INFORMATION SCIENCE

The RSIC staff includes specialists in several disciplines, and each staff member must have cognizance of more than one discipline. In addition to the physical science and engineering aspects of shielding, computer science and information science are essential components of all information analysis center activities. Since we seldom publish news related to the science of collecting, evaluating, packaging, disseminating, and developing interfaces which ensure the feedback essential to the information cycle, perhaps it is time to bring information science activities to the forefront.

ASIS Meeting

The American Society for Information Science (ASIS), in its 11th Mid-Year Meeting to be held in Knoxville, Tennessee, June 13–16, 1982, is concerned with the theme "Information — The Critical Difference." The keynote address by *Alvin M. Weinberg* is entitled "Computers, Information and Brains." Other major addresses include "What's Happening to Information Services and Sciences Today," by *Ruth M. Davis,* president of the Pymatuning Group, Inc., in Washington, D. C.; and "Scientific Information as a Commodity," by *Philip H. Abelson,* editor, *Science* magazine. Invited and contributed papers will cover the topics: Information for Decision Making, Quality Assurance for Technical Information, Role of the Information Specialist and the Subject Specialist, Theoretical Bases for Designing Information Systems, Information Support to Research and Development, Improved Techniques for Database Design, Information Product Design, Designing User Friendly Systems, Education for Information Professionals, Information: Implications for National Policy, Energy and the Environment, System Design and Implementation, and Technology Transfer. There will be several tutorials, panel discussions, special sessions, and plenary discussions as well as the aforementioned contributed paper sessions.

Betty F. Maskewitz, who serves on the program committee, will chair the session entitled, "Information: Implications for National Policy," and will present a paper on "The Role of the Information Analysis Center" in a session on quality assurance. Other persons presenting papers on quality assurance in technical information well known to the RSIC user community are: *Charles L. Dunford, Robert R. Kinsey,* and *Jagdish K. Tuli* of the National Nuclear Data Center at Brookhaven National Laboratory; *David R. Lide, Jr.,* of the National Bureau of Standards; and *Jacob Barhen, C. R. Weisbin,* and *R. G. Alsmiller, Jr.* of the Oak Ridge National Laboratory.

DOE EXPANDS REAC/TS

On February 4, 1982, the Radiation Emergency Assistance Center/Training Site (REAC/TS), operated by Oak Ridge Associated Universities, responded to its first request from the Pan American Health Organization (PAHO) for assistance in a radiation incident. The call came as the result of REAC/TS recently being designated the World Health Organization's (WHO) Collaborative Center for Radiation Emergency Assistance for the Western Hemisphere. A similar center has been designated by WHO for Europe at the Curie Institute, Paris, France. Assistance by REAC/TS staff is arranged between the Department of Energy's Oak Ridge Operations Office and PAHO's headquarters staff in Washington, D. C.

James Berger, REAC/TS health physics leader, was chosen to respond because of his expertise with radium and radon. He spent February 4–9 in a Kingston, Jamaica, hospital evaluating possible

leaks from radiotherapy sources. He also appraised the hospital's entire radiation protection program, its procedures, and personnel. He reported his findings to the hospital management and made recommendations for correcting the deficiencies he found.

While the main responsibility of REAC/TS is to provide backup assistance to the medical department of DOE's Oak Ridge plants, it has also provided on-call assistance throughout the U. S. whenever local facilities have not been prepared to meet an emergency.

NCRP STUDIES AND LONG-RANGE PLANNING

The Report of the National Council on Radiation Protection and Measurements (NCRP), released at the 1982 Annual Meeting on April 6–7, 1982, stresses studies completed in 1981 and long-range planning efforts initiated during the year.

Five documents were published by the NCRP during 1981 and three additional documents were in press at the close of the year. Of these, we call attention to the following:

NCRP Report No. 69 — *Dosimetry of X-Ray and Gamma-Ray Beams for Radiation Therapy in the Energy Range 10 keV to 50 MeV,*

Proceedings No. 2 — *Quantitative Risk in Standards Setting,*

Taylor Lecture No. 5 — *How Well Can We Assess Genetic Risk? Not Very,* by James F. Crow,

NCRP Report No. 70 — *Nuclear Medicine — Factors Influencing Choice and Use of Radionuclides in Diagnosis and Therapy,* and

Symposium No. 1 — *Control of Exposure of the Public to Ionizing Radiation in the Event of Accident or Attack.*

We also call attention to another NCRP special report, *Preliminary Evaluation of Criteria for the Disposal of Transuranic Contaminated Waste,* issued February 5, 1982. NCRP has also announced the publication of the Proceedings of the Seventeenth Annual Meeting, *Critical Issues in Setting Radiation Dose Limits* (Proceedings No. 3). The proceedings make available papers prepared by individuals from a variety of different backgrounds.

"A Risk System for Setting Radiation Dose Limits," by *Bo Lindell* of the National Institute of Radiation Protection, Stockholm, Sweden;

"The Conceptual Basis for Evaluating Risk from Low-Level Radiation Exposure," by *Victor P. Bond* of the Brookhaven National Laboratory;

"Pitfalls of a Risk Approach," by *Roy C. Thompson* of Battelle Pacific Northwest Laboratories;

"The Estimation of Risk from Whole-Body Exposure to Ionizing Radiation," by *Gilbert Beebe* of the National Cancer Institute;

"The Role of *In Vitro* Cell Studies in Low Dose Extrapolations," by *Eric J. Hall* of Columbia University;

"The Role of Animal Studies in Low Dose Extrapolations," by *R. J. Michael Fry* of Oak Ridge National Laboratory;

"Establishing Risk Estimates for Individual Organs," by *William J. Bair* of Battelle Pacific Northwest Laboratories;

"Risks of Radiation-Induced Lung Cancer," by *Richard G. Cuddihy* of Lovelace Biomedical and Environmental Research Institute;

"Risk Estimates for Bone," by *Robert A. Schlenker* of Argonne National Laboratory;

"Risk Estimates for Breast," by *John D. Boice, Jr.* of the National Cancer Institute;

"Risk Estimates for Liver," by *Charles W. Mays* of the University of Utah;

"Cancer Risks from Low-Level Radiation — A Commentary on the BEIR Report — 1980," by *Edward W. Webster;* and

reports on the activities of the *Ad Hoc* Committee on Policy in Regard to International System of Units by *Randall S. Caswell,* The Scientific Committee 1 on Basic Radiation Protection Criteria by *George W. Casarett,* and The Task Group on Atomic Bomb Dosimetry of Scientific Committee 40 by *Harold O. Wyckoff.*

These reports are available from NCRP Publications, 7910 Woodmont Avenue, Suite 1016, Bethesda, Maryland 20814.

CHANGES TO THE RSIC CODES COLLECTION

Five updates, two extensions, three new versions, and four new code systems were added to the RSIC collection. Included are contributions from the Federal Republic of Germany, Austria, IAEA NDS, Japan, and the United Kingdom.

CCC-245/TIGER, CCC-280/CYLTRAN, CCC-308/SPHERE, CCC-373/TIGER-P, CCC-374/ACCEPT,

A correction of an error in Subroutine RANGE of the DATPAC Cross Section Routine was made to the CDC versions of each of the above code packages in the TIGER series contributed by the Theoretical Division of Sandia National Laboratories. The information about the error and its correction was furnished by the contributors who also contributed input data for sample problems for each package.

Current users may correct their operating code systems by making the following change in Subroutine RANGE of DATPAC. Change statement number 850 to read:

850 RAT(L) = 1.0

The erroneous statement has an "N" for the subscript. This correction should be made in both the card image format and update format. Users are urged to check their results by rerunning the program after making the correction. Effects of the error are expected to be insignificant for electron sources with energies less than 10.0 MeV and for all photon sources.

CCC-276/DOT 3.5

The two-dimensional discrete ordinates radiation transport code package, DOT 3.5, was extended to add GRTUNCL, a routine for calculating a first collision source for input to DOT on unit NPSO. GRTUNCL offers the specification in a more general way than allowed by the DOT internal calculation option. The use of a "first collision source" can alleviate ray effects for certain problems. This update was made using the GRTUNCL from RSIC package CCC-209/DOT3, which is compatible with DOT 3.5. The extension was made to both the IBM 360/370 and the CDC 6600 versions.

CCC-414/DIAMANT-2

A multigroup two-dimensional, discrete ordinates neutron transport code system for triangular and hexagonal geometry was contributed by Institute for Neutron Physics and Reactor Technology, Karlsruhe Nuclear Research Center, Karlsruhe, Germany. DIAMANT 2 solves the multigroup neutron transport equation in planar geometry using the S_n method. Spatial discretization is accomplished by taking finite differences on a mesh grid composed of equilateral triangles. The stationary multigroup neutron transport equation is solved for two spatial dimensions. The code system is capable of handling direct and adjoint equations. Isotropic and anisotropic scattering (only downscattering) is permitted using a spherical harmonics expansion of the scattering cross section and scattering source. Homogeneous and inhomogeneous problems (external source or boundary source) are treated. Reference: KfK 3033 (ORNL-tr-4797). FORTRAN IV; IBM 360/370-168, 370/3033.

CCC-423/FONTA

A code system for the calculation of radiological consequences of radioactive releases due to hypothetical accidents in nuclear power plants was contributed by the Institute for Reactor Safety, Research Center at Seibersdorf, Austrian Research Association for Atomic Energy, Inc., Vienna, Austria. Based on Pasquill's plume model which is modified by some corrections such as plume rise effect, FONTA considers the building-wake effect and the effects of wet and dry deposition. The doses to seven organs may be evaluated by summing up the doses due to immersion, inhalation, and irradiation by deposits. Contributions of 54 isotopes may be taken into consideration for the evaluation of individual and collective doses. Reference: RS-116/77. FORTRAN IV; SIEMENS 4004.

PSR-131/CARP-82

A new version of the code system for preparing multigroup albedo data using CCC-320/DOT-IV angular flux results has been provided by Oak Ridge National Laboratory. Modifications to the I/O package and storage allocation routines were made to improve the transportability of the system. The package can be used with the data in DLC-59/CAD, or with angular flux from DOT-IV, to prepare input data for PSR-143/BREESE-II. The latter allows the implementation of the albedo option in CCC-203/MORSE. An informal memo from M. B. Emmett has been added to the original document (ORNL/TM-6503) to guide the user in implementing CARP-82. FORTRAN IV and IBM Assembler; IBM 370/3033.

PSR-143/BREESE II

The Oak Ridge National Laboratory has contributed a newly frozen version of BREESE II to provide a more consistent package and to clarify its use in relation to RSIC code packages PSR-131/CARP and CCC-203/MORSE. Sample input and output were added to demonstrate a sequence of calculations linking the various packages. No change in the documentation was required. FORTRAN IV; IBM-370/3033.

PSR-159/RENDER

Several pre-processing codes for nuclear data in ENDF format have been replaced with 1982 version packaged in February 1982 contributed by the International Atomic Energy Agency (IAEA) Nuclear Data Section, Vienna, Austria. Included are: LINEAR, RECENT, SIGMA1, GROUPIE, EVALPLOT, MERGER, DICTION, and CONVERT (see February 1982 *RSIC Newsletter* for functional descriptions). The codes will operate on data in ENDF/B-IV or -V formats. Methodology is documented in UCRL-50400, Vol. 17, Parts A–E; updates are summarized in IAEA-NDS-39, "Summary of ENDF/B Pre-processing Codes." CONVERT allows user to automatically convert computer codes to IBM, CDC, or CRAY.

PSR-180/MINIGAL

This data processing code system is a contribution of the UKAEA Atomic Energy Establishment, Winfrith, England via the OECD Nuclear Energy Agency Data Bank, Gif-sur-Yvette, France. From data in Standard UK Nuclear Data Library (NDL) format, the processing system calculates cross sections from 0.0253 eV to 14.04 MeV, Maxwellian averages, epithermal integrals, and fission spectrum averages. Input data can be on cards, card image tape, or binary tape. The user may specify the Maxwellian temperature and the energy limits of the regions over which averages are taken or accept default values. Reference: UNDG(79)/P211. FORTRAN IV; IBM 370/3033.

PSR-181/DORGLIB

DORGLIB, contributed by Power Reactor and Nuclear Fuel Development Corporation (PNC), Tokyo, Japan, was designed to display data for CCC-217/ORIGEN interactively on a graphic display terminal TEKTRONIX T-4014. Parameters displayed are as follows: (1) table of nuclides and their half lives, (2) half-life, decay scheme, energy released by decay, natural abundancy, and neutron cross sections for each nuclide, and (3) figure of production and decay routes for each nuclide.

Included in the code package are nine data libraries for ORIGEN taken from CCC-217/ORIGEN and DLC-38/ORYX-E. DORGLIB is written for a FACOM-M series computer in FORTRAN IV and Assembler language. Reference: Informal Notes, User's Manual.

SCA-3/TRUMP

The code package for calculating transient and steady-state temperature distributions and multidimensional systems for the SCALE modular code system was extended to include a PRIME computer version (C) contributed by Ridihalgh, Eggers and Associates, Columbus, Ohio. FORTRAN IV.

CHANGES TO THE DATA LIBRARY COLLECTION

Two new data libraries have been added to the RSIC collection, one of which is a contribution from Japan.

DLC-88/TPASGAM

This compilation of decay data for 748 isotopes contains the necessary data for measuring the concentration of photon emitting radionuclides as well as conducting activation analysis using gamma-ray spectrometry. Contributed by Oak Ridge National Laboratory, the data library was developed specifically for use with RSIC code package PSR-164/TPASS. It was developed using DLC-19/DECAYGAM as a starting parent data library and additions and changes were made primarily for fission product and heavy actinides. Alternate versions of the library are: first, ordered by nuclide number; second, by energy; and third, by half-life. Two retrieval codes are provided to operate on the file ordered by nuclide number. FIXISO, a PDP-10 interactive routine, can be used to update the library. DECAYDAT, an IBM-370 code, can be used to read and list the file. EBCDIC card images, FORTRAN IV; PDP-10, IBM-370/3033.

DLC-92/GICX40

This coupled 42-neutron, 21-gamma-ray group

cross section data library was contributed by the Division of Thermonuclear Fusion Research, Tokai Research Establishment, Japan Atomic Energy Research Institute (JAERI). The data were processed by the CCC-300/RADHEAT-V code system (a JAERI contribution) using data from ENDF/B-III and -IV for neutrons and PSR-11/POPOP4 for gamma ray production. The data have been applied to fusion reactor systems. The format is group independent card image and data are included for 40 elements. No retrieval code is available at this time. Reference: JAERI-M-8818. EBCDIC card images; IBM-370/3033.

STANDARDS ACTIONS

We note the following standards activities.

ANSI — Call for Comment by July 2, 1982

45B (Central Office) 43 Beta, X and Gamma Radiation Dose Equivalent Rate Meters for use in Radiation Protection, $18.00.

45 (Central Office) 158 Test Procedures for Semiconductor Charged Particle Detectors, $12.00.

Order these IEC standards from ANSI, send comments to *D. W. Smith,* director, International Operations, ANSI.

ANSI — Final Actions

ANSI N545-1975 (R1982) Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications) (HPS) (reaffirmation).

ANSI/ANS-10.2-1982 Recommended Programming Practices to Facilitate the Portability of Scientific Computer Programs (new standard).

PERSONAL ITEMS

Kyoshi Takeuchi, Ship Research Institute recently received the award of the Atomic Energy Society of Japan at the Annual Meeting of the society. The award recognizes his work in developing the PALLAS radiation transport code system over a period of 20 years. Two versions of PALLAS are in the RSIC collection: CCC-380/PALLAS-PL/SP and CCC-391/PALLAS-2DCY. The PL/SP version is a multigroup one-dimensional neutron transport code system for plane or spherical geometry; the 2DCY version is for a two-dimensional (r, z) geometry and treats neutrons or gamma rays. The method of direct integration of the transport equation is used in which the equation is integrated along the flight path of the particle in the direction of motion at each discrete ordinate direction. Anisotropic scattering is treated precisely using differential scattering cross sections. No iteration or convergence techniques are used for determination of the flux density. The RSIC FORTRAN IV versions of the PL/SP and 2DCY codes are operable on IBM and FACOM computers respectively.

Betty F. Maskewitz presented a paper to the National Bureau of Standards FIPS Software Documentation Workshop, March 3, 1982, in Gaithersburg, Maryland. The paper, entitled "User Experience and Compatibility in Documentation Standards — A Summary," reviewed existing guidelines for documentation of scientific computer programs or data libraries and outlined the essential elements for facilitating exchange of the software. The NBS Institute for Computer Sciences and Technology, sponsor of the Workshop, plans to publish the proceedings.

A. T. Luksic and W. L. Bunch of the Hanford Engineering Development Laboratory were selected to receive the ANS Radiation Protection & Shielding Division's Best Paper Award. The two were selected for their paper "Lessons Learned from FFTF Hot Cell Shield Measurements," which was presented at the ANS Winter Meeting in San Francisco. An award certificate and prize money will be presented to the winners during the division's business meeting in Los Angeles in June.

David K. Trubey, of the RSIC staff, has recently been appointed the American Nuclear Society representative to ANSI Committee N13, Radiation Protection. In this capacity he will be balloting proposed standards which come before the committee. Trubey has been alternate ANS representative since 1979 and succeeds *Eric T. Clarke* who recently retired from Technical Operations, Inc. Eric was ANS representative for approximately 10 years.

VISITORS TO EPIC

During the month of April, the following persons came for an orientation visit and/or to use EPIC facilities: *Ivo Petr* and *Dr.Josef Seda,* professors in the Technical University of Prague, Czechoslovakia; *Takumi Asaoka* from the Japan Atomic Energy Research Institute, Tokai, Japan; *Michael J. Kolar,* EPRI, Palo Alto, California; *Gerald P. Lahti,* Sargent & Lundy, Chicago, Illinois; *G. Lee Simmons,* Science Applications, Inc., La Jolla, California; and *Lowell Langford,* ORNL, Oak Ridge, Tennessee.

UPCOMING MEETINGS AND COURSES

ANS Special Sessions

The ANS Division of Radiation Protection and Shielding (RP&S) has scheduled three special and two general sessions at the upcoming (June 6–10) Annual Meeting to be held in Los Angeles. The following topics are included:

Reassessment of Dosimetry Data from Hiroshima and Nagasaki, Monday p.m.

Methods and Applications of Neutral and Charged Particle Transport — I, Tuesday p.m.

Methods and Data for Radiation Transport and Shielding, Wednesday a.m.

Methods and Applications of Neutral and Charged Particle Transport — II, Wednesday p.m.

Fusion Reactor Neutronics and Shielding, Thursday a.m.

The ANS Mathematics and Computation Division has arranged related sessions:

NEA Library Programs in LWR Safety, Monday p.m.

Reactor Physics Methods, Monday p.m.

Fusion Reactor Methods — I, Tuesday a.m.

Fusion Reactor Methods — II, Wednesday a.m.

Several sessions are now being planned for the 1982 Winter Meeting to be held in Washington, D. C. The sessions and their sponsors are:

- "Deep Penetration: Problems and Methods of Solution," *Joseph Mack* and *Magdi Ragheb;*
- "Medical and Accelerator Shielding," *Keran O'Brien* and *David Bartine;* and
- "Radiation Protection Planning," *Thomas Murphy* and *Thomas Albert.*

Suggestions regarding any of the sessions planned for the winter meeting should be directed to their organizers.

The RP&S Division is planning its first topical meeting for the spring or fall of 1984, to be jointly sponsored with the Reactor Physics Division. Radiation Protection and Shielding members or local sections interested in helping to organize future topical meetings should contact *David E. Bartine,* Vice Chairman, at Oak Ridge National Laboratory, phone 615/574-6100, or FTS 624-6100.

CAFEM-7

The 7th International Seminar on Computational Aspects of the Finite Element Method (CAFEM-7), held in conjunction with the 7th International Conference on Structural Mechanics in Reactor Technology (SMiRT-7), is scheduled for August 29–30, 1983 in Chicago, Illinois. Topics to be addressed are: Applications, Algorithms and Numerical Methods, Interactive Graphics and Computer Aided Design, The Integration and Verification of Computing Software, Hardware and Software Requirements, and Data Management.

Health Effects Course Offered

The University of Colorado School of Medicine Continuing Medical Education Program offers "The Health Effects of Low Level Radiation Exposure," August 22–27, 1982 at the YMCA of the Rockies, Snow Mountain Ranch, Colorado.

During each day of this symposium, in-depth discussions will be presented on data concerning the health effects of radiation, critical analyses of studies contributing to these data, standards for protection against radiation, nuclear power and its alternatives, problems of waste disposal, cost/benefit and risk/benefit analyses and related topics. Although all topics will be explained in depth, no particular background in the subjects will be required of participants. On some evenings, general sessions of interest to attendees and spouses will be presented on topics such as x-ray mammography, Three Mile Island, truths and fallacies concerning radiation exposure, etc. Ample time for discussion of topics will be included in the program.

The University of Colorado School of Medicine certifies that this continuing medical education offering meets the criteria for 24 hours in Category I of the Physician's Recognition Award of the American Medical Association. Application has been made for prescribed credit hours from the American Board of Health Physics.

For further information contact the Course Director, *Dr. William R. Hendee,* Professor and Chairman, Department of Radiology, University of Colorado, 4200 East Ninth Avenue, C-295, Denver, Colorado 80262.

CALENDAR

June 1982

Eleventh International Symposium on the Effects of Radiation on Materials, sponsored by ASTM Committee E-10 on Nuclear Technology and Applications, Mountain Shadows Resort, Scottsdale, Arizona, June 28–30. Chairman: Howard R. Brager, Hanford Engineering Development Laboratory, Richland, Washington 99352.

Probabilistic Risk Assessment: Applications and Uses for Decision-Making in the Nuclear Industry, a short course offered by the Massachusetts Institute of Technology Department of Nuclear Engineering, June 28–30. For further information contact

Carolyn D. Heising, Department of Nuclear Engineering, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts 02139.

APRIL ACCESSION OF LITERATURE

The following literature cited has been ordered for review, and that selected as suitable will be placed in the RSIC Information Storage and Retrieval Information System (SARIS). This early announcement is made as a service to the shielding community. Copies of the literature are not distributed by RSIC. They may generally be obtained from the author or from a documentation center such as the National Technical Information Service (NTIS), Department of Commerce, Springfield, Virginia 22151.

RSIC maintains a microfiche file of the literature entered into SARIS, and duplicate copies of out-of-print reports may be available on request. Naturally, we cannot fill requests for literature which is copyrighted (such as books or journal articles) or whose distribution is restricted.

THIS LITERATURE IS ON ORDER. IT IS NOT IN OUR SYSTEM. PLEASE ORDER FROM NTIS OR OTHER AVAILABLE SOURCE AS INDICATED.

REACTOR AND WEAPONS RADIATION SHIELDING LITERATURE

AEEW-R-1301 Energy Multiplication and Fissile Material Production in Fission-Fusion Systems., . . Jakeman, D., . . October 1979, . . NTIS (U.S. Sales Only), PC A03/MF A01

AERE-R-10295 Neutron Scattering Studies of Vitrified Radioactive Waste., . . Sinclair, R.N.; Desa, J.A. E.; Wright, A.C., . . October 1981, . . UKAEA Atomic Energy Research Establishment, Harwell, Materials Physics Division

AERE-R-10340 A Computer Program for Gamma Ray Identification Using the Westmeier Data., . . Sims, H.E., . . October 1981, . . UKAEA Atomic Energy Research Establishment, Harwell, Chemistry Division

ASTM-STP-683 Effects of Radiation on Structural Material., . . Sprague, J.A.; Kramer, D. (Eds.), . . October 1979, . . American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 $58.50

ASTM-STP-698 Effluent and Environmental Radiation Surveillance., . . Kelly, J.J., . . February 1980, . . American Society for Testing and Materials, 1916 Race Street Philadelphia, PA 19103 $36.50

ASTM-STP-725 Effects of Radiation on Materials., . . Kramer, D.; Brager, H.R.; Perrin, J.S., . . May 1981, . . American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 $60.00

BLG-552 Study of the Corrosion Products in the Primary System of PWR Plants as the Source of Radiation Fields Build-Up., . . Brabant, R.Van; Regge, P.de, . . January 1982, . . E. Plaskylaan 144, 1040 Brussel (Belgie)

BLG-553 Optimization of NDA Measurements in Field Conditions for Safeguards Purposes., . . Menlove, H.; Keddar, A.; Griggs, J.; Beets, C.; Bemelmans, P.; Boermans, P., . . January 1982, . . E. Plaskylaan 144, 1040 Brussel (Belgie)

BNL-30659; CONF-8110113-3 Radiation Damage Studies on Natural Rock Salt from Various Geological Localities of Interest to the Radioactive Waste Disposal Program., . . Levy, P.W., . . 1981, . . NTIS, PC A03/MF A01

BNL-30806; CONF-8009240-1 First-Wall Fusion-Blanket Heat Transfer., . . Fillo, J.A., . . 1980, . . NTIS, PC A02/MF A01

BNL-NCS-51320 Uranium Half-Lives: A Critical Review., . . Holden, N.E., . . January 1981, . . NTIS, PC A03/MF A01

BNL-NUREG-30724; CONF-820609-11 In-Core Detector Activation Rate for a PWR Assembly., . . Todosow, M.; Eisenhart, L.D., . . January 1982, . . NTIS, PC A02/MF A01

CEA-R-5129 (In French) Rationalizing Radiation Protection Choices: A Review of the Main Methods Available., . . Lombard, J., . . September 1981, . . NTIS (U.S. Sales Only), PC A05/MF A01

CONF-791051-17 Uncertainties and Covariances of Spectra Derived from Integral Measurements., . . Greenwood, L.R., . . 1980, . . NTIS, PC A02/MF A01

CONF-800111, pp. 848-852 Neutron Nuclear Cross Section Data for Fusion Technology., . . Srinivasa Rac, C.V.; Rama Rao, J., . . October 1979, . . National Bureau of Standards (U.S.), Special Publication

CONF-810905-34 Calculation of Doses Received While Crossing a Plume of Radioactive Material., . . Scherpelz, R.I.; Desrosiers, A.E., . . April 1981, . . NTIS, PC A02/MF A01

DOE/ER/01359-T2 Systematic Efficiency Enhancement in Monte Carlo Applications. Final Progress Report, July 1, 1976-January 31, 1980., . . Spanier, J., . . June 11, 1980, . . NTIS, PC A02/MF A01

DOE/EV/01105-280 Cavity Theory for Spherical Ionization Chambers Irradiated by Fast Neutron., . . Kearsley, E.E., . . 1981, . . NTIS, PC A03/MF A01

DOE/EV/01105-281 Transport Calculations for a 14.8 MeV Neutron Beam in a Water Phantom., . . Goetsch, S.J., . . 1981, . . NTIS, PC A02/MF A01

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Gamma Shielding Estimates on the Back of an Envelope,
(An inquisite newcomer squeezes his teacher)
Part II (A Supplement) HANS PENKUHN ESIS

Newcomer's question (Q): The last time (ref./1/) you said that most gamma shielding calculations refer to source energies below 4 MeV. But now my boss asks me to treat gamma sources in the high MeV-range. Are there simple rules for estimates beyond source energies of 4 MeV, too?

Teacher's answers (A): That's an exception which confirms the rule. But first you are cautioned: check whether in your shield or source material high energy photons can cause photonuclear processes, as photoneutrons, photofissions etc. Example: in normal water, about 140 ppm of the hydrogen atoms are deuterons. Their photo-neutron cross section is below 4 millibarn, with a threshold gamma energy at 2.2 MeV. Nevertheless, in a swimming-pool reactor, at more than 2 m distance from the core periphery in water, there are far more photoneutrons from the process D (γ,n) H than fission neutrons emitted by the reactor core.

Another example is given in ref./1/, chapter 7.

Q: When these "photonuclear checks" are done, are there simple rules for the gamma attenuation coefficient μ, and for the dose buildup factor B in the source energy range from 4 to 15 MeV?

A: For light and heavy water, apply the old $\sqrt{\ }$E-rules: (densities 1 g cm^{-3} for H_2O, 1.1 for D_2O) μ(water) $\simeq 0.07/\sqrt{E}$ with μ in cm^{-1}, and E in MeV. The error limits are $\pm$4% from 0.5 to 3 MeV., and $\pm$8% from 0.4 to 15 MeV; for high E the fit is conservative, for the lowest E-values optimistic.

Q: And in air?

A: The μ/ρ of air is by 6-11% below the μ/ρ of light water, from 40 KeV to 15 MeV.

Q: Which μ do you propose for the other shielding materials, from Al to Pb?

A: For iron, tin, lead and other shield materials in the medium and high Z-range, take beyond 4 MeV the minima of μ/ρ listed in table I. Remember that μ/ρ at 3.3 MeV lies in the range 0.033-0.037 cm^2/g (ref./1/,for $6 \leq Z \leq 53$)

Q: What about lead glasses?

A: They can - conservatively - be compared with tin.

Q: How can I treat aluminium?

A: For Al - and similarly for ordinary concretes and glasses, or for SiO_2 (units as defined before) use

$$\mu(E)/\rho \simeq 0.06/\sqrt{E} \quad (0.3\text{MeV} \leq E \leq 9\text{MeV})$$

Table I - Minima of μ/ρ,in cm^2 /g

Material	Z or Z_{eff}	E_{min} (MeV)	Min(μ/ρ)
H_2O, Air	7-8	$\simeq$ 50	0.016-0.017
Na.Al.SiO_2	11-13	$\simeq$ 20	0.020-0.022
Argon	18	15	0.024
Iron	26	9	0.03
Tin	50	5	0.035
W,Pb	74-82	$\simeq$ 4	$\simeq$ 0.04

For $E \geq 9$ MeV, take the minimum of μ/ρ for these materials, i.e. 0.02 cm^2/g

Q: Which are the errors of these rules?

A: For high E, they are rather safe. Example: At E=9 MeV, the value of 0.02 cm^2/g for Al, SiO_2, ordinary glass, and normal concrete is safe by 14-19%.
At E=4 MeV the rule $\mu/\rho = 0.06/\sqrt{E}$ is safe by 1-6%. In the worst case, there can be optimistic errors by 1-2%; but this is the natural uncertainty limit of μ.

Q: Why are the rules for μ/ρ for water and for Al so different, once with a coefficient 0.07 for H_2O, but with a value 0.06 for Al?

A: In the Compton range, μ/ρ is proportional to Z/A, with A=atomic weight, Z= atomic number.
Z/A is 0.48 for Al. The corresponding quantity referred to the water molecule (H_2O) is $\Sigma Z/\Sigma A = 10/18 \simeq 0.56$
and the ratio 0.56/0.48 is just 0.07/0.06.
The difference between μ/ρ of H_2O and air can be explained in the same way.

Q: And what about the buildup factors?

A: For low and medium Z-materials (e.g. H_2O, Al, Fe, normal and iron concrete) with source energies E_0 from 6 to 10 MeV and $\mu r \leq 20$ (r=distance source-detector, in cm)
$B_D(\mu r) \leq 1 + 0.7\,\mu r$ (H_2O, Al, Fe)
but for high-Z-materials (Sn, W, Pb, lead glass, or barytes concrete):
$B_D(\mu r) \simeq 1 + \mu r/4 + 1/10\,(\mu r)^2 \quad (\mu r \leq 20)$

Reference:
/1/ ESIS Newsletter 38-39 (July-October 1981), p.5, H.PENKUHN, Gamma Shielding Estimates on the Back of an Envelope.

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