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 37830

No. 115 June 1974

Many a man fails to become a thinker
for the sole reason that his memory is too good.

...Nietzsche

RSIC CODES COORDINATOR WANTED

RSIC has a job opening for a Scientist/Engineer to carry responsibility in connection with the RSIC codes collection: technical review and selection, act as consultant to technical support team in testing; study the collection and advise requesters; assist in the preparation of documentation and the publishing of abstracts; collaborate in solving neutronics, radiation protection and radiation transport problems; and complement all RSIC technical efforts. Applicant needs to communicate well verbally and in writing; should know programming languages and be interested in using computers.

Send resumé to RSIC Coordinator, Betty F. Maskewitz, or call 615-483-8611, extension 3-6944, or FTS #615-483-6944.

CONTRIBUTED PAPERS SOUGHT BY ANS SHIELDING AND DOSIMETRY DIVISION

Special sessions sponsored by the Shielding and Dosimetry Division are planned for the Washington American Nuclear Society meeting scheduled for October, 1974. These are:

1. "CTR Blanket, Shielding, and Cross Section Studies," being organized by Don Dudziak, LASL. (CTR=Controlled Thermonuclear Reactor).

2. "Process and Area Radiation Monitoring," being organized by Ed Warman, Stone and Webster, Boston.

Contrary to the information in the call for papers in the April Nuclear News, both invited and contributed papers are being solicited. It is the policy of the S&D Division to include contributed papers in all Division-sponsored sessions.

RSIC REACTOR-WEAPONS BIBLIOGRAPHY ISSUED

ORNL-RSIC-5, Volume IV, "Bibliography, Subject Index, and Author Index of the Literature Examined by the Radiation Shielding Information Center (Reactor and Weapons Radiation Shielding)," has gone to press. This volume, which complements prior issues, contains literature reviewed since January 1971. It includes literature titles by subject categories for accession numbers 2301-3500. Author and keyword indexes are given for the entire file published as volumes I-IV.

The current issue represents the work of RSIC technical reviewers R. W. Roussin and D. K. Trubey, information specialists Jane Gurney and Ann Gustin.

ORNL-RSIC-5, Vol. IV will be distributed only by individual request. Those interested in having a copy may reserve one by writing to the Radiation Shielding Information Center, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, Tennessee 37830.

CATALOG OF NUCLEAR INDUSTRY STANDARDS PUBLISHED

Has a standard been set for radiation exposure records? Are there standards for shielding concrete...construction quality assurance... bolting materials? What standards cover special nuclear materials...radiographic examination? Check the NUCLEAR CATALOG. Listed are some 1200 standards known to be applicable to the nuclear industry - those approved as national consensus standards by ANSI and also standards of trade, technical, and professional organizations and government agencies. Included are standards for materials, equipment, instrumentation and controls, programs, procedures, methods, and quality assurance. Atomic Energy Commission Regulatory Guides are identified in an appendix.

Published April 1974, the price of the catalog is $5.50. Included in this price are three supplements which will be mailed automatically in the course of the year. Order from the American National Standards Institute, 1430 Broadway, New York, N. Y. 10018.

PROCEEDINGS FROM 1972 PARIS SHIELDING CONFERENCE AVAILABLE

The Proceedings of the 4th International Conference on Reactor Shielding held in Paris, 9-13 October 1972, are available for sale. The Proceedings may be purchased at a price of 120 francs at EYROLLES Editeur, 61, Boulevard Saint Germain, 75240 - PARIS CEDEX 05, FRANCE.

CORRECTION TO CCC-187/SAM-CE

Martin O. Cohen, MAGI, has forwarded to RSIC corrections numbered 25 and 26 to Revision B of the SAM-F code. A mailing has been made to those known to be using SAM-CE. If you did not receive this mailing, please contact RSIC.

INFORMATION ON CCC-142/MERCURE 364 CODE PACKAGE

C. Devillers, Reactor Shielding Group, CEN/Saclay, France, calls attention to the following facts concerning his group's contribution: Kernel Integration Codes - Straight-Line Attenuation in Three-Dimensional Geometry.

"The programme MERCURE 4 (CCC-142B)that you received from NEA/CPL can replace MERCURE 3 (CCC-142A) for most applications; however, because MERCURE 4 is based on a Monte Carlo integration technique, it gives accurate contributions only for the space-energy regions which give important contribution to the result; as a consequence, the utilization of one calculation for extrapolation to other source distributions may be impossible. On the contrary, MERCURE 3, although less capable, did allow such extrapolations."

CHANGES TO DATA COLLECTION

Updates were made during the month to the following data packages.

DLC-28/CTR — The 73-Group Coupled Cross Section Library containing materials of interest in CTR Neutronics studies has been updated with the addition of a data set for fluorine. Requests for the entire library should be accompanied by a full 2400' reel of magnetic tape. If desired, the fluorine data can be sent to requesters on cards (569).

DLC-30B/DECAYREM — The number of nuclides in the radioactive decay spectra and decay chain data package have been increased to 196 and the chain data have been revised. The constant used to combine pathways has been changed to 1000 to allow the nuclide identification number to exceed 500.

RSIC TO DISTRIBUTE A NEW CLASS OF DATA LIBRARIES

The Defense Nuclear Agency (DNA) is sponsoring the generation of processed data libraries for use by its contractors in solving radiation transport problems. The libraries, which will be available upon request from RSIC as Data Library Collection 31 (DLC-31), will include data in multigroup and point energy form. Although these have been generated specifically for DNA interests, the processed data libraries will be available for general distribution.

Source of the Library

The multigroup libraries will be generated at Oak Ridge National Laboratory using the AMPX system and evaluated data from the DNA and ENDF/B cross section libraries. These will be coupled neutron and secondary gamma-ray cross section libraries in the ANISN format and can be used in the ANISN, DOT-III, MORSE, DTF-IV, and TWOTRAN computer codes.

The point energy libraries will be generated at the Mathematical Applications Group, Inc., using the SAM-X system operating on evaluated data from the DNA and ENDF/B libraries. These will be neutron, gamma-ray interaction, and gamma-ray production libraries for the SAM-CE (Rev.B) series of Monte Carlo computer codes.

Special Features

It is anticipated that the multigroup libraries will eventually include few-group (≈ 60 groups), fine-group (≈ 250 groups), mid-group (≈ 100 groups), and problem-dependent sets. Different versions of the sets may be generated using various weighting functions ($1/E$, $1/E \cdot \Sigma_t$, etc.).

Documentation

It is planned that the DNA Processed Library will be documented in a special RSIC publication. This document will include detailed information such as plots of point versus multigroup values, tables of individual reaction cross sections, comparisons of results of calculations utilizing the data, characteristics of the processing codes used to generate the libraries, and other pertinent information.

Abstracts of each of the DPL sets will be published in ORNL-RSIC-30 under the designation DLC-31. This will allow prospective data users to see in a single document information on all processed data distributed by RSIC.

Designation

Present plans call for designating the libraries in DLC-31 by DPL-N (DNA Processed Library) where N will be an integer in a range designated as follows:

N	Library Type
1-99	Few Group
100-199	Mid Group
200-299	Fine Group
300-399	Problem Dependent Group
400-499	Point Energy

When a given library is updated, we will affix a letter to the number designation to identify the version created by the update.

Current Contents of the DNA Processed Data Library Collection

DLC-31

DPL-1/FEWG1: 37 Neutron, 21 Gamma-Ray Coupled, P_3, Multigroup Library in ANISN Format. Data included for H, Be-9, B-10, C-12, N, O, Na, Mg, Al, Si, K, Ca, Cu, Fe, Ta-181, W-182, W-183, W-184, W-186, Pb, U-238, and Pu-239. Neutron energy range 19.64 to 1.0 E-11 MeV and gamma-ray energy range from 14.0 to 0.01 MeV. The weighting spectrum for neutron groups was 1/E with a thermal group Maxwellian weighting spectrum with a 300°K temperature. A retrieval program (ARID) is included for collapsing the library to a smaller number of groups. Requests should be accompanied by a full (2400') reel of magnetic tape.

DPL-400/GEDT1: Gamma-ray Element Data Tape in SAM-CE Format. Data included for materials with atomic numbers 1-83, 86, 90, 92, and 94, and for some naturally occurring elements. A retrieval program (BCDEAN) is included which converts from card image format to binary (unformatted) form as required by SAM-CE. Data given for the energy range from 100 MeV to 1 keV.

DPL-401/NEDT1: Neutron Element Data Tape in SAM-CE Format. Data included for H-1, H-3, He-4, C-12, N, O, Na, Al, Si, Ca, Fe, Cu, W-182, W-186, Pb, and U-238. Retrieval program BCDEAN included. Neutron energy range from 19.99 to 1.+E-9 MeV.

DPL-402/GPDT1: Gamma-Ray Production Data Tape in SAM-CE Format. Data included for H-1, N, O, Al, Si, Ca, and Pb. BCDEAN retrieval program included.

CHANGES TO THE DNA WORKING CROSS SECTION LIBRARY

The nitrogen, oxygen, and sodium, and two tungsten evaluations have been modified recently. The updated versions are designated DNA MAT 4133, MOD 5 nitrogen; DNA MAT 4134, MOD 3 oxygen; DNA MAT 4156, MOD 1 sodium; DNA MAT 4583, MOD 3 tungsten-183; and DNA MAT 4584, MOD 3 tungsten-184. The changes are summarized below.

Nitrogen MAT 4133 LASL
MOD 5 April 1974

Error information was added, using the MF=33 format using options LB=0,1,2, and 3.

Oxygen MAT 4134 LASL
MOD 3 April 1974

Error information was added using the MF=33 format using options LB=0,1,2, and 3.

Sodium MAT 4156 ORNL
MOD 1 May 1974

The neutron and secondary gamma-ray production data were extrapolated to 20 MeV to conform to ENDF/B-IV requirements.

Tungsten-183 MAT 4583 LASL
MOD 3 May 1974

At certain energies, additional parameters were specified to make energy ranges for all L-states consistent with the energy range specified for the unresolved resonance region.

Tungsten-184 MAT 4584 LASL
MOD 3 May 1974

Revisions similar to that for MAT 4583 MOD 3.

PERSONAL ITEMS

C. Devillers, Reactor Shielding Group, CEA/CEN Fontenay-aux-Roses, France, announces that his group has moved to SACLAY; are still involved in shielding studies and in addition have been asked to look at specific core physics problems that can only be accurately solved presently by general Monte Carlo codes. Two papers from J. M. Lanore indicate progress in her simulation work of the annealing of radiation induced defects by the Monte Carlo method.

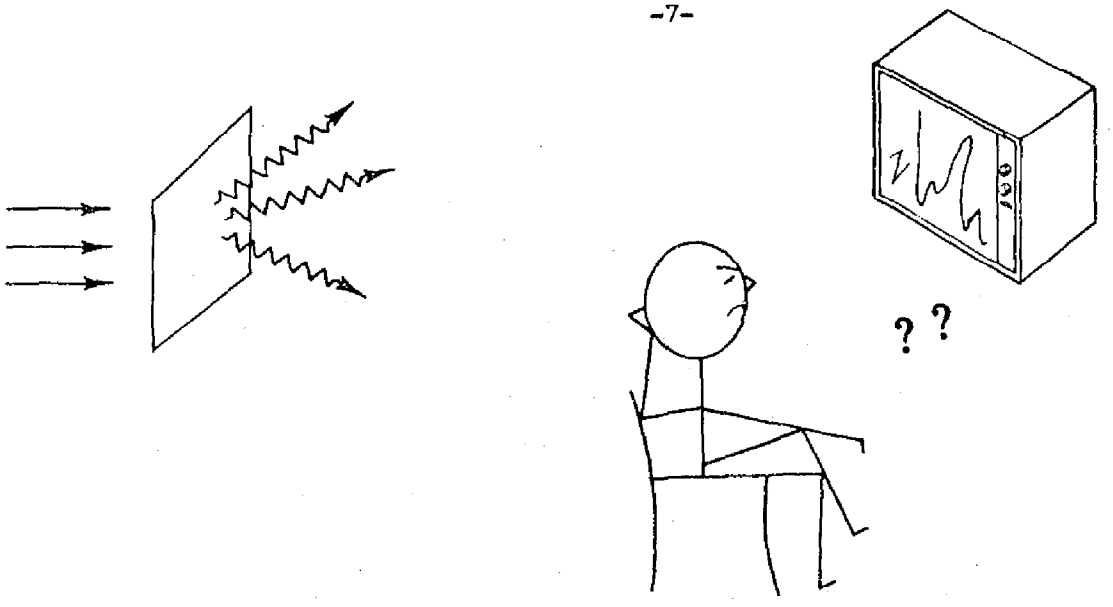
Shunsuke Uchida, who for the past year worked for ORNL Neutron Physics Division in radiation shielding, has returned to Hitachi Research Laboratory of Hitachi, Ltd., 3-1-1, Saiwaicho, Hitachi, Ibaraki, Japan. He will be involved in radiation shielding and safety research on the BWR and the FBR for Hitachi.

T. W. Armstrong, formerly with the ORNL Neutron Physics Division, is now associated with Science Applications, Inc., La Jolla, California.

James Stewart, formerly with the Division of Reactor Research and Development, AEC Headquarters, Washington, is now with Group TD-6 at Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

VISITORS TO RSIC

Visitors to RSIC during the month of May were: T. Bohn, Martin Marietta Corp., Orlando, Fla.; J. T. Brisbois, L. Patarin, J. Rastoin, C.E.N. Saclay, Gif-sur-Yvette, France; R. Cerbone, General Atomic Co., San Diego, Calif.; R. Y. Hukai, Instituto de Energia Atomica, Sao Paulo, Brazil; R. LaBauve, Los Alamos Scientific Laboratory, Los Alamos, N. M.; K. Larson, Vanderbilt University, Nashville, Tenn.; T. Lefvert, Research Institute of National Defence, Stockholm, Sweden; H. Morton, Nuclear Fuel Services, Rockville, Md.; T. Nakamura, Kyoto University, Japan; N. Olson, Commonwealth Associates, Jackson, Mich.



Activation Analysis
Chemists, Physicists, Environmentalists,
Are You In It?

If so, here are some tables that have been published in Atomic Data, (AD), Nuclear Data Tables, (NDT), and the combined journal Atomic Data and Nuclear Data Tables, (ADNDT) with your needs in mind.

Radioactive-Decay Gammas — ADNDT **13**, 89 (1974)
Ordered by Energy and Nuclide
W. W. Bowman and K. W. MacMurdo

Neutron Activation Cross Sections — NDT **11**, 622 (1973)
Measured and Semiempirical
W. F. Alley and R. M. Lessler

Photon Cross Sections from 0.1 KeV to 1 MeV — AD **5**, 51 (1973)
Wm. J. Veigele

Photon Cross Sections from 1 KeV to 100 MeV — NDT **7**, 565 (1970)
E. Storm and H. I. Isreal

Radioactive Atoms — NDT **8**, 1 (1970)
Auger-Electron, α-, β-, γ-, and X-Ray Data
M. J. Martin and P. H. Blichert-Toft

The 1971 Atomic Mass Evaluation — NDT **9**, 265 (1971)
A. H. Wapstra and N. B. Gove

Range and Stopping-Power Tables For Heavy Ions — NDT **7**, 233 (1970)
L. C. Northcliffe and R. F. Schilling

Auger Catalog, Calculated Transition Energies — AD **5**, 317 (1973)
W. A. Coghlan and R. E. Clausing

SI Units in Radiology and Radiation Measurement

(*Received* 18 *January* 1973)

AFTER a considerable time of preparatory work the International Commission on Radiation Units and Measurements (ICRU) in 1953–1962 presented its definitions of the quantities absorbed dose, exposure and activity and the corresponding special units 1 rad, 1 röntgen (1 R) and 1 curie (1 Ci). They are now generally accepted in the whole field of radiology and radiation protection for routine use although certain misuse of some of these quantities is still noticed.

Simultaneously with the work of the ICRU, international efforts were going on in order to establish a practical system of units of measurement suitable for adoption by all signatories to the Metre Convention. In 1960 the 11th General Conference of Weights and Measures (CGPM) adopted the International System of Units, with the international abbreviation SI, for this practical system. Today SI is officially introduced in a large number of countries, including the U.S.S.R. and the member countries of the European Economic Community (EEC). A remarkable exception is the U.S.A.

It is clear that the general implementation of SI means new difficulties in the future use of the special radiological units. When they were introduced in the 1950's a fully developed SI system was not available. Nevertheless the units curie, röntgen and rad can all be exactly expressed in SI units in the following way:

$$1 \text{ curie} = 1 \text{ Ci} = 3.7 \times 10^{10} \text{ s}^{-1} \text{ (exactly)}$$

$$1 \text{ röntgen} = 1 \text{ R} = 2.58 \times 10^{-4} \text{ C/kg (exactly)}$$

$$1 \text{ rad} = (1 \text{ rd}) = 0.01 \text{ J/kg (exactly)}.$$

It follows from the strict SI rules that the numerical factors involved prevent the adoption of these units as SI derived units. However, in view of existing practice, the International Committee of Weights and Measures (CIPM, 1969) considered it was preferable to keep the units curie, röntgen and rad *for the time being*, to be used with the SI. But steps towards the eventual abandonment of the special radiological units have already been taken by the EEC countries. And the important benefits to be gained by world wide use of a common international and coherent system of quantities and units now calls upon a careful consideration of the "be or not to be" of the special radiological units.

Radiological SI units and their equivalents expressed in the present special units are given in Table 1.

Table 1 shows that the SI units imply substantial changes in the numerical values of the actual quantities. In the case of an *absorbed dose* of 6400 rad to a patient a change to the corresponding SI quantity value 64 J/kg should be relatively easy to perform. The difficulties may be more pronounced if the absorbed dose rate has to be expressed in watts per kilogram, W/kg, replacing rad/min, because the time unit is not explicitly given in the unit W/kg, which also masks the fact that the time unit is the second and not the minute. From a medical safety point of view it is also desirable that the absorbed dose and absorbed dose rate are expressed in units containing the same derived SI unit. The units J/kg and J/(kg.s) should then be the better choice; even J/(kg.min) for absorbed dose rate could be considered, as minute is retained for general use with the SI units.

The quantity *exposure* will be given a rather large SI unit, 1 C/kg, and an inconvenient conversion factor, 1 C/kg = 3876 R. The main field for the use of the quantity exposure will be medical roentgen diagnosis. For instance, the exposure rate 20 R/s corresponds to 0.0052 C/(kg) *or* 5.2 mC/(kg.s) *or* 5.2 mA/kg; a 10 mR film exposure equals 2.6 μC/kg. This change to an SI unit may involve some difficulties for persons with insufficient experience in handling the results of physical measurement.

The replacement of the *activity* unit 1 Ci with the SI unit 1 per second, s^{-1}, seems to imply certain particular problems. The SI unit is inconveniently small (Table 1) and the formation of the necessary multiple units will not be possible in the usual straightforward way. For instance, the activity 10^6 s^{-1} (≈ 27 μCi) can *not* be written Ms^{-1}, as according to the strict SI rules this means $(\text{Ms})^{-1}$ or 1/Ms, which is equal to 10^{-6} s^{-1}. The recommended symbol for 10^6 s^{-1} is then 1 μs^{-1}, one per microsecond; for 10^9 s^{-1} (≈ 27 mCi) it is 1 ns^{-1}, one per nanosecond, etc. And the rate of change of a radioactive substance necessitates the use of notations such as 10 per microsecond per second, 10 μs^{-1}/s. Both examples may create confusion and increased risk of mistakes in radiation protection operations and in clinical practice.

The safety of the patient in medicine and hospital care has to be carefully considered before the responsible national authorities prescribe a change in the present system of units. A replacement of the special

Table 1. Radiological SI units

Quantity	Derived SI unit	Symbol	Present equivalent
Activity	1 per second	s^{-1}	$\approx 2.703 \times 10^{-11}$ Ci
Absorbed dose	1 joule per kilogram	J/kg	100 rad
Absorbed dose rate	1 watt per kilogram	W/kg = J/(kg.s)	100 rad/s
Exposure	1 coulomb per kilogram	C/kg	$\approx$ 3876 R
Exposure rate	1 ampere per kilogram	A/kg = C/(kg.s)	$\approx$ 3876 R/s

radiological units with SI units implies several difficulties as shown by the examples above. Some of these problems may well be solved by introducing new names for the derived SI units discussed in this context. However, such new names are not desirable according to the principles of the CGPM; nevertheless this body recently accepted special names for the unit of pressure (1 pascal) and of electric conductance (1 siemens). Other measures may also be suggested in order to overcome the difficulties.

The International Commission on Radiation Units and Measurements (ICRU) has as its principal objective the development of internationally acceptable recommendations regarding quantities, units and measurement of ionizing radiation and radioactivity. The ICRU therefore invites and welcomes constructive comments and suggestions regarding the possible replacement of the special radiological units 1 rad, 1 röntgen and 1 curie with derived SI units. These comments may be transmitted to the Chairman, Dr. H. O. Wyckoff,* the vice chairman Professor A. Allisy† or the present writer.

KURT LIDÉN

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* Dr. H. O. Wyckoff, Chairman, ICRU, 7910 Woodmont Avenue, Suite 1016, Washington, D.C. 20014, U.S.A.

† Professor A. Allisy, Bureau International des Poids et Mesures, Pavillon de Breteuil, F 92-Sèvres, France.

Health Physics Pergamon Press 1973. Vol. 25 (August), pp. 200-201. Printed in Northern Ireland

SPECIAL RADIATION UNITS AND/OR SI UNITS?*

THE EDITOR,

Sir,

The publication of my letter *SI Units in Radiology and Radiation Measurement* in your journal (Lidén 1973) was appreciated by the International Commission on Radiation Units and Measurements, ICRU. The interest of many readers has obviously been awakened by this letter, which also appeared in several other journals. By 10 October 1973 the ICRU had received about 30 written comments from organizations and individuals. Even more comments will no doubt be received in the near future.

At its meeting in Madrid, 6 to 13 October 1973, the ICRU devoted much attention to these comments, which displayed a whole spectrum of opinion for and against a conversion to SI units. After considerable discussion, the Commission decided to include the following statement in its report to the 13th International Congress of Radiology (ICRU 1973a):

*Reprinted from Phys. Med. Biol. 19(2), 225-226 (1974).

"Special radiation units

For a number of years the ICRU has recommended the use of the International System of Units (SI) although it has continued to recognize and to use the special radiation units—curie, rad, röntgen and rem. Recently the International Committee of Weights and Measures (CIPM) has listed the curie, rad and röntgen as temporary units and made no mention of the rem. One may infer that CIPM visualizes the eventual replacement of special units by those of the International System. Of course, if this replacement takes place, there will be no modification of the current definitions of radiation quanties such as activity, absorbed dose and exposure.

Realizing that such a replacement might result in difficulties as well as advantages, the Secretary of the ICRU prepared a document on the problem and published it in pertinent professional journals. This document requested opinions and arguments for and against the abandonment of the special radiation units. Comments are still being received and must be considered. The ICRU will formulate a recommendation on this matter at its July 1974 meeting. For the time being, new ICRU Reports will state numerical values of quantities in both SI and special units."

In my previous letter the quantity *dose equivalent*, H, and its unit, the rem, were not mentioned. This topic has recently been the subject of a special statement from ICRU (ICRU 1973b), in which it is recognized that dose equivalent H has the same physical dimension as absorbed dose, that H can be expressed in $J\,kg^{-1}$, and that it is highly desirable, in matters of radiation safety, that H have its own special unit. At present the rem is the special unit of dose equivalent: $1\ rem = 10^{-2}\ J\,kg^{-1}$ (exactly). A change to the SI unit $1\ J\,kg^{-1} = 100$ rem would then introduce a unit 100 times greater and would also require consideration of a special name for this new unit.

The ICRU would greatly appreciate receiving further comments from members and societies of the radiological community and health physics profession before its meeting in July 1974.

KURT LIDÉN,
Scientific Secretary of ICRU,
Radiation Physics Department,
University Hospital,
S-221 85 Lund, Sweden

13 *November* 1973

REFERENCES

ICRU, 1973a, *Report to the International Executive Committee of the Thirteenth International Congress of Radiology, Madrid, October* 1973.

ICRU, 1973b, *Dose Equivalent.* Supplement to ICRU Report 19 (ICRU Publications, P.O. Box 30165, Washington, D.C. 20014, USA).

LIDÉN, K., 1973, *Phys. Med. Biol.*, **18**, 462 , also Health Phys.25(2),199-200 (1973).

CONFERENCE ON NUCLEAR AND SPACE RADIATION EFFECTS

An announcement has been made of the 1974 IEEE Annual Conference on Nuclear and Space Radiation Effects to be held July 15-19, 1974 at the Colorado State University, Fort Collins, Colorado. The technical sessions include BASIC MECHANISMS - IONIZATION AND DISPLACEMENT EFFECTS, CHARGE BUILDUP AND SURFACE EFFECTS, RADIATION EFFECTS IN DEVICES, MODELING OF RADIATION EFFECTS, ELECTRON EMISSION AND TRANSPORT, IEMP AND SGEMP (PHENOMENOLOGY, CALCULATIONAL PROBLEMS AND APPLICATIONS), HARDNESS ASSURANCE, and DOSIMETRY. Additional information on the conference may be obtained from Conference Chairman, Edward A. Burke, AFCRL LQR/Stop 30, L. G. Hanscom Field, Bedford, Mass. 01730, or Conference Coordinator, Lorraine C. Ehlers, Colorado State University, Fort Collins, Colorado 80521.

MAY 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.

Special bibliographies and selected computer-printed abstracts of the literature in the RSIC system are available upon request. The Selective Dissemination of Information (SDI) Service is available by submitting a list of subject categories defining the recipient's interests.

N O T I C E

A mailing is going out this week to determine who wishes to continue receiving the Newsletter and other RSIC materials. Please STAMP and RETURN the message card immediately.

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

REACTOR AND WEAPONS SHIELDING

AI-AEC-13,123
Proton Range and Energy in Irradiated Type 316 Stainless Steel.
Keefer, D.W.; Pard, A.G.
No Date
Atomics International Div., Rockwell International

ANL/NDM-5
Delayed Neutron Data: Review and Evaluation.
Cox, S.A.
April, 1974
Dep., NTIS $6.25

BNL-18574; CONF-740201-1
Radiation Damage in Reactors.
Vineyard, G.H.
1973
Dep., NTIS $3.00

BNL-TR-548
Contribution of Direct Interactions to the Cross Sections for Neutron Scattering by Mg, Ti, Cr, Ni-58, Ni-60, and Ni-62 Nuclei.
Sokolov, L.S.; Fedorov, M.B.; Korbetskii, P.V.; Surovitskaya, N.T.; Yakovenko, T.I.
1973
NTIS

BNL-TR-549
Angular and Energy Distributions of Neutrons Inelastically Scattered by Fe and Ni Nuclei.
Tertychnyi, G.Ya.; Shubin, Yu.N.
1973
NTIS

BNWL-SA-4864; CONF-731133-2
Use of Fission Product Nuclear Data in Life Sciences.
Alpen, E.L.
No Date
Dep., NTIS $3.00

BRL-R-1703
Neutron Response Measurements for Various Passive Gamma Dosimeters.
Jacobson, J.R.
March, 1974
NTIS

BRL-R-1704
Investigation of Possible Synergistic Effects of Neutrons and Photons in Selected Dosimetric Materials.
Jacobson, J.R.; Rodgers, M.P.
March, 1974
NTIS

BNWL-1754
Models and Computer Codes for Evaluating Environmental Radiation Doses.
Soldat, J.K.; Robinson, N.M.; Baker, D.A.
February,1974
Dep., NTIS $7.60

CEA-CONF-2540 (In French); CONF-730907-21 (In French)
Dosimetry of Cosmic Radiation on Board the Supersonic Transport Concorde.
Francois, H.; Delahaye, R.P.; Simon, P.; Portal, G.; Kaiser, H.; Durney, P.
No Date
Dep., NTIS (U.S. Sales Only) $3.00

CINDA 73 Supplement; TID-26460 Supplement
An Index to the Literature on Microscopic Neutron Data.
IAEA
December,1973
IAEA,1973 $31.00

CNLM-6155
Fuels and Materials Highlights: SNAP-50 and Advanced Programs.
Raring, L.M.
February 18,1965
Declassified September 17,1973
Dep., NTIS $3.75

CONF-740104-7
Radiation Blistering of Structural Materials for Fusion Devices and Reactors.
Das, S.K.; Kaminsky, M.
1974
Dep., NTIS $3.00

CONF-740402-2
Transport Calculations for D-T Burning Tokamak Reactors.
Stacey, W.M.,Jr.
1973
Dep., NTIS $3.00

CONF-740402-3
Cross-Section Sensitivity of Tritium Breeding in Fusion Reactor Blankets.
Tobias, M.; Steiner, D.
1973
Dep., NTIS $3.00

DC-59-10-166
GE-ANPD Shield Materials, a Status Report.
Baxter, W.G.; Bauer, P.; Kilb, E.P.; Welch, F.H.
October 15,1959
Declassified September 13,1973
Dep., NTIS $6.00

DC-60-5-11
Investigation of Thermal Shield Poisoning Effects on the P140B Shield.
Wysnewski, R.R.; Jacobs, F.P.
May 5,1960
Declassified September 13,1973
Dep., NTIS $3.00

DHEW(FDA)-8022
Progress in Radiation Protection.
FDA
1973
Bureau of Radiological Health, Food and Drug Administration, Rockwell, Md.

DHEW(FDA)-73-8047
Population Exposure to X-Rays, U.S., 1970. (Report on the Public Health Service X-Ray Exposure Study).
FDA
November,1973
Bureau of Radiological Health, Food and Drug Administration, Rockwell, Md.

DNA-3197F
Final Report for Period January 1,1971 - August 31,1972: Adjoint Monte Carlo Generation of Radiation Response Functions for Complex Missiles.
Scott, W.H.,Jr.; Lonergan, J.A.; Woolson, W.A.
February 5,1974
Science Applications, Inc., La Jolla, Calif.

DP-1339
252-Cf Shielding with Water-Extended Polyester.
Stoddard, D.H.
November,1973
Dep., NTIS $4.00

DP-1346; ENDF-196
Standard Thermal Energy Group Structure for Generation of Thermal Group Constants from ENDF/B Data.
Finch, D.R.
March,1974
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