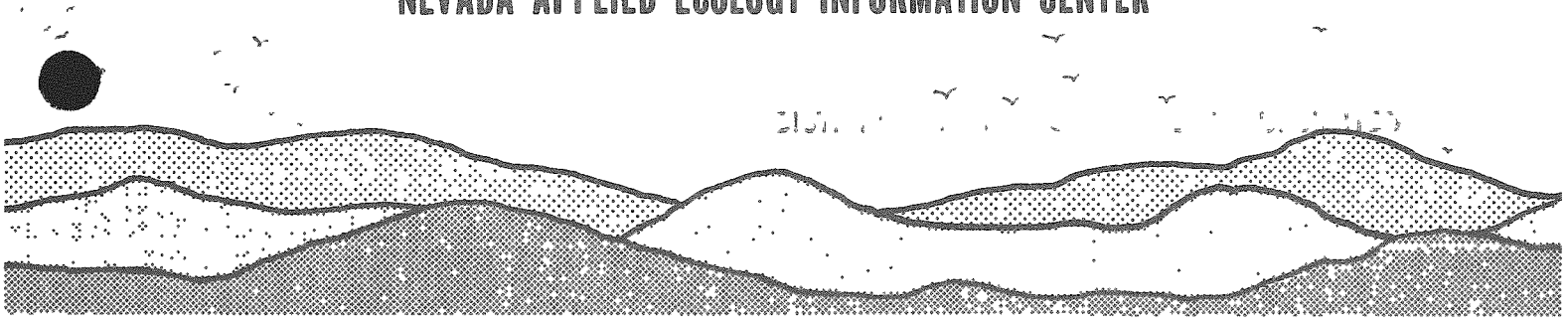
OAK RIDGE NATIONAL LABORATORY
OPERATED BY UNION CARBIDE CORPORATION FOR THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

ORNL/EIS-91/V8
(NVO/AEIC-77-1)

ENVIRONMENTAL ASPECTS of the TRANSURANICS
A Selected Annotated Bibliography -- Vol. 8

Sponsored by
Nevada Applied Ecology Group/Nevada Operations Office, USERDA

NEVADA APPLIED ECOLOGY INFORMATION CENTER



AVAILABILITY OF NAEIC PUBLICATIONS

The published bibliographies issued previously by the Nevada Applied Ecology Information Center (NAEIC) are listed below:

ORNL-EIS-72-21 (NVO-AEIC-72-21)	*Environmental Aspects of Plutonium--A Selected, Annotated Bibliography*, Environmental Plutonium Data Base Group (September 1972)
ORNL-EIS-73-21 (Suppl. 1) (NVO-AEIC-73-21)	*Environmental Aspects of Plutonium and Other Elements--A Selected, Annotated Bibliography*, Environmental Plutonium Data Base Group (February 1973)
ORNL-EIS-74-21 (Suppl. 2) (NVO-AEIC-74-21)	*Environmental Aspects of Plutonium and Other Elements--A Selected, Annotated Bibliography*, Environmental Plutonium Data Base Group (February 1974)
ORNL-EIS-74-21 (Suppl. 3) (NVO-AEIC-74-21A)	*Environmental Aspects of the Transuranics --A Selected, Annotated Bibliography*, F. M. Martin, C. T. Sanders, and S. S. Talmage (December 1974)
ORNL-EIS-75-21-No. 5 (NVO-AEIC-75-1)	*Environmental Aspects of the Transuranics --A Selected, Annotated Bibliography*, R. A. Faust, F. M. Martin, C. T. Sanders, and S. S. Talmage (June 1975)
ORNL-EIS-75-21-No. 6 (NVO-AEIC-75-2)	*Environmental Aspects of the Transuranics --A Selected, Annotated Bibliography*, F. M. Martin, R. A. Faust, and C. T. Sanders (July 1975)
ORNL/EIS-91-No. 7 (NVO-AEIC-76/1)	*Environmental Aspects of the Transuranics --A Selected, Annotated Bibliography*, C. S. Fore, F. M. Martin, and R. A. Faust (July 1976)

DISCLAIMER

ORNL/EIS-91/V8
(NVO/AEIC-77/1)

Contract No. W-7405-eng-26

Information Division

ENVIRONMENTAL ASPECTS OF THE TRANSURANICS A SELECTED, ANNOTATED BIBLIOGRAPHY VOL. 8

Compiled and Edited by

J. T. Ensminger

F. M. Martin

C. S. Fore

Nevada Applied Ecology Information Center
Ecological Sciences Information Center
Information Center Complex

Manuscript Completed - March, 1977

Date Published - August 1977

Sponsored by
Nevada Applied Ecology Group
Nevada Operations Office
of the
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Services of the Nevada Applied Ecology Information Center are available without charge to ERDA-funded researchers. Other requesters will be billed through the National Technical Information Service (NTIS). All inquiries for information services should be addressed to:

Nevada Applied Ecology Information Center
Oak Ridge National Laboratory
P. O. Box X Building 2029
Oak Ridge, TN 37830

(615) 483-8611, Ext. 3-6524 or
FTS 850-6524

TABLE OF CONTENTS

	Page
ABSTRACT	v
PREFACE	vii
SAMPLE REFERENCE	ix
BIBLIOGRAPHIC REFERENCES	
Biological Aspects, Animals	1
Biological Aspects, Plants	41
Chemical Aspects	46
Ecological Aspects, Aquatic	49
Ecological Aspects, Terrestrial	52
Energy	56
Environmental Assessment	57
Explosive Devices	60
Geological Aspects	61
Instrumentation	65
Legal and Political Aspects	67
Medical Aspects	68
Monitoring, Measurement and Analysis	83
Physical Aspects	99
Production	100
Radiation Safety and Control	101
Waste Disposal and Management	106
INDEXES	
Author	111
Geographic Location	117
Keywords	121
Taxon	133
Title	135
Publication Description	183
DISTRIBUTION	195

ABSTRACT

This eighth published bibliography of 427 references is compiled from the Nevada Applied Ecology Information Center's Data Base on the Environmental Aspects of the Transuranics. The data base was built to provide information support to the Nevada Applied Ecology Group (NAEG) of ERDA's Nevada Operations Office. The general scope covers environmental aspects of uranium and the transuranic elements, with emphasis on plutonium. This bibliography highlights literature on plutonium 238 and 239 and americium in the critical organs of man and animals. Supporting information on ecology of the Nevada Test Site and reviews and summarizing literature on other radionuclides have been included at the request of the NAEG. The references are arranged by subject category with leading authors appearing alphabetically in each category. Indexes are provided for author(s), geographic location, keyword(s), taxon, title, and publication description.

PREFACE

This publication of 427 abstracted references is the eighth in a series of bibliographies published by the Nevada Applied Ecology Information Center to provide information support to the Nevada Applied Ecology Group (NAEG) of ERDA's Nevada Operations Office. The scope is centered on the environmental aspects of plutonium, but it has been expanded to include uranium and the transuranics. Studies on the ecology of the Nevada Test Site, redistribution and resuspension, low-level radiation effects, and reviews and bibliographies on other fission products have been included at the request of the NAEG. The subject category, Ecological Aspects, is subdivided to separately list the aquatic and terrestrial areas of the environment in a field study condition. Where a laboratory study exists, Biological Aspects is used with identifying type of biota. A majority of the references deals with several subject areas requiring multiple categories; however, each entry is chosen to be categorized according to the main subject area described. This bibliography highlights the biological and medical aspects of plutonium 238 and 239 and americium on the liver, bones, and lungs of man and animals. Studies on the movement of plutonium and other transuranics thrcugh the environment are also emphasized. Current and pre-1962 domestic literature, as well as foreign literature, is actively sought. This publication contains literature dating from April, 1944 to August, 1976.

All the published literature references are contained in the Data Base on the Environmental Aspects of the Transuranics and are available for searching upon submission of specific requests. Services of the Nevada Applied Ecology Information Center are free to all ERDA-funded researchers.

Citation Form

The references are arranged by subject category with leading authors appearing alphabetically within each category.

As a result of computer limitations in indicating superscripts and subscripts in the standard manner, certain conventions have been established in the bibliography:

1. X sub t (X being a variable) means X_t or X subscript t.

2. In chemical compounds and elements, NaIO3 (for example) means $NaIO_3$.

3. 10(E+3) or X(E-3) (E denoting exponent) means 10^3 or X^{-3} respectively

4. For units of measurement, such as centimeters, meters, and feet, X3 means X^3.

Indexes

Indexes are provided for: (1) author(s), (2) geographic location, (3) keyword(s), (4) taxon, (5) title, and (6) publication description.

ACKNOWLEDGEMENTS

P. B. Dunaway, Director of the Bioenvironmental Sciences Division, Nevada Operations Office, and M. G. White, Scientific Director of the Nevada Applied Ecology Group, Nevada Operations Office, have closely guided the Nevada Applied Ecology Information Center staff in the selection of material for this project.

Appreciation is due to the many researchers who have contributed their publications for inclusion in this bibliography. Acknowledgement also goes to Dr. C. W. Francis, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, who reviewed this bibliography for its content and completeness.

Ruth Slusher of the Computer Sciences Division, ORNL, and Faye Fletcher and staff of the Information Storage and Retrieval Processing Section of the Information Center Complex, ORNL, have managed the computer production of this document.

SAMPLE REFERENCE

This is an example of the format for the descriptive fields used in this bibliography:

1 - *Subject Category*

2 - *Record Number (Sequential Number of Reference)*

3 - *Author*

4 - *Corporate Author*

5 - *Publication Date*

6 - *Document Title*

7 - *Publication Description*

8 - *Abstract*

9 - *Abstractor's Initials*

10 - *Comments (Pertinent Numerical Data)*

1 BIOLOGICAL ASPECTS, ANIMALS

2 <000>

3 Dagle, G.D., R.D. Phemister, J.L. Lebel, R. Jaenke, and R.L. Watters,
4 Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA; U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, D.C. 5 1975.

6 Plutonium-Induced Popliteal Lymphadenitis in Beagles. 7 Radiation Research, 61, 239-250; BNWL-SA-5119; 14 p.

8 Fifteen adult male beagles were implanted with 10.6 to 39.4 uCi of high-fired Pu 239 PuO2 subcutaneously with a mass median diameter of about 0.7 um into the left hind paws. The Pu particles accumulated in the popliteal lymph nodes. Histopathologic changes in these lymph nodes were characterized primarily by reticular necrosis and fibroplasia. Eventually the Pu particles became sequestered by scar tissue that often replaced the normal architecture of the lymph node. Light-microscopic autoradiographs of the popliteal lymph nodes showed a time-related increase in number of alpha tracks per Pu source. Electron microscopy showed that Pu particles were aggregated in phagolysosomes of macrophages. 9 (RAF)

10 Four electron micrographs of Pu particles in popliteal lymph nodes are given.

BIOLOGICAL ASPECTS
ANIMALS

<1>
Abrams, R., University of Chicago, Chicago, IL. 1945, June 15

Inhalation of Plutonium. CN-2992; Part of Barron, E.S.G., et al, Monthly Health Report on Problems Relating to Product for Month of May, 1945, (p. 12-15), 47 p. (Declassified February 4, 1956)

Rats were exposed to a tracer aerosol consisting of a mixture of Pu(+4) and 65 day Zr. It was found that the rate of elimination was of the same order of magnitude for both isotopes, with the Zr possibly leaving the lung at a somewhat faster initial rate than the Pu. Half-time in the lung was about 8 days fcr Zr and 17 1/2 days for Pu. Intubation experiments were also done to test the effects of complexing agents and valence state on the fate of Pu in the lung. It was seen that lung absorption with Pu(+6) nitrate or complex cccurred very rapidly during the first days and then subsided to a rate characteristic of PU(+4). In the case of Pu(+4) nitrate absorption was slow with the major sites of deposition being the liver (approximately 1.0%) and the skeleton (approximately 4.4%). Addition of citrate caused rapid absorption from the lung. Calgon acted much like citrate but seemed to be a poorer complexing agent. The distribution of Pu in the tissues is summarized in tabular form. (FHM)

Tables are presented showing the distribution of Pu in tissues (lung, trachea, kidney, liver, spleen, skeleton, GI tract, and skin).

<2>
Abrams, R., H.C. Seibert, A.H. Potts, L.L. Forker, D. Greenberg, S. Postel, and W. Lohr, University of Chicago, Chicago, IL. 1947, January 13

Metabolism and Distribution of Inhaled Plutonium in Rats. CH-3655; 31 p. (Declassified June 13, 1947)

Several different techniques were used to introduce tracer quantities of plutonium into the lungs of rats. When aeroscls were produced by atomizing aqueous solutions of the nitrates it was found that approximately 20 per cent of the dose was absorbed and deposited in the skeleton with tetra, hexa, and trivalent plutonium. Thus with these compounds, the lungs represent a more dangerous portal of entry than either oral (0.05 per cent) or intramuscular (13 per cent) administration. Tetravalent Pu was eliminated most slowly from the lung, the average half-time during the first month being 15 days. But when citrate was added to complex the Pu, over 70 per cent was eliminated within 1 day. This was accompanied by a deposition of over 30 per cent in the skeleton and over 20 per cent in the liver. Presumably citrate breaks up the insoluble colloid in which Pu exists in the lungs. Complexing with cupferron which, unlike citrate, produces a "fat soluble" compound, greatly diminished the extent of absorption from the lungs. Plutonium oxide smokes which were produced at high temperatures were eliminated more slowly from the lungs (average half time of 30 days during the first month) and were deposited in the skeleton to a much lesser extent (6.2 per cent) than was the case with the nitrates). (Auth)

Table 6 shows distribution of inhaled Pu oxide in the rat. Table 7 shows tissue concentration of inhaled Pu oxide in the rat.

<3>
Anderson, E.C., P.N. Dean, G.A. Drake, L.M. Holland, J.E. London, and J.S. Wilson, Los Alamos Scientific Laboratory, Los Alamos, NM. 1972

Retention and Excretion. LA-5227-PR; Part of Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972, (p. 4-5), 144 p.

At one month post injection excretion rates were estimated to correspond to biological half-times of about 7000 days for Pu and 400 days for Co 57. Eleven month retention studies with Co 57 indicate an initial loss of 5 percent followed by a declinine corresponding to a half-time of about 4600 days. Ninety percent of the Co 57 was retained after one year. Animals given Co 57 labeled spheres by intratracheal insufflation show a faster excretion rate corresponding to a biological half-time of about 270 days. (JTE)

<4>
Bair, W.J., E.G. Tombropoulos, and J.F. Park, Hanford Atomic Products Operation, Richland, WA. 1963

Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route. STI/PUB/65; Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 319-344), 450 p.

A summary of the results of studies undertaken to determine the fate of transuranic elements deposited by inhalation in animals was presented. Tissue distribution and excretion of inhaled radioactive isotopes varied with the chemical form and the particle size of the aerosols. In dogs, 30 d after inhalation of plutonium nitrate, 70% of the body burden was in the lungs, 10% in liver, and 15% in the skeleton. After inhalation of Pu 239 PuPuO2 aerosols with a Count Median Diameter (CMD) of 0.12 um 71% of the body burden was in the lungs, 3% in the bronchial lymph nodes, 4.4% in muscle, 1.3% in skeleton, and 20% was uniformly distributed throughout all remaining tissues. After inhalation of Pu 239 O2 aerosols with CMD's of 0.3 to 0.6 um, the lungs contained 98%, the bronchial lymph nodes about 1% and all other tissues the remaining one per cent. These data and the analysis of urine and feces defined the relative importance of the three routes by which inhaled radioactive isotopes were cleared from the lung, e.g. movement up the trachea by ciliary action followed by excretion in the feces, transport across the alveolar membrane and redistribution in other tissue with gradual excretion in urine and transport to the bronchial lymph nodes which accumulate inhaled insoluble materials. Therapy agents were tested that would be expected to increase the clearance of radioactive isotopes from the lung by routes which would avoid accumulation in other, perhaps more radiosensitive tissues. These include chelating agents, wetting agents, irritants, sympathomimetic, parasympathomimetic, parasympatholytic and anithistamine drugs. Diethylenetriaminepentaacetic acid (DTPA), a chelating agent, administered by aerosols or intraperitoneally caused rapid transport of Ce 144-Pr 144 from the lung and from the body

<4>

BIOLOGICAL ASPECTS
ANIMALS

<4> CONT.
via urinary excretion. One month after exposure to Ce 144 CeO2 treated rats and dogs retained less than 10% of the Ce 144-Pr 144 levels of untreated animals. (Auth)(JTE)

<5>
Baisogolov, G.D., and V.N. Podgorodetskaya. 1964

Hematopoiesis in Dogs Submitted to Subacute Plutonium 239 Intoxication. AEC-tr-7590; Part of Moskalev, Yu. I. (Ed.), Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 238-242), 405 p.

Studies were conducted on mongrel dogs weighing about 16.6 kg. Plutonium was given intravenously in the nitrate form, in a dosage of 2 uCi/kg. Hematopoiesis was studied for one year. Throughout the experiment the dogs showed moderate and fluctuating decreases in erythrocyte count. There was negligible change in hemoglobin content; a substantial rise of 12% was noted only at the late stages (8th-12th month). A significant decrease in reticulocyte count was observed from the very first days. More marked changes were found in the leukocyte count; after an initial small increase in some animals, there was a decrease up to 40% from the 7th to 28th day; thereafter it remained at about the same level. Leukopenia was due to a decrease in granulocytes. No significant changes in the quantity of thrombocytes was observed in most animals. Findings suggested a rapid development of a number of destructive changes in bone marrow which affected the morphology of peripheral blood. (RAF)

Tabular data are given on the quantity of erythrocytes, hemoglobin, reticulocytes, thrombocytes, leukocytes, neutrophils and lymphocytes after injection of 2 uCi/kg Pu 239, and of the quantity of myelokaryocytes in canine bone marrow at different time intervals.

<6>
Ballou, J.E., R.A. Gies, and W.G. Morrow, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, August

Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol. BNWL-1850 (Part 1); Part of Thompson, R.C., et al, Annual Report for 1973, (p. 121), 162 p.

Studies were in progress to determine the late effects of inhaled DTPA and inhaled Pu(NO3)4 in 519 male rats. Plutonium retention was reduced about 50% by six weekly DTPA inhalations starting 20 days after Pu inhalation. After 500 days there were no statistically significant differences in survival, weight change or incidence of gross pathological lesions among rats receiving Pu with no treatment, sham treated, or treated with DTPA, despite differences in cumulative lung dose of 1200, 600, and 320 rads, respectively. (Auth)(JTE)

<7>
Boecker, B.B., University of Rochester, Department of Radiation Biology, Rochester, NY. 1959

A Study of the Deposition and Retention of Plutonium Dioxide in Rats. TID-15685; Ms. Thesis, University of Rochester; 110 p.

Four groups of 6 female rats were exposed for 45 minutes to a PuO2 aerosol generated by aspiration of an aqueous PUO2 suspension. Particle size measurements were made with a point-to-plane electrostatic precipitator, and an electron microscope indicated the aerosol had a count median diameter of 0, 19 u with og = 2.08. Samples of the air concentration indicated an acitivity range of 65-89 dpm/cc for the 4 runs. Total deposition values ranged from 5.5 to 30% with a mean of 11%. Lung deposition ranged from 1.5 to 7.7% with a mean of 3.6%. Fifty-five per cent of the activity was deposited in the head and trachea as opposed to 45% in the lungs. Examination of sacrificed rats showed that PuO2 was cleared from the head rapidly with a half-time of approximately 2 hours. The introduction contained a review of the literature concerning the following aspects of Pu; historical background, nuclear properties, physical properties, chemical properties, toxicity, distribution and excretion, bone deposition, oral absorption and inhalation. (JTE)

An extensive bibliography of 53 references was included. The data was summarized in numerous tables and figures.

<8>
Brightwell, J., and R.F. Carter, National Radiological Protection Board, Harwell, England; Atomic Weapons Research Establishment, Berkshire, England. 1975, February

Absorption from the Gut of Suspension of Plutonium Sodium Aerosol. Health Physics, 28(2), 156-158.

The gut absorption of a plutonium 239-sodium aerosol suspension administered by gastric intubation in female rats (3-4 months old) was studied. The gut, lungs, and liver were analyzed. Analysis of gut samples showed that no plutonium was passed out in the feces until more than six hours after intubation. The total gut levels of plutonium up to six hours were used to obtain a mean value of 274 plus or minus 13 nCi for the initial gut content. About 18 per cent of the administered plutonium remained in the gut at 24 hours and 4 per cent at 48 hours. The quantity of plutonium in the lungs was below the limit of detection for each animal indicating that all the intubated suspension had entered the gut. Little further increase in the total quantity of plutonium taken up by liver and bone after nine hours was found and the partition of the absorbed plutonium between these two organs, with the liver containing about 16 per cent of the total, was similar to that found for monomeric plutonium (ICRP, 1972). The average transport of plutonium to liver and bone one day after intubation was 1 X 10(E-2) per cent of that administered. The plutonium-sodium aerosol used in this experiment behaved more like a soluble form of plutonium with a gut uptake of about 100 times that suggested for an insoluble form. (ND)

<9>
Brooks, A.L., R.O. McClellan, and D.K. Mead, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971

BIOLOGICAL ASPECTS
ANIMALS

<9> CONT.
through September 30, 1972, (p. 234-240), 355 p.

Fifty-four Chinese hamsters received intravenous injections of 10(E-3) uCi Pu 239/gm body weight as monodisperse particles of three sizes: 0.84, 0.44 and 0.12 um. Eighteen additional animals were injected with saline as controls. The animals were partially-hepatectomized in three groups of 24 each at 4, 13 and 40 days to stimulate cell division to permit the recording ot metaphase chromosome damage in the liver. Particle size had no effect on the average number of aberrations produced per cell when related to average dose. The aberration frequency increased as a function of dose and time with an aberration coefficient of 1.6 x 10(E-3) aberrations/cell/rad and an intercept of 0.05 aberrations/cell. This slope was about one-fourth that observed following Am 241 citrate injection. When related to local dose, the efficiency of producing aberrations decreased as particle size increased. There was no significant difference in the distribution of aberrations among cells for the different particle sizes. However, at each sampling time, animals injected with the largest particles had cells with the largest number of aberrations. The distribution of aberrations from Pu 239 PuO2 showed a higher proportion of cells in the normal class and more cells with extreme damage as compared to Am 241 citrate. (Auth)

<10>
Buell, U., D. Balser, and K.W. Frey, Munich University, Klinik und Poliklinik fuer Radiologie, Munich, German Federal Republic; Munich University, Chirurgische Pcliklinik, Munich, German Federal Republic. 1974, April

Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85. Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, 120(4), 481-488. (German, English Abstract)

Strontium 85, Tc 99m-pyrophosphate (n=20) and Tc 99m diphosphonate (n=8) were injected intravenously into 28 rabbits. The animals were killed one to three hours after injection and radioactivity was determined in blood, urine, kidneys, muscle, liver, thyroid and in various bones. Technetium 99m-phosphate compounds tended to be deposited more markedly in spongy bone than was the case for Sr 85. Compared with Sr 85 the most marked radioactvity differential for bone and muscle (target-non-target) and spongiosa and compacta was achieved by Tc 99m pyrophosphate. Tc 99m-diphosphonate showed the most rapid muscle clearance; three hours after injection lower bone activity was found with Tc 99m than with Sr 85. Minimal radioactivity in the thyroid suggests good in vivo stability of the Tc 99m-compound. Technetium 99m-pyrophosphate proved to be the best bone-seeking compound. (F.St.)

<11>
Cole, K.S., and C.L. Prosser, University of Chicago, Chicago, IL. 1945, May 9

Monthly Health Report on Problems Relating to Product. CN-2905; 29 p. (Declassified December 22, 1952)

Studies on health problems relating to plutonium are updated in a monthly report. After 80 days, 50% of rats injected with 0.5 mgm/k of radium have died. After 140 days, 50% of the rats injected with 0.26 and 1.0 mg/k have died, but only 17% of rats receiving 0.5 mg/k have died. Retardation of growth is slight in animals receiving 0.25 mg/k. At 14 days, livers contain 20% of the dose. From 70-126 days 1.5 to 11% of the dose is in the liver with at least part of the plutonium migrating to the skeleton. After 57 days about 0.01% is excreted in urine and 0.08 in feces. Plutonium appears to be more than 1/50 as toxic as radium. In other studies, water was nearly as effective as sodium citrate and potassium bisulfate in washing plutonium from skin lacerations. Two dogs receiving doses of plutonium just below the acutely lethal level 60 days ago are excreting 0.01% in urine and 0.02-0.03 in feces. A value of 66% of tolerance for plutonium in air was obtained which is the highest figure yet. A spill involving 4.2 mg of plutonium of the Simpson Proportional Air Counter is in use. Routine assay of urine has not shown any specimen with greater than two counts per minute per 100 cc for any employee. Further study of plutonium bone radioautographs have conclusively substantiated the opinion that the primary regions of deposition are the endosteum and cancellous bone. Long term PuO2 and PuO2(NO3)2 aerosal studies are concontinuing. (BBM)

<12>
Cole, K.S., and C.L. Prosser, University of Chicago, Chicago, IL. 1945, February 8

Monthly Health Report on Problems Related to Product. CN-2653; 18 p. (Declassified January 2, 1952)

A dog was injected with plutonium (+4) nitrate intravenously at a dose of 0.36 mg/kgm. Twelve days later, the animal was severely ill, and 16 days after injection, it was sacrificed. Pu concentration in blood increased 10 times in the first half hour, and after 10 days reached an equilibtrium of 0.01 ugm/ml blood, most in the beta globulin fraction of plasma. Urinary excretion was 6.2% of the injected dose in the first day but reached an equilibrium of 0.19% daily. Fecal excretion at equilibrium was 0.04% of the dose daily. Ninety percent of the Pu was retained. The liver contained 30%, but specific activity of the spleen was twice as high. Lymph nodes and bones, particularly the spicules, had high concentrations. During the first 12 days, food and water intake, urine and feces output, weight, urine pH and specific gravity and chlorine were unchanged. On the 12th day intake and output dropped, weight fell, rectal temperature rose 2 degrees, the heart rate increased, and blood pressure fell. Plasma volume increased 23% and blood volume increased 14.7% by the eighth day. After a slight fall, plasma protein rose, but serum proteins were less altered. A terminal electrophoretic picture of serum and plasma proteins showed low albumin, normal alpha, beta and gamma globulin, very high alpha 2 globulin, and high fibrinogen. A relatively unaltered liver function was seen. Hematocrit, red cell count and hemoglobin fell 22%. Sedimentation rate increased gradually but prothrombin time was not altered. Platelets decreased and the white cell count dropped dramatically. At autopsy, dye from blood volume tests indicated decreased activity of the reticulcendothelial system. Not as much hemorrhage occurred in cervical lymph nodes and kidneys after x-radiation. Other work performed in the report period involved development of a method for the analysis of

<12>

BIOLOGICAL ASPECTS
ANIMALS

<12> CONT.
radium by beta ray measurement. (BBM)

<13>
Colvin, M.C., and J.M. Everts, U.S. Environmental Protection Agency, Eastern Environmental Radiation Facility, Montgomery, AL. 1971

Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds. CONF-710809; Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 281-284), 807 p.

This study has investigated the possibility of chromosomal damage following skin absorption of tritium from luminous compounds in the Chinese hamster. Tritium was absorbed through the skin of the hamsters as indicated by the appearance of significant amounts of tritium in the urine of test animals. There was only a slight indication of tritium in the urine of the control animals. Chromosomal aberrations were produced at 7 and 30 days in both lung and kidney tissues. With both compounds tested, the percentage of lung and kidney cells containing aberrations was several times greater than the control values. The production of chromosome aberrations is attributed to the luminous compound (tritium compound plus fluor) since the comparison of controls and test animals was a comparison between animals exposed to luminous compounds and those exposed to no compound. The types of aberrations found most often were chromatid breaks, which demonstrated that the most damage occurred during the G2 phase of the cell cycle. (Auth)

<14>
Dagle, G.D., J.L. Lebel, R.D. Phemister, R.L. Watters, and L.S. Gomez, Colorado State University, Fort Collins, CO; Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA; U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC; Los Alamos Scientific Laboratory, Los Alamos, NM. 1975, April

Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles. Health Physics, 28, 395-398.

The translocation kinetics of high-fired plutonium oxide from the popliteal lymph nodes was studied in beagles with 9.2 to 39.4 uCi of plutonium 239 oxide implanted subcutaneously in the left hind paws to simulate accidental contamination of hand wounds. The left hind paw was amputated 4 weeks after implantation to prevent continued deposition of plutonium oxide particles in the left popliteal lymph node. External in situ scintillation data showed slight clearance of plutonium from the popliteal lymph nodes of beagles monitored for 32 weeks. The estimtaed time for the fraction of plutonium retained at 100 days to be reduced by one-half varied from 290 to 1508 days. Treatment with DTPA did not have a measurable effect on the clearance of high-fired plutonium oxide from popliteal lymph nodes. (Auth)

<15>
Dagle, G.D., R.D. Phemister, J.L. Lebel, R. Jaenke, and R.L. Watters, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA; U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC. 1975

Plutonium-Induced Popliteal Lymphadenitis in Beagles. Radiation Research, 61, 239-250; BNWL-SA-5119; 14 p.

Fifteen adult male beagles were subcutaneously implanted with 10.6 to 39.4 uCi of high-fired Pu 239 PuO2 with a mass median diameter of about 0.7 um into the left hind paws. The Pu particles accumulated in the popliteal lymph nodes. Histopathologic changes in these lymph nodes were characterized primarily by reticular cell hyperplasia, increased numbers of macrophages, necrosis, and fibroplasia. Eventually the plutonium particles became sequestered by scar tissue that often replaced the normal architecture of the lymph node. Light-microscopic autoradiographs of the popliteal lymph nodes showed a time-related increase in number of alpha tracks per plutonium source. Electron microscopy showed that plutonium particles were aggregated in phagolysosomes of macrophages. (RAF)

Four electron micrographs of Pu particles in popliteal lymph nodes are given.

<16>
Dilley, J.V., J.F. Park, B.O. Stuart, D.H. Willard, and W.J. Bair, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1970, February

The Disposition of Inhaled Plutonium. Part 1. Comparison of Chemical Forms. BNWL-1221; Part of Bair, W.G., Plutonium Inhalation Studies, A series of Lectures Given in Japan in 1969 at the Invitation of the Japanese Atomic Energy Commission, (p. 2.1-2.44), 277 p.

Three plutonium compounds were studied in more than 200 beagle dogs to determine the dynamics of plutonium retention, distribution, and excretion following inhalation. While some studies have been done with $Pu(NO_3)_4$ and PuF_4, the major interest has been PuO_2, which seems to be the plutonium compound most likely to be encountered in an accident situation. Preliminary experiments, in which dogs were exposed to a soluble form of plutonium, Pu 239 Pu $(NO_3)_4$, as an aerosol and by intravenous injection, showed that 60-70% of the inhaled plutonium was in the lungs, 20% in the skeleton and 12% in the liver after 30 days. The liver of dogs injected intravenously contained more than 80% and the skeleton only about 77%, thus showing that plutonium nitrate is not rapidly translocated from the lung to skeleton and liver. Experiments with inhaled Pu 239 PuF_4 showed that the lung retained 70-80% of alveolar-deposited plutonium for 3 months. Whole body retention half times ranged from 127 to 405 days; pulmonary half times from 78 to 266 days. Four different plutonium dioxides were prepared by calcining the oxalate at 1000 degrees C and at 350 degrees C, and by oxidizing the metal at 458 degrees C and 123 degrees C. Four groups of beagle dogs were given a single exposure to one of 4 different PuO_2 aerosols. In all dogs but two, alveolar deposition ranged from 20-45% of total amount of plutonium deposited. Whole body retention half times ranged from 1000 more than 3400 days. Highest values were noted in dogs having inhaled metal oxidized at 450 degrees C. Lung retention half times ranged between 600-1000 days for

BIOLOGICAL ASPECTS
ANIMALS

<16> CONT.
all dogs except those inhaling the oxalate calcined at 350 degrees C, their retention half time being 300-400 days. The results of this study show the relatively long-term pulmonary retention of inhaled PuO2, its gradual accumulation in bronchial and mediastinal lymph nodes, and the accompanying low rate of translocation and excretion. None of the four types of PuO2 deviated from this general pattern, although certain differences in their behavior were apparent, demonstrating the ability of biological processes to discriminate among compounds which were crystallographically indistinguishable. (Auth) (LR) CSF)

<17>
Dockum, N.L., R.S. Mical, R. Tegge, M. Lowe, C.W. Mays, and W.S.S. Jee, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1964, March 31

Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones. COO-119-229; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 127-132), 209 p.

Young adult beagles were injected at 489-559 days of age with 0.3 and 0.015 uCi of Pu 239/kg of body weight. The animals were serially sacrificed from 5 to 362 days after the administration of Pu 239. Quantitative autoradiographic dose determinations of Pu 239 revealed that: the surface deposition of plutonium is non-uniform and varies from bone to bone as well as from one anatomical site to another. Vertebral surface deposits of Pu 239 are higher than deposits found in other bones. Specific dose-rates to given areas may be as high as 11 to 48 times greater than skeletal retention data. Mosaic trabeculae, consisting of viable and non-viable bone, appear in the femoral epiphysis and metaphysis after 186 days in animals receiving 0.3 uCi of Pu 239/kg of animal weight. The 0.015 uCi Pu 239/kg of weight dose resulted in no gross histopathlgoical changes at one year, but in ten years post administration two cases of osteogenic sarcoma appeared. (Auth) (FHM)

Table 1 shows dose-rates (rads/day) to distal femora and lumbar vertebrae of dogs injected with 0.015 uCi Pu 239/kg.

<18>
Dougherty, J.H., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31; 1960

Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 221), 225 p.; Radiation Research, 12, 431.

The blood picture was followed at monthly intervals in ten adult beagles given a single intravenous injection of an average of 10.4 uCi/kg of Ra 226 and nine dogs given an average of 2.88 uCi/kg of Pu 239 intravenously. Comparisons were made to similar data in twenty four control animals. The skeletal dose rates to the radium dogs are approximately 2.5 times that to the plutonium dogs at one year. However, due to differences in the radionuclide distribution in bone this does not accurately reflect bone marrow dose. The average survival time was 1046 days for radium injected dogs and 1338 days for the plutonium group. There were eight bone tumors in the radium group and three bone tumors in the plutonium group. The detailed hematological findings for all groups will be presented. No tumors of hematopoietic origin were found. Despite differences in radionuclide distribution, tumor incidence, survival time and amount and distribution of skeletal damage between the two groups of dogs, the degree and time sequence of depression in blood cell elements and hematological findings at time of death were remarkably similar. (Auth) (Complete Text)

<19>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1967, March 31

Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program. COO-119-236; 268 p.

Injection tables are given for the toxicity and test animals involved in the internal irradiation study on dogs using the radionuclides Ra 226, Pu 239, Ra 228, Th 228, Sr 90, Ra 224 and Am 241. Included in the tables are the age and weight of the animals, injected dose, date injected, dose to the skeleton and pathological findings in dead animals. Special topics are discussed and 8 of these have been abstracted separately for inclusion in the data base. Among them are studies on Pu 239 in liver, spleen and kidneys of the beagle, in vivo studies on the interactions of Pu (+4) with blood constituents, americium metabolism in beagles, a comparison of the effects of Am 241 and Pu 239 on serum enzymes, alterations in androgen biosynthesis by canine testicular tissue after the internal deposition of some radionuclides and incidence of myelogenous and lymphatic tumors in irradiated and non-irradiated beagles. (FHM)

<20>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1961, March 31

Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program. COO-223; 30 p.

The injection tables are given for the chronic toxicity study on dogs using the radionuclides, Ra 226, Pu 239, Ra 228, Th 228 and Sr 90. Included in the tables are the weight and age of the dogs, the injected dose, date injected, dose to the skeleton and pathological findings in dead animals. (FHM)

<21>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1965, September 30

Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program. COO-119-233; 109 p.

The injection tables are given for the studies on internal irradiation in dogs using the radionuclides Ra 226, Pu 239, Ra 228, Th 228 and Sr 90. The tables include the age and weight of the animals, injected dose, date injected, dose to the skeleton and

<21>

BIOLOGICAL ASPECTS
ANIMALS

<21> CONT.
pathological findings in dead dogs. Some special topics are discussed such as soft tissue retention of Sr 90 in the beagle and the use of the chinchilla in the study of bone seeking radionuclides. (FMM)

<22>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1964, September 30

Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program. COO-119-231; 172 p.

Injection tables are given for the animals in the chronic toxicity program involving the radionuclides Ra 226, Pu 239, Ra 228, Th 228, Sr 90 and Ra 224. Included in the tables are the age and weight of the dogs at injection, dose injected, date injected, dose to the skeleton and pathological findings in dead animals. Progress is reported for the studies and two papers from them have been abstracted separately for inclusion in the data base. Among the studies reported are the effects of ionizing radiations on endocrine cells, the low natural incidence of osteosarcomas in beagles, and the chemical state of Pu(+4) in beagle blood, and serum lactic dehydrogenase levels in adult beagle dogs. (FMM)

<23>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1962, September 30

Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program. COO-226; 133 p.

The injection tables are given for the animals involved in the chronic toxicity studies using the radionuclides Ra 226, Pu 239, Ra 228, Th 228 and Sr 90. Included in the tables are age and weight of the animal at injection, injected dose, date injected, and dose to the skeleton. Other work in progress is reported and three papers have been abstracted separately for inclusion in the data base. Among the topics reported are the long-term effects of Pu 239 in adult beagles, radium studies in man soon after injection, effects of estradiol valerianate and sulphated mucopolysaccharides on hyperossification in autogenous tibial transplants and liver injury in beagles with Pu 239. (FMM)

<24>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1963, September 30

Injection Tables. COO-228; Part of Dougherty, T.F., Research in Radiobiology, Semiannual Report of Work in Progress on the Chronic Toxicity Program, (p. 3-55), 185 p.

Dogs were put into toxicity study groups of six or seven of the same sex. Litter mates were used whenever possible. Each animal received the designated dose of one radionuclide in a single intravenous injection at about 17 months of age. The dose levels were specified as "retained" doses. The actual injected doses were four times the desired retained--doses of Ra 226, Ra 228, Sr 90, and 1.11 times the desired retained doses of Pu 239 and Th 228. Present measurements indicate the following average retention values for each of these radionuclides; Ra 226=0.25 after 330 days, Pu 239=0.90 after 6 days, Ra 228=0.225 after 235 days, Th 228=0.90 after 6 days, and 0.25 after 150 days. The numbering system for the dogs is discussed, and the toxicity and test animals are listed along with "Comments on Dead Dogs." (JTE)

<25>
Erokhin, R.A., N.A. Koshurnikova, V.K. Lemberg, A.P. Nifatov, A.A. Puzyrev, and I. (Translator) Hynie, Not given. 1969

Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds. Gigiena Truda i Professional'nye Zabolevaniya, 13(5), 61-63. (Russian, English Abstract)

Plutonium nitrate and Na plutonylacetate 0.42-1.0 uCi/animals in 0.01 N HNO3 decreased the average survival time of the experimental animals when compared with the controls treated with HNO3 only. In later periods both benign and malignant tumors with a pneumosclerotic background were observed. (IH)

<26>
Eto, K., National Institute of Radiological Sciences, Chiba, Japan. 1973

Effect of Internal Irradiation on Fish. Part of Egami, N. (Ed.), Radioactivity and Fishes. Contamination, Injuries, and Utilization, (p. 298-315). (Japanese)

A review is given of the effects of low concentrations of radioactive wastes accumulated in fish over extended time periods. Killifish, goldfish, chasmichthys gulosus and fish in brackish waters were used in some of the experiments. Radionuclides investigates were P, Ca, Co, Sr-Y, Ru, I, Cs and Pu. Different effects were noted in identical locations when ecological conditions varied. In hematopoietic-system studies on adult fish, a rainbow trout received Sr 90-Y 90 continuously. In the 0.5 uCi/g group a cessation of growth, increased mortality, and a decrasse of white blood cells was observed. In Heteropneustes fossils d in P 32 the number of red and white was lowest after 4-5 days. The genital glands were critical organs in the low concentration studies. The effects of I 131 on the thyroid had a greater influence on the occurrence of malformations than on the hatching rate. Fetal radiosensitivity was high. From the experiment by Polikarpov and Lvanov, a correlation was observed between the quantity of Sr 90 and the occurrence rate of abnormal young fish. The absorbed dose in the body consisted of dose from various nuclides deposited in the body (D sub int) and dose of external radiation from the environment of living animals (D sub out). Absorbed dose (D) was calculated from D = D sub int + D sub out in Loevinger formula. From the genetic aspect, various nuclides seemed not to have an influence on the individual itself, but it became evident that they had an influence on the reproduction of individuals. (JA) (RAF)

<27>
Finkel, M.P., Argonne National Laboratory, Division of Biological and Medical Research, Lemont, IL. 1953

Relative Biological Effectiveness of Radium and

BIOLOGICAL ASPECTS
ANIMALS

<27> CONT.
cther Alpha Emitters in CF No. 1 Female Mice. Proceedings of the Society for Experimental Biology and Medicine, 83, 494-498.

Female mice, 9-10 weeks old were injected intravenously with the following radionuclides, Ra 226 (0.6-4170 micro Ci/1 g) Po 210 (0.46-100 uCi/kg), Th 228 (6.6-360 uCi/kg), Pu 239 (0.04-50.4 uCi/kg), U 233 (0.1-100 uCi/kg) and U 232 (0.1-10 uCi/kg.) Radium, Po and Th were injected as chlorides, Pu and U were given as nitrates. The animals were autopsied, tissues were taken for histological examination and roentgenograms were prepared. The results show that Pu 239, Po 210, U 233, and Th 228 were 20 times as effective as Ra 226 in killing 50% of the population of mice in 20 to 100 days after intravenous administration. At levels approaching those that produced no effect, polonium was 3 times as effective, plutonium was equally effective, and uranium 233 was slightly less effective than radium in decreasing the expectation of life. The ratios relative to radium of the proportion of mice that developed malignant bone tumors after the latent period were 7:1 for plutonium and 2:1 for uranium 232. Uranium 233 and polonium were less effective than radium in this instance. On the basis of these criteria, the best present estimate of the relative biological effectiveness at near-tolerance levels in CF No. 1 female mice is 7(Pu 239):3, (Po 210):2, (U 232):1 U 233):1 (Ra 226). (Auth) (FHM)

<28>
Finkel, M.P., Argonne National Laboratory, Chicago, IL. 1947, August 1

Some Further Notes on the Mice Treated with Plutonium Before Weaning. AECD-2024-H; 11 p. (Declassified May 26, 1948)

The 15-day dose level of Pu was calculated for litters of mice whose mothers had previously received Pu in utero, by adding 0.12 percent of the total dose originally given to the mother to the Pu content of a litter mate. It was noted that the relative proportions of Pu from placenta and from milk depend on the dose level of the mother; as the dose level of the mother increased, the proportion of the 15-day dose derived from the milk increased. This is illustrated in a figure. The litters were assigned to dose range groups: Group 1, 0.0691-0.0413 ug, Group 2, 0.0374-0.0208 ug, Group 3, 0.0190-0.0069 ug. A statistical analysis was made of the weights of the mice from Pu-treated mothers and control mice from birth to 13 months of age. At 30 days the males and females were separated and their weights were followed individually. When the weights for only the first 5 months are considered, the males showed significantly lower weights than the controls, whereas the females did not. At 6 months and later, significant weight decreases were found in the females as well as in males of Group 2. (LR)

Table 11 shows comparison of control and Pu-treated mice from birth to 30 days of age.

<29>
Frazier, M.E., and R.H. Busch, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, August

Transmission of Radiation-Induced Tumors in Beagle Dogs. BNWL-1850 (Part 1); Part of Annual Report for 1973, (p. 74-75), 162 p.

Osteogenic sarcomas were induced in beagle dogs by inhaled Pu, and primary cell cultures were prepared from these tumors. Approximately 2 x 10(E+6) cells, from fifth passage cell cultures, were inoculated into 31 to 33-day dog fetuses in utero. Shortly after birth (within 2 to 7 days) palpable growths developed in all of the living pups. All of the pups developed large tumor masses at the site of inoculation. Similarly, they all had widespread metastases. These metastatic tumors involved muscle, lymph nodes, mandible, scapula, and various long bones. Histopathology reports indicated that the tumors bore a striking resemblance to the donor tumor. Studies are continuing to characterize the transmitted tumor and identify the sources, i.e., whether of graft or host origin. (FHM)

<30>
Geesaman, D.P., Lawrence Livermore Laboratory, Livermore, CA. 1968, October 9

An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum. UCRL-50387 (Add.); 9 p.

Several experiments are reviewed involving skin and lung carcinogenesis in mammals after intense localized doses of ionizing radiation. A high incidence of cancer occurred for the exposures described. The observations suggest that the carcinogenesis is primarily mediated by injury or disruption of local tissue. It is concluded that there is a substantial possibility of enhanced cancer risk associated with the deposition of intense alpha-emitting particulates in deep respiratory tissue. Within this description lung cancer risks as high as 10(E-3) to 10(E-4) per disruptive source particle are indicated. The possibility of this enhanced risk places the present standards for maximum permissible lung burdens in serious question when applied to particulates such as Pu 238 PuO2 and Pu 239 PuO2. It is again suggested that in the absence of detailed knowledge of pulmonary carcinogenesis, the best course of action is an experimental determination of the risk per disruptive particle for particle burdens less than 10(E+8) particles. (Auth)

<31>
Goldthorpe, H.C., S. Bennett, and B. Smith, Univeristy of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

The Terminal Blood Chemistry of Radioisotope Injected Dogs. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 75-77), 225 p.

Results are given for the average values, found at death, of various constituents of the blood serum of dogs, due to the injection of Pu 239, Ra 226, Ra 228, Th 228 and Sr 90. There appears to be an upset in the calcium-phosphorus metabolism. Urea nitrogens go down in value except for radiothorium dogs which are higher. The question seems to be whether plutonium, radium, mesothorium, and strontium lower liver function while radiothorium decreases kidney function as is shown in the high inorganic phosphorus values. There seems to be an upset in the acid-base relationship in all categories. The increased glycoprotein

<31>

BIOLOGICAL ASPECTS
ANIMALS

<31> CONT.
and seromucoid values show either tissue destruction or neoplasm development. Increased fibrinogen values are not clear at this time; all globulin fractions are increased, so that this is perhaps a part of the overall picture. (Auth) (FMM)

<32>
Green, D., G.R. Howells, and E.R. Humphreys, Medical Research Council, Radiobiology Unit, Harwell, England. 1975, November

Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection. Health Physics, 29(5), 798-795.

Plutonium 239 in 1% trisodium citrate was injected in traperitoneally (IP) or intravenously (IV), into 12 week old male CBA mice. At 4 or 12 weeks the animals were killed and the testes, right femur, liver, and remaining carcass, were analyzed for Pu 239. At 4 weeks post injection significantly more Pu was deposited in all of the tissues of the IP injected mice than in the IV injected animals. Whole body deposition values were 61 and 51% respectively. At 12 weeks post injection the difference was maintained in the femue, was reduced in the testes and reversed in the liver which showed values of 8.8% (IV) and 6.0%, (IP). The smaller whole body retention (45% IV and 50% IP) of the IV injected mice may have resulted from the greater excretion or from extra Pu taken up directly by the tissues bathed by the solution during the IP injection. (JTE)

<33>
Hamilton, J.G., University of Chicago, Metallurgical Laboratory, Chicago, IL. 1944, November 23

Metabolism of Product for Period Ending October 15, 1944. CN-2383; 22 p.

The results of detailed metabolic studies of plutonium following oral, intramuscular, intravenous, subcutaneous and intrapulmonary administration are presented. Plutonium is not absorbed from the digestive tract. The skeleton is the chief organ of deposition for Pu absorbed by the body following parenteral administration. The soft tissues having the greatest concentration of Pu are the liver, kidney, and spleen. Their per gram content of Pu, however, is from 1/5th to 1/10th that of bone. The digestive tract is the principal channel of elimination and the degree of retention is very great. The rate of excretion is very low and the half-period of retention of Pu by the skeleton is estimated to exceed 6 months. No significant differences in the metabolic properties of Pu absorbed by the body were observed for its three valence states. Considerable retention of Pu by the lungs follcwing interpulmonary administration was observed and was found to be highest for the +4 state, less for +3 Pu and least for +6 Pu. A significant degree of absorption of Pu from the lungs with subsequent deposition in the skeleton took place following the intrapulmonary administration of solutions of this element is its three valence states. It is speculated that Pu in the body exists in its +4 state. (Auth) (RAF)

<34>
Hamilton, J.G., University of Chicago, Chicago, IL. 1945, June 15

Technical Progress Report on the Metabolic Studies of Product. CN-2992; Part of Barron, E.S.G, et al, Monthly Health Report on Problems Relating to Product for Month of May, 1945, (p. 32-35), 47 p. (Declassified January 4, 1956)

Experiments were done to determine what proportion of inhaled PuO_2 smoke was retained in rats. A valve system developed for the measurement is described. It was seen that approximately 75% of the inhaled smoke was retained in the animal. Photomicrographs of the PuO_2 smoke revealed particle sizes ranging from 0.1 to 1.0 u in diameter. Results using $PuO_2(NO_3)_2$ aerosol in rats were also reported. These results when compared to the others, indicated that between the 16th and 64th day, relatively little Pu was absorbed from the lungs to be deposited in the skeleton. However, during this time interval it appeared that the Pu in the lungs diminished by a factor of approximately 3. Decontamination studies were described and it was felt that the most promising method of decontaminating the Pu in some was not by elimination but by translocation of the Pu from the superficial endosteum and trabeculae to a position deep in the inert cortical bone. Animals could then be placed in a diet high in Ca and P so that new bone would be formed over the old shell of bone containing the Pu, thus effectively shielding the cells from radiations. Decalcification studies were also done in rats which were given a Ca or P deficient diet during the period of lactation and the translocation of Pu was studied in these animals by radioautography. (FMM)

<35>
Hamilton, J.G., University of California, Radiation Laboratory, Berkeley, CA. 1944, December 7

Technical Progress Report on the Metabolic Studies of Product. CN-2312; Part of Nickson, J.J., et al, Monthly Health Report on Problems Relating to Product for Period Ending October 31, 1944, (p. 1-12), 13 p. (Declassified January 18, 1956)

Radioautographic studies with lungs from animals inhaling PuO_2 smoke produced by the volatilization of $PuCl_4$ and $Pu(NO_3)_4$ with the aid of an electric arc were done for various intervals of time ranging from 0 to 64 days inclusive. The radioautographs secured from the lungs of animals sacrificed 64 days after exposure revealed a very fine and uniform distribution of the retained activity throughout the alveolar tissue. This pattern resembled very closely the distribution of plutonium in the lung at 1, 4, and 16 days after inhalation. A large number of lung radioautographs from animals exposed to PuO_2 smoke produced by burning the metal in an electric arc were made. For the 0, 1, 4 and 16 day interval after exposure the radioautographic patterns were essentially the same as observed using $PuCl_4$ and $Pu(NO_3)_4$. Tracer studies with PuO_2 smoke produced from $PuCl_4$ and $Pu(NO_3)_4$ were done to the 64 day interval. The results of these studies indicated that approximately 10% of the inhaled plutonium smoke remained in the lungs at the end of the 64 day interval after exposure. The rate of release of the deposited plutonium in the lung at the end of this interval was extremely slow and indicated that the apparent half-time of retention of this final 10% was greater than six months. The retention by the lungs in experiments using PuO_2 smoke from metal revealed the following percentage of inhaled

BIOLOGICAL ASPECTS
ANIMALS

<35> CONT.
activity deposited in the pulmonary tissue: 35.8%, 33.0%, 29.8% and 32.4% at 0, 1, 4, and 16 days respectively. The amount of activity absorbed through the pulmonary tissue and deposited elsewhere in the body was observed to be less than 1%. The measured per daily rate of excretion of Pu at 14 days after intramuscular injection was found to be 0.2% , 0.05%, 0.15% of the administered dose of Pu in the +3, +4 and +6 valence states respectively. At 144 days the corresponding values were 0.1%, 0.025% and 0.05% (PHM)

<36>
Hamilton, J.G., and K.G. Scott, University of California, Berkeley, CA. 1952, November 10

The Metabolic Properties of Varicus Materials. Tracer Studies, Versene Studies with Plutonium. UCRL-2001; Part of Medical and Health Physics Quarterly Report, July, August, and September, 1952, (p. 84-87), 134 p.

Twenty-five days after receiving intravenous injections of plutonium 238(+6), rats were injected intraperitoneally with the calcium salt of Versene (Ca EDTA) at a dose level of 600 mg/kg body weight. A definite increase in urinary excretion of plutonium was observed. Analyses of organs, tissues and body fluids indicated that, with the exception of blood and the kidney, plutonium content was lower in the treated animals than in controls. (ST)

<37>
Hamilton, J.G., et al, University of California, Berkeley, CA. 1948, August 17

Technical Progress Report on the Metabolic Studies of Product. CN-1990; Part of Cole, K.S., et al, Monthly Report on Problems Relating to Product for Period Ending July 31, 1948, (p. 4-6), 6 p. (Declassified January 2, 1952)

Radioautographic studies included the preparation of lungs taken from animals exposed to PuO2 and PuCl4 smokes. Formalin was replaced by absolute alcohol as a fixative due to leaching in the former. Animal tracer studies with product given intramuscularly in a 64-day study showed a bone deposition of 52.2%, 64.0% and 58.3% for the plus 3, plus 4 and plus 6 valence states, respectively. Deposition in liver, kidney and spleen was essentially the same for the 3 valences ranging from 1/10 to 1/4 of that of bone. The half-time of product retained in the body was estimated to be in the order of one year. (RAP)

<38>
Hollins, J.G., and M.C. Storr, National Research Council of Canada, Division of Biological Sciences, Ottawa, Canada. 1975

An Analysis of the Retention of Plutonium by the Tissues of the Rat. Radiation Research, 61, 468-477.

The amount of plutonium 239 in the blood, six bones, the kidneys, and the liver of male rats was measured at 18 different intervals of time between 5 min and 1 yr after a single intravenous injection of 0.1 micro Ci pu 239/kg rat as plutonium citrate. The data collected have been used to obtain models for the retention of plutonium by an organ. The rate of transfer of plutonium from blood to bone was found to depend simply on the amount of plutonium in the blood, but the rate of transfer of plutonium from blood to the soft organs involved plutonium in three species, each species being transferred at a characteristic rate that led to a triphasic exponential equation for the retention of plutonium by blood. (Auth)

Table 1 gives the retention of plutonium by the blood, kidneys, liver, and skeleton after unit uptake by each of these tissues.

<39>
Jacobson, L.O., and E.L. Simmons, University of Chicago, Metallurgical Laboratory, Biology Division, Chicago, IL. 1946, June

Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects. CH-3884; AECD-2372; 65 p. (Declassified November 3, 1948)

The effects of the parenteral administration of radium chloride on the hematological constituents of the peripheral blood of rats, mice, and rabbits have been studied. Intraperitoneal and intravenous doses of from 0.005 to 0.94 uc/g have been given to rats; intraperitoneal doses of from 0.000066 to 0.85 uc/g, to mice; and interaperitoneal or intracardial doses of from 0.0016 to 0.1 uc/g, to rabbits. There appeared to be no significant species difference in the sensitivity of the hematopoietic systems of the rat and mouse to radium, but rabbits appeared to be slightly more resistant than the other two species. In the rat, mouse, or rabbit no significant hematological alteration occurred after an injection (by any route) of 0.01 uc/g or less of radium chloride. A dose of 0.02 uc/g produced an anemia and sustained leucocyte reduction in rats. A dose of 0.03 uc/g resulted in a severe recurrent anemia in ABC male mice (but not in CF=1 females), comparable changes in heterophil levels in both strains, and in initial moderate reduction in lymphocytes in the ABC male mice. Doses as high as 0.1 uc/g, however, failed to produce an anemia in the rabbit, but did cause a mild, early, persistent reduction in leucocytes. A dose of 0.94 uc/g in the rat resulted in an initial reduction in reticulocytes with subsequent overproduction and in a marked reduction in platelets with only moderate recovery. Morphological changes were seen in the nucleated cells of the peripheral blood after radium administration. These were largely comparable to those previously described in animals following the external application of radiations such as x rays, gamma rays, and fast neutrons, or internal radiation in animals following the parenteral administration of plutonium. As evidenced by an increased erythrocyte diameter and increased mean corpus cular hemoglobin, macrocytosis became apparent in rats, mice, and rabbits after the parenteral administration of doses of radium between 0.1 and 0.2 uc/g. (Auth) (JTE)

<40>
Jaworowski, Z., J. Bilkiewicz, and I. Radwan, Central Radiological Protection Laboratory, Warsaw, Poland. 1973

Influence of Irradiation on the Incorporation of Radionuclides. CONF-720503; Part of Bujdoso, E. (Ed.), Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972. Akademiai Kiado, Budapest, Hungary, (p. 303-306), 655 p.

<40>

BIOLOGICAL ASPECTS
ANIMALS

<40> CONT.
The influence of internal radiation on the incorporation of Pu 239, Ra 226, Pb 210, Ce 144 and H 3 in hair and other tissues has been studied in rabbits and rats. In tritium experiments internal irradiation effects were compared with those caused by external x-ray exposure. It was found that the uptake of radionuclides by hair and tissues depended on the amount of injected radionuclide and on the mode of its administration. Fractionated doses resulted in higher uptake as compared to single doses. Increasing the dose of radionuclide per gram of body weight by one order of magnitude usually decreased the uptake in hair and tissues; in Pb the opposite effect was observed. This phenomenon may be explained by radiotoxic effects produced locally in hair matrix or in one or more organs controlling the retention and excretion of radioelements. (Auth) (RAF)

<41>
Jee, W.S.S., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

A Case of a Bone Tumor Arising from the Temporal Bone. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 166), 225 p.

In a routine survey of skeletons of toxicity animals with decalcified celloidin sections, the areas reported where there have been cases of carcinomas of the accessory nasal sinuses, paranasal sinuses and mucosa of temporal bone in radium patients and carcinoma of the external auditory meatus in rabbits injected with strontium 90 was considered. None of these soft tissue tumors was ever detected, however, in the survey of these regions a case of osteogenic sarcoma was seen arising from the temporal bone about the external auditory meatus in dogs injected with 0.3 uCi/kg of plutonium (NBP3). This animal survived 1771 days after the acquisition of plutonium. (Auth) (Complete Text)

<42>
Jee, W.S.S., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1962, March 31

Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium. COO-225; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 129), 136 p.

Contact and detailed radioautograms of undecalcified sections of lumbar vertebrae and ground sections of tibiae from adult beagles injected with plutonium 239 revealed the patterns and rates of pathologic and normal bone remodelling. Plutonium, an alpha-emitting bone-seeking radionuclide, initially deposited on mineralized surfaces. In the spongiosa, new bone formed after injection overlayed the stratum of plutonium and is identified by its lower diffuse concentration. A typical bone formation and mosaic trabeculae are formed in dogs receiving 2.7 and 0.9 uCi/kg of plutonium, while normal remodelling patterns are apparent with lower dose levels. In the compacta, plutonium initially localized on mineralized surfaces of forming osteones, haversian and Volkmann canals. New osteones formed after injection are identified by their diffuse labelling. The radiotoxic effect of the radionuclide and the accompanying histopathologic bone changes as well as the rates of remodelling of spongy and compact bones from dogs injected with various dose levels of plutonium are discussed. (Complete Text)

<43>
Jee, W.S.S., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1974, March 31

Injection Tables. COO-119-249; Part of Jee, W.S.S., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 9-119), 330 p.

Beagles were put into the toxicity study at graded injection levels. Each animal received one radionuclide in a single intravenous injection at 17 months of age. Twelve such groups have been injected for each of the six radionuclides, Ra 226, Pu 239, Ra 228, Th 228, Sr 90, and Am 241. Since the injection levels were orginally specified in "retained" activities, the actual injections were 4 times the desired retained uCi/kg of Ra 226, Ra 228, and Sr 90, and 1.11 times the desired retained uCi/kg of Pu 239, Th 228, Cf 249, Cf 252 and Cm 243 and 244. Injection level 1 was 10 times the maximum permissible concentration of Ra 226 in man, all other levels were multiples of level 1.

The tables included the calculated average dose in rads to the skeleton at death.

<44>
Jee, W.S.S., J.S. Arnold, R. Mical, M. Lowe, and J. Twente, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 99-143), 225 p.

Dental tissues and jaws from forty-two adult beagles injected with a single intravenous dose of radium 226 (3.51-10.8 uCi/kg), plutonium 239 (0.26-3.30 uCi/kg), mesothorium 228 (9.93-10.1 uCi/kg), radiothorium 228 (0.88 uCi/kg) or strontium 90 (93.6-111.0 uCi/kg) were studied. The autoradiograms of the undecalcified sections of teeth and their supportive structures revealed that plutonium and radiothorium localized in high concentration on the surfaces of dentine and root canals of the pulp cavities and to a lesser degree at the surface of cementum and bone while radium, mesothorium and strontium were deposited intensely on the newly calcified surfaces of dentine, root canals, cementum and bone and, to a lesser degree and diffusely, in old bone. The dental lesions in 13 dogs injected with 3.0, 0.9 or 0.27 uCi/kg and 15 serially sacrified dogs injected with 3.0 uCi/kg of plutonium were studied by celloidin and radiographic methods. The sites of plutonium localization were observed to approximate the sites of roentgenographic and histopathologically detectable lesions. The lesions induced by the isotope included early changes in the formation of secondary dentine, death of cementoblasts and cementocytes, disappearance

BIOLOGICAL ASPECTS
ANIMALS

<44> CONT.
of cementoid tissue, apposition of abnormal cementum and resorption of cementum, dentine and alveolar bone. The late changes involved equivocal vascular disturbance, damage of periodontal ligament, fusion of bone to teeth (ankylosis), replacement of dentine by lamellar bone, cementum or gingiva and loss of teeth. A comparison of the relative toxicities of 3.0, 0.9 and 0.27 uCi/kg of injected dose of plutonium on dental tissue and supportive structures found that the changes were dose dependent. No tumor was observed arising from dental tissue but one osteogenic sarcoma occurred in the mandible of an animal given plutonium. The abnormal radioresistency of the odontoblasts under intense alpha ray bombardment and the sequence of histopathologic changes in teeth and the relationship of absorbed dose in rads to dental lesions were also discussed. (Auth.)

<45>
Jee, W.S.S., and J.S. Arnold, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p, 150-165), 225 p.

The mid-diaphyses of tibiae from four normal and twenty-three beagles that died or were sacrificed from 1 to 1724 days following the adminstration of radium 226 (10.0 uCi/kg), plutonium 239 (3.0 uCi/kg) and radiothorium 228 (0.9 uCi/kg) were studied. The young adult beagles of mixed sexes between 14 and 24 months were administered a single IV injection of the radionuclide. The injection solutions were prepared in citric-sodium citrate buffer, 0.08 M in total citrate and pH 3.5. It was observed that after an extensive latent period following the acquisition of plutonium, radiothorium and radium in cortical bone, plugging of the haversian canals occurred which, in turn, resulted in bone necrosis. Investigation of this phenomenon with a vascular injection technique and a bone-seeking alpha emitter (plutonium) which deposited on surfaces of haversian canals and allowed the remainder of the osteones and adjacent interstitial lamellae to be free of activity, showed that the death of osteocytes was principally the result of disrupted blood supply and not from direct alpha ray killing. With radiothorium, the concentration of alpha particles about haversian canals was sufficient to result in total plugging of the vascular tree within the haversian canal, resulting in complete bone necrosis and inhibition of internal reconstruction of cortical bone. With radium and plutonium only about half of the canals were plugged which allowed internal reconstruction to proceed; however, the nature of the remodelling in this environment was abnormal (formation of large cavities and abnormal osteones). It was also suggested that both the devitalization of bone and the occurrence of large cavities weakened the bone which, in turn, resulted in the spontaneous fracturing of long bones. (Auth) (FHM)

<46>
Jee, W.S.S., T.H. Cochran, and R. Mical, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

Microscopic Distribution of Plutonium 239 and Thorium 228 in Beagles. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 144-148), 225 p.

Mineralized and soft tissues from young beagles that died or were sacrified from 1 to 1724 days after the administration of a single intravenous injection of either plutonium(+4) or radiothorium citrate (.09 to 2.5 uCi/kg) were studied by radioautography. Microscopic distribution of radiothorium and plutonium in bone, teeth and calcified cartilage was observed to be similar (calcified bone surfaces and diffusely in calcified cartilage) while the deposition patterns in soft tissues were quite different. Radiothorium was located in the reticuloendothelial cells of all tissues and had a special affinity for blood vessels, kidney and lung. Plutonium differred from the microscopic distribution of radiothorium in that it deposited diffusely and intensely in the liver and had little or no avidity for lung tissue. (Auth) (FHM)

<47>
Jee, W.S.S., and T.P. Dougherty, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1962, March 31

Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles. COO-225; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 133-135), 136 p.

The relation of bone damage and radiation dose in adult beagles given a single intravenous injection of widely varying dose levels of bone-seeking radionuclides (Ra 226, Pu 239 or Sr 90) was summarized. These studies, which span nine years to date, described the incidence and distribution of bone cancers and fractures, types and quantities of histopathologic bone changes, distribution of the radionuclides in space and time, and local and average skeletal radiation doses obtained by radiographic, histological, radiochemical, detailed and quantitative radioautographic analyses. These bone seekers induced high incidence of osteogenic sarcoma, and cases of a squamous cell sarcoma of the paranasal sinus and a myeloma. The average accumulative skeletal dose ranged from about 60 to about 15,000 rads. Fractures occurred with animals bearing Ra 226 and Pu 239. Rib fractures were most numerous, only Ra 226 treated dogs had long-bone fractures, and only Pu 239 treated dogs had fractures of the innominate bone. Isolated empty lacunae and Haversian canal plugs were the most subtle histological changes observed. The pathogenesis of histological bone changes, the relation of the distribution of the radionuclide to osseous tissue damage and tumor induction were also discussed. (Complete Text)

<48>
Jee, W.S.S., M. Lowe, R. Togge, R. Mical, and K. Scars, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1963, March 31

The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult

<48>

BIOLOGICAL ASPECTS
ANIMALS

<48> CONT.
Long Bone Cortex. COO-227; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 120-142), 231 p.

Plutonium was found to deposit in pre-injection and post-injection osteons in divergent patterns, thus allowing for an accurate method to assess the amount of bone formed subsequent to the introduction of the radionuclide. This unique technique was used to determine the rate of remodeling and the distribution pattern of remodeled osteons in the proximal tibial compacta of dogs. Three groups of young adult beagles, 524, 594 and 517 days average age, were injected with 2.7, 0.9, or 0.3 uCi Pu 239/kg. The Pu was given intravenously in the +4 valence state in citrate. Microradiographs and celloidin section were analyzed for histologic endpoints for irradiation damage. A reduction in patent vascular channels and viable osteocytes was found in the treated dogs accompanied by a tendency to enhance the rate of internal reconstruction. These events also appeared to be dose dependent. Other indices of rate of remodeling, such as areas occupied by recently formed osteons and per cent of forming osteons, helped to estimate the remodeling rate of the proximal tibial compacts of controls to be 2% per year. The distribution patterns of building sites of Haversian systems in beagles treated with plutonium tended to shift in location from the anteromedial wall to the anterior quandrant and from the outer and inner portions into the middle region of the tibial compacta. The significance of the role of vascularity, internal irradiation, and necrosis of osteocytes as causal factors of remodeling as well as changes in distribution pattern of remodelling sites were discussed. (Auth) (FNM)

<49>
Jee, W.S.S., and B.J. Stover, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1962, March 31

The Long-Term Effects of Plutonium 239 in Adult Beagles. COO-225; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 132), 135 p.

The relation of osseous tissue damage and radiation dose in 39 adult beagles given a single intravenous injection of 2.7, 0.9, 0.3 or 0.1 uc/kg of Pu 239(+4) citrate is summarized. The studies which span nine years describe the incidence and distribution of bone tumors, the types and quantities of histopathologic bone changes, the non-uniform distribution and redistribution of the radionuclide in space and time, and the local and average skeletal radiation dose obtained with histological, radiochemical, detailed and quantitative radioautographic techniques. All four dose levels resulted in nearly 100% incidence of osteogenic sarcoma. The tumors arise principally from the spongiosa of vertebral bodies and long bones. The average cumulative skeletal doses range from about 300 to about 6000 rads. Radiochemical and quantitative radioautography show about a factor of 10 variation in the initial non-uniform distribution on mineralized surfaces and in bones resulting in an overlapping spectrum of bone changes between dose levels. However, each dose level exhibits a characteristic change. Isolated empty lacunae in trabeculae and Haversian canal plugs along with loss of osteocytes in cortical bone are the most subtle changes observed to date. The pathogenesis of histopathological bone changes and the relation of tissue damage to bone tumor production are also discussed. (Complete Text)

<50>
Kalmykova, Z.I., Not given. 1964

Oxygenation of Rat Blood Following Inhalation of Plutonium 239. AEC-tr-7590; Part of Moskalev, Yu.I. (Ed.), Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 243-250), 405 p.

Experimental Wistar rats with an initial weight of 150-170 grams were administered plutonium citrate by inhalation at ph 6.5 in a specially designed chamber. Immediately after inhalation the rat lungs contained the following quantitites of alpha-emitter: 0.033, 0.043 and 0.107 uCi for female rats, and 0.035 and 0.048 uCi for male rats. Blood oxygenation was determined once a month in rats anesthetized with chloral hydrate using an O-38 oxyhemometer. The functional test involved brief asphyxia to block access of air; then the dynamics of recovery of initial blood oxygen was observed. Impaired oxygenation of blood, alternating with periods of normalization, developed in rats following inhalation of plutonium citrate. The severity and duration of these disturbances were related to the quantity of alpha-emitter deposited in the lungs; the more radioisotope present, the more marked were the changes. Disturbances of oxygenation of blood were most distinctly demonstrable with the functional test involving brief asphyxia. During an 8-month period, no significant quantitative changes of hematological indices were observed. (RAP)

Table 1 shows oxygenation of rat blood following inhalation of Pu 239. Table 2 shows total restoration of initial blood oxygen level after arrest of asphyxia.

<51>
Karpova, V.N., and Z.I. Kalmykova, Not given. 1974, June

Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats. Gigiena i Sanitariya, 6, 47-51. (Russian, English Abstract)

The preventive use of pentacin with lydase causes a five-fold fall in Am 241 content, produced in first 24 hours, and is, consequently, able to diminish considerably the intratracheal radiation effect and convert it into a lighter form. The effect of the combined use of both compounds in their single introduction after poisoning with americium depends on the time of their introduction. A significant fall in the content of radionuclides in rats was noted only on conditions of the use of pentacin and lydase in the 1st 24 hours after poisoning. In case of repeated use of the compounds the preventive effect was mainly due to the first administration. (Auth)

<52>
Katz, J., Hanford Works, Richland, WA. 1951, January 2

Plutonium Metabolism. A Literature Review. HW-21868; 24 p. ("Official Use Only" Cancelled November 15, 1975)

BIOLOGICAL ASPECTS
ANIMALS

<52> CONT.
A review of the metabolic behavior of Pu is presented. The effects of valence on the metabolism of Pu administered by various route are discussed. It was shown that hexavalent Pu was most readily absorbed, the tetravalent form was taken up to a much lesser extent, while the trivalent Pu uptake was between the two extremes. Other data show that when various forms of Pu were injected intravenously into rats on the first day Pu(+6) was excreted to a greater degree in urine and to a lesser extent in feces then Pu(+3) or Pu(+4). The deposition of Pu in various times after its IV injection is summarized. Deposition in kidney, spleen and carcass was somewhat affected by the form in which the element was injected. Another study showed that the maximum uptake by the skeleton was 45% and by the liver 24% of the injected dose within 24 hr for intravenously injected Pu(+4). The effects of various substances and of diet on the absorption and distribution of Pu are reported. Deposited Pu has been shown to be transmitted from mother to both fetus and young. In an attempt to provide a basis for extrapolation to man work on interspecies comparison of the radiotoxicity has been done. The removal of Pu from the body is discussed. It was pointed out that zirconium citrate increased the excretion of Pu to a much greater extent when administered before the injection of the radioelement than after. Finally the inhalation and oval absorption of Pu are discussed. The following order of rate of absorption of Pu from the lungs was found by some workers: Pu(+6) citrate > Pu(+4) citrate > Pu(+6) nitrate > Pu(+4) nitrate. It has been reported that approximately 0.01% of the orally administered dose of Pu was absorbed and that about 79% of the Pu absorbed from the GI tract was deposited in the skeleton and 7.3% in the liver. (FMM)

Table 1 shows effect of valence state on absorption of Pu administered by various routes. Table 4 shows the distribution of ingested Pu in a mouse at 26 days.

<53>
Konstantinova, V.V., Not given. 1962

Urea Synthesis and Arginase Activity in Plutonium Injured Rats. FTD-tt-63-559; Part of Lebedinskii, A.V. and Moskalev, Yu.I. (Eds.), Plutonium 239: Its Distribution, Biological Effects and Accelerated Elimination, (p. 88-91), 267 p., (Translated Edition).

Male rats were injected intraperitoneally with a plutonium nitrate solution at a dose of 20 uCi/kg to study possible disruptions of urea synthesis. This dose proved lethal for 80-90% of the animals within six months. At two and four months, when a distinct subacute injury was noted, rats were sacrificed and the level of urea synthesis was determined in liver sections. The rate of urea formation from NH4Cl for controls averaged 63 um of ammonia per 1 g of tissue. In the experimental animals the rate of urea synthesis by the liver was found to be reduced by 32 and 43% at two and four months, respectively. The ionizing doses equaled 1400 and 1900 rep at these times. Arginase activity declined by 18% at two months; but was at normal levels at four months. Thus lowered rate of urea synthesis in test rats did not appear to be related to lowered arginase activity. (ST)

<54>
Krivolutskii, D.A., and M.N. Fedorova, Academy of Sciences, Institute of Evolutionary Morphology and Ecology of Animals, Moscow, USSR. 1973

Effect of Soil Pollution with Plutonium 239 on Field Fauna. Zoologicheskii Zhurnal, 52(4), 601-603. (Russian, English Abstract)

On a region of wheat field on chernozem soil experimentally polluted with Pu 239 (1.78 mCi/m2), a sharp decrease in numbers and a decline of microarthropod diversity were noted. As a result of pollution, the population density of soil mesofauna decreases 2.3 times, the decrease being especially marked in deep soil horizons. (Auth)

<55>
Kunzle-Lutz, M., H. Metivier, D. Nolibe, A. Simon-Vermot, J.L. Gimbert, P. Jockey, and A.A. (Translator) Horvath, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1970

Pulmonary Lavage, Therapy of Pulmonary Contaminations. LF-tr-71; 10 p.; Poumon et le Cour, 26, 1029-1038.

In vivo lung wash-out with saline solutions was tested in baboon monkeys of 3 to 4 kg body weight previously dusted with plutonium oxide. The dust was administered by inhalation for one hour and a half in an atmosphere loaded with particles of plutonium oxide (average dia. 0.5 u). Animals were submitted to 1, 3 or 5 series of wash-out of the inferior lobe; each wash-out session including 5 or 10 repeated irrigations. From the obtained results it was concluded: a) that it is not necessary to perform more than 6 irrigations in the course of a wash-out session; b) that the maximal efficiency is obtained when the wash-out takes place in the first days consecutive to the dust contamination; c) that a wash-out session eliminates in the washed out territory 10% of the particles, while numerous sessions reduce from 45 to 55% the pulmonary load of the territory submitted to treatment. Repeated treatment is therefore recommended. (Auth) (FMM)

<56>
Lemberg, V.K., Not given. 1964

Bone Tumors in Dogs Given Plutonium 239. AEC-tr-7590; Part of Moskalev, Yu.I. (Ed.), Distribution Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 257-265), 405 p.

The results are given of a pathoanatomical examination of the skeleton of 10 dogs that died or were sacrificed in agonal condition at different times after four (once a month) intravenous injections of plutonium nitrate (pH 2, 0.05 uCi/kg) to a cumulative dosage of 0.2 uCi/kg. Malignant skeletal tumors were demostrated in 6 out of 8 dogs that survived over 2 years after IV administration of plutonium nitrate in a cumulative dosage of 0.2 uCi/kg. In dogs given the above dosage, the latency period of osteosarcoma development constituted a mean of 1421 days, or 32.5% of mean life expectancy. Four of the seven osteosarcomas developed in the epi-metaphysical region of long bones (femur, humerus and tibia), two developed in the vertebrae, and one in the scapula.

<56>

BIOLOGICAL ASPECTS
ANIMALS

<56> CONT.
Histologically, six osteosarcomas were of the osteoplastic type and one was of the osteolytic type. (RAF)

<57>
Lindenbaum, A., M.W. Rosenthal, D.W. Baxter, J.E. Parks, G.S. Kalesperis, E.S. Moretti, and J.J. Russell, Argonne National Laboratory, Argonne, IL. 1973, December

Metabolic and Therapeutic Studies of Plutonium and Americium. ANL-8070; Part of Division of Biological and Medical Research Annual Report, 1973, (p. 137-143), 242 p.

An experimental to test removal of polymeric plutonium from dog liver was performed. Fifteen adult female dogs were given a single intravenous injection of a highly polymeric Pu (0.28 uCi/kg) and treated with diethylenetriaminepentaacetic acid (DTPA), glucan, or both, with termination of the experiment at 90 days. Ca DTPA (ca. 100 mg/kg) was given twice weekly from 6 days onward, and 15 mg/kg of glucan was given at 6, 34 and 62 days. At 90 days after Pu administration, the liver retained 86% of the injected dose without treatment, 78% after continuing DTPA therapy, 82% after glucan alone and 71% after combined therapy. The small reduction in the liver burden of plutonium produced by DTPA was taken as evidence that most of the liver plutonium was intracellular. Plutonium removal by DTPA and glucan appeared additive. The 90 day urinary excretion of plutonium was unchanged by glucan (4.0% of the injected dose compared to 3.5% in controls), increased to 13.4% by DTPA and further increased to 21.1% by DTPA plus glucan. Fecal excretion of plutonium was low and essentially unchanged by therapy. Studies of the use of DTPA encapsulated in lipid spherules, liposomes, for removal of polymeric plutonium in mice showed that more plutonium is removed from the liver by liposomal DTPA than by aqueous DTPA. Twenty-five to 50 mg/kg doses of liposome-encapsulated DTPA were effective in removal of hepatic plutonium. The same amount of hepatic plutonium was removed by the same dose of liposomal DTPA, independent of the concentration of encapsulated DTPA (6%, 12.5%, or 25%). Multiple injections of liposomal DTPA (100 mg/kg, given at 3, 10, 17 and 24 days after plutonium) removed 45% of the hepatic plutonium not removed by the same regimen of aqueous DTPA. Quantitative autoradiography of dog livers obtained 90 days after injection of monomeric Pu 239 citrate indicates there is little or no translocation of monomeric plutonium within the dog liver up to 3 months. A non-light-sensitive film (Eastman Kodak Co. LR115) was used for autoradiograms of skeletally deposited radionuclides in mice injected with either monomeric or polymeric plutonium. Rats injected intravenously with highly polymeric, "mid-range" polymeric, and monomeric plutonium preparations, and dogs injected with a highly polymeric preparation, were used to compare partitioning of plutonium between plasma and cells. With highly polymeric Pu rapid blood removal occurred, leaving in both species only a small amount of residual Pu in the cells or plasma. Blood fraction work with rats showed that 2 hours after intravenous injection of either monomeric or "mid-range" polymeric plutonium, the total plasma Pu/total cell Pu ratio was about 10. By 24 hours the ratio dropped to 6. (LR)

<58>
Lisco, H., Argonne National Laboratory, Division of Biological and Medical Research, Lemont, IL. 1959

Autoradiographic and Histopathologic Studies in Radiation Carcinogenesis of the Lung. Laboratory Investigation, 8, 162-170.

Female rats of the Sprague-Dawley strain, weighing 200 g were exposed to several dose levels of a smoke of PuO2 through glass cannulae which had been inserted into the trachea. The mean diameter of the particles in the smoke was 0.2 u and the initial dose levels in the lungs for three groups of animals were 3 ug, 3-4 ug and 13-14 ug. The lungs retained approximately 50% of the intially deposited Pu 30 days after exposures. Thereafter, elimination from the lungs proceeded at a slower rate, reaching a level of about 6% of the initial dose one year after exposure. Autoradiography was used in tracing the movement and behavior of plutonium in the lungs of the rats. The use of this method made it possible to correlate the location of the characteristic pathologic changes in the lungs with the sites of deposition of this material. The pathogenesis of the malignant tumors which occurred in many of the animals could be related to the severe focal tissue damage which was produced in the lungs by exposure to plutonium oxide. (Auth) (PMM)

<59>
Lloyd, R.D., C.W. Mays, G.N. Taylor, D.R. Atherton, and L.R. Shabestari, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1967, March 31

Americium Metabolism in Beagles. COO-119-236; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 197-206), 268 p.

Fourteen adult beagles were injected with 0.02 to 35.9 uCi Am 241. The Am 241 activity in their skeletons and in their livers was evaluated serially using a combination of total-body and partial-body counting via the 60 keV gamma-ray. By one day post-injection, about 40% and 50% of the injected Am 241 was deposited in the skeleton and liver, respectively. This pattern of retention persisted to burden times of more than 6 months. Excreta collections from four animals during the first three weeks after injection showed that 7/8 of the excretion was urinary. Nearly 3/4 of the total Am 241 excreted during this period appeared in the first day's collection. (Auth)

<60>
Lloyd, R.D., C.W. Mays, G.N. Taylor, and D.R. Atherton, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1970, March

Americium 241 Retention in Beagles. COO-119-241; Part of Lloyd, R.D. (Ed.), Retention and Dosimetry of Some Injected Radionuclides in Beagles, (p. 123-143), 162 p.

Forty-eight adult beagles were injected with 0.00179 to 4.49 uCi Am 241/kg body mass. Retained activity in the living animals was evaluated via the 60 keV gamma-ray using a combination of total-body and particle-body counting to determine the proportion in the liver and in non-liver tissue. Soon after

BIOLOGICAL ASPECTS
ANIMALS

<60> CONT.
injection, about 50% and 40%, respectively, of the administered Am 241 was deposited in the liver and non-liver tissue (mainly skeleton). In the animals injected with 0.00179 to 0.305 uCi/kg the liver and non-liver burdens decreased slowly each with a biological half-time of about 10 years during the first 850 days. Two dogs injected with about 2.80 uCi/kg exhibited a sharp decrease in liver retention beginning about 100 days after injection accompanied by an increase in non-liver Am 241. Both showed extreme degenerative liver changes at death 401 and 448 days after injection. Similar but more slowly progressing effects were observed in the retention of Am 241 by two animals injected with about 0.904 uCi/kg. At even longer times after injection, corresponding effects were noted in the lower level dogs. Excreta collections from four dogs during the first three weeks after injection showed that 7/8 of the excretion was urinary and that nearly 3/4 of the total Am 241 excreted during this period appeared in the first day's collection. Evaluation of the activity of individual bones, organs, and tissues of six animals autopsied 1 to 448 days after injection showed that although Am 241 was distributed in many soft tissues, the liver and skeleton were the principal deposition sites; however, americium concentration in the thyroid gland was higher than in the skeleton and was higher than in any other soft tissue except the liver. Autoradiography showed that Am 241 was deposited close to the location of the functioning thyroid cells. The kidney also had a relatively high concentration of activity, selectively deposited in the glomeruli. (Auth)

<61>
Lutz, M., D. Nolibe, G. Petany, J.C. Rannaud, and A.A. (Translator) Hornath, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1970, April-May

Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages. LF-tr-46; 17 p.; Archives des Maladies Professionnelles de Medicine du Travail et de Securite Sociale, 31(4-5), 185-196.

Rabbits weighing approximately 2-200 gm were allowed to inhale particles of Pu oxide to study the effects of these particles on alveolar macrophages which engulf them. The animals were exposed for 1 hour and 30 minutes and it was determined that approximately 400 pCi were retained by the lungs. Pulmonary macrophages were removed by perfusal of Hanks' solution through intratracheal channels and collection by natural reflux. The liquid obtained from the rabbits was centrifgued for 5 minutes at 600 g. Macrophages were separated from the cellular precipitate by allowing them to adhere to Leighton's tube at 37 degrees C. The cells were studied by means of the electron microscope. Morphological characteristics of macrophages of both normal rabbits and rabbits exposed to aerosols of Pu 239 oxide were described. From 5 to 15% of the pulmonary macrophages had phagocytized particles of Pu. On the periphrey of the particles the cytoplasm formed an amorphous halo. Cells obtained 2 to 4 days post-exposure showed an important vacuolization, and a highly developed network of filaments, indicating cellular suffering. (JTE)

Numerous electron micrographs of macrophages are included.

<62>
Lyubchanskii, E.B.. 1964

Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof. AEC-tr-7590; Part of Moskalev, Yu.I. (Ed.), Distribution, Biological Effects and Accelerated Excretion of Radioactive Isotopes, (p. 34-41), 405 p.

Experiments were conducted on Wistar rats of both sexes, weighing 140-160 grams, that inhaled aerosols of a plutonium citrate complex, ph 6.5, for 20 minutes. The activity of the solution ranged from 15 to 300 uCi/ml. The rats were sacrificed immediately after inhalation and at 6 hrs., 1, 8, 16, 32, 64, 128 and 256 days later. Plutonium levels were estimated in the lungs, liver and femur; in some animals also in blood, gastrointestinal tract, head and muscles. The radioactivity was determined by scintillation after ashing. Immediately after inhalation the gastrointestinal tract, head, lungs and other internal orgnas showed 50, 18.7, 28.8 and 2.6%, respectively, of the radioactivity found in the rat organism. The Pu level in the gastrointestinal tract showed a 100-fold decline in 8 days and 1,000-fold decline in 32 days. Clearance of Pu from the lungs occurred in 4 stages: about 9% was eliminated within a few minutes, about 56%-biological half-life 19 hours, 65% within 24 hours (biological half-life 7.4 days) and 35% with a half-life of 137 days. The resorption level constituted 35-40% of the initial level in the lungs after 64 days. Deposition in bones did not exceed 25% and in the liver it did not exceed 6% of the initial level in the lungs. Elimination from the liver occurred with a biological half-life of 119 days, starting on the 32nd day. Most of the resorbed Pu was deposited in the skeleton, starting on the 1st day. The Pu concentration was higher in the lungs at all examination times than it was in the skeleton. (HAF)

Data on Pu 239 levels at different tissues after inhalation, Pu 239 levels in rat organs and tissues, patterns of accumulation and excretion, and clearance from the lungs are given in tabular form.

<63>
Lyubchanskii, E.B., Not given. 1964

Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration. AEC-tr-7590; Part of Moskalev, Yu.I. (Ed.), Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 124-130), 405 p.

A solution of Pu citrate, with a pH of 6.5, was administered in a single intraperitoneal dose of 0.56 uCi/rat to male Wistar rats 3 and 18 months of age. The animals were divided into 2 groups. Group 1 was sacrificed after 5, 10, 20, 40, 80, 160 and 320 days. Group 2 at the same time intervals, but 5 days prior to sacrifice they were given the same dosage of Pu citrate. Separate estimation was made in urine and feces of rats between the 1st and 5th day, 15th and 20th, 35th, 40th, 75th and 80th, 155th and 160th and between the 315th and 320th days. Five days after single intraperitoneal administration of Pu to rats, the liver

<63>

BIOLOGICAL ASPECTS
ANIMALS

<63> CONT.
showed 13%, the femur 3.72%, the scapula 0.81%, and the muscles 2.11% of the given dose. For 85% of the isotope, the biological half-life was 7 days and for 15%--125 days, for elimination from the liver; with regard to the spleen, 35% was excreted with a half-life of 31 days and 65%--600 days. The biological half-life of Pu elimination from the femur was 840 days, from the scapula 700 days and for muscles 108 days. The age of the rats affected the magnitude of deposition and excretion of Pu: 5 days after Pu administration, there was 25 and 20% less retention in the femur and scapula of old rats (18 months) than in young ones (3 months); the magnitude of excretion was 100% greater in old rats. When given the 2nd time, the behavior of Pu differed from its behavior following single administration; a gradual decrease in Pu deposition in the femur and scapula and an increased excretion in feces was noted. The pattern of Pu deposition in the liver and muscles fluctuated. (BAF)

Tabular data are given on Pu 239 levels in rat organs and tissues at different times following single intraperitoneal administration, and on deposition, excretion and distribution of readministered Pu 239.

<64>
Lyubchanskii, E.R.. 1965, January

The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection. Medical Radiology, 10(1), 45-49. (Russian, English Abstract)

In experiments on albino rats it was shown that when a single prophylactic inhalation of pentacynium (1.8 mg) was performed 30 minutes before Pu administration, the Pu content of the lungs, skeleton, and liver was 12.1, 5.5, and 6.5 times lower respectively than in the controls. When the pentacynium inhalation occurred at 5 minutes, 1 hour, and 4 hours after Pu inhalation, the content of Pu in the same organs was 4.5-6.0, 1.9-2.8, 3.8-5.5 times lower, respectively. Pentacynium inhalation at 24 hours after Pu inhalation resulted in organ contents 1.5-2.3 times lower than the nontreated animals. The use of insignificant quantities of pentacynium (1.8 and 3.6 mg) 40 days after Pu inhalation proved to be ineffective. Intravenous administration of 2.5 mg of pentacynium 30 minutes before Pu inhalation exerted no influence on the isotope content in the lungs and skeleton of treated animals. (Auth)(JTE)

<65>
Masse, R., B. Sedaghat, D. Nolibe, J. Martin, and J. Lafuma, Commissariat a l'Energie Atomique, Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France. 1973

Homeostasis of the Alveolar Macrophage Population. CONF-730570; CEA-CONF-2368; Part of Proceedings of the Congress on Alveolar Macrophages held in Lille, France, May 28-29, 1973, (7 p.). (French)

The counting of the intraalveolar macrophages in the rat using isotopic methods establishes the fact that the population varies with the breed and the sex of the animal and its health. The population varies as a function of these parameters proportionally to the number of cells dividing in the alveolus. Only pathological conditions of alveolar irritation from silica and Pu aerosols, which increase the populations, have varied the percentage of cells in synthesis phase. (tr-auth)

<66>
Mauderly, J.L., J.A. Newhinney, O.G. Raabe, R.G. Cuddihy, D.O. Slauson, and J.J. Miglio, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1974, December

Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide. LF-49; Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 43-47), 384 p.

Techniques and apparatus were developed for the exposure, maintenance, and profile scanning of Shetland-type ponies. Two ponies were exposed to monodisperse aerosols of Yb 169 labeled Pu 238 PuO2. One pony was maintained for 36 days after exposure, but had an abnormal lung which made projections about early distribution and translocation of Pu 238 difficult. The ability to achieve substantial lung burdens of inhaled particulates and to perform meaningful linear profile scans in the pony was demonstrated. (Auth)

<67>
Mays, C.W., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 200-207), 225 p.

The chief initial deposition of Pu 239 is on mineralized bone surfaces. The equation for the dose rate resulting from this type of deposition has been previously derived. However, as time progresses, this initial surface deposition may become buried under new layers of mineralized bone or removed and redeposited diffusely in newly forming bone. Alterations in the deposition pattern change the localized dose rate. In the article the equations for the dose rate in soft tissue are derived for 3 cases of special interest. These are: a) dose rate from a uniformly radioactive plane buried a certain distance in mineralized bone, b) dose rate from a uniformly radioactive volume extending from one distance to another in bone and c) dose rate from a thick uniformly radioactive volume of mineralized bone. A comparison is made of surface deposition versus volume deposition and it is calculated that an endosteal surface deposition of Pu 239 would deliver 6-7 times more dose into the soft tissue lining the bone than would be the case if the Pu were uniformly deposited throughout the volume of the trabeculae. (FMH)

<68>
Metevier, H., G. Rateau, R. Masse, and D. Nolibe, Commissariat a l'Energie Atomique, Centre d'Etudes, Department de Protection, Section de Pathologie et de Toxicologie Experimentales, Bruyeres-le-Chatel, France. 1974, July

A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols. CEA-N-1722; 14 p. (French, English Abstract)

BIOLOGICAL ASPECTS
ANIMALS

<68> CONT.
A system has been developed for the contamination of rats, rabbits, dogs and monkeys by inhalation of Pu 239 oxide aerosols. The contamination enclosure is fitted with an air circulation system, the aerosol generator produces standardized dry aerosols and the aerosol concentration can be regulated. The successive safety devices and the particular restraining of the animals required by the aerosol toxicity are also described. (Auth)

<69>
Mewhinney, J.A., C.H. Hobbs, R.O. McClellan, J.J. Miglio, and D.O. Slauson, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1974, December

Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters. LF-49; Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 145-149), 384 p.

Syrian hamsters have been exposed via inhalation to polydisperse aerosols, or one of three sizes of monodisperse aerosols of Pu 238 PuO2 to achieve 7 levels of initial lung burden in the polydisperse study and 4 levels at each of the three monodisperse studies. Animals were exposed as young adults at 84 days of age. Groups of animals are being maintained for serial secrifice to determine the radiation dose pattern and for lifespan observation to determine dose response relationships. The data show slight translocation of Pu 238 from the lung to liver and skeleton to 256 days post-exposure, confirming the relatively insoluble nature of Pu 238 PuO2 particles. Significant excess mortality has been observed in animals exposed at the higher levels (100-720 nCi achieved initial lung burden) in the polydisperse study. The major pathological finding in animals that have been examined has been radiation pneumonitis and pulmonary fibrosis. No malignant lesions have been observed to date. Observations are continuing on all survivors. (Auth)

Photomicrographs of Pu particles in lung tissue are given showing differences between the monodisperse and polydisperse particles.

<70>
Mewhinney, J.A., C.H. Hobbs, D.O. Slauson, and H.A. Boyd, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1974, December

Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters. LF-49; Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 156-159), 384 p.

Syrian hamsters have been exposed via inhalation to polydisperse or monodisperse aerosols of Am 241 AmO2 to better define the resulting dose response relationships. The data reported are preliminary because the study has been in progress less than 1 year. Animals were exposed to achieve graded initial lung burdens of 240, 60, 15, 3.8, 0.95, 0.24 and 0.029 nCi Am 241 for the polydisperse aerosol and 240, 60, 15, and 3.8 nCi Am 241 for three sizes of monodisperse aerosols (0.75, 1.5 and 3.0 um AD). Animals are being maintained both for serial sacrifice to determine the radiation dose pattern and for lifespan observation to determine dose response relationships. To date only animals with the highest two initial lung burden levels have shown an excess mortality compared with the control groups. The major pathological findings to date in animals that have died has been radiation pneumonitis and pulmonary fibrosis. Observations are continuing on all surviving animals. (Auth)

Photomicrographs of Am 241 particles in lung tissue are given showing differences between the monodisperse and polydisperse particles.

<71>
Mewhinney, J.A., and C.H. Hobbs, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 50-54), 355 p.

Syrian hamsters were exposed to a Cr 51 labeled Pu 239 PuPuO2 aerosol to determine the effectiveness of the gamma emitting tag as an aid in the determination of lung burden of Pu 239 PuO2 during and soon after experimental exposures. Aerosol sampling during this exposure indicated a bimodal particle size distribution with about 25% of the Cr 51 activity associated with particles less than 0.5 um AMAD and of unknown density. The remaining Cr 51 and all Pu 239 activity was associated with particles of 2.0 um AMAD and density of 10.3 gm/cm3. Whole-body retention, initial tissue deposition, and lung retention of the labeled aerosol was consistent with the bimodal particle size distribution. In vitro solubility studies on the reclaimed aerosol particles used in the exposure confirmed the aerosol characterization and animal data regarding the nature of the aerosol. Results of the study indicated that a modification of the techniques and methods was necessary to insure complete incorporation of Cr 51 into the Pu 239 O2 aerosol particles. (Auth)

<72>
Mewhinney, J.A., B.A. Muggenburg, J.J. Miglio, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1974, December

Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures. LF-49; Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 40-42), 384 p.

Lung retention and tissue distribution of inhaled Pu 239 aerosols produced at temperatures of 325, 600, 900 and 1150 degrees C were studied in beagle dogs for 56 days duration. Aerosol characterization showed no differences in activity median aerodynamic diameter, geometric standard deviation or in estimated density among the various treatment temperatures. Lung retention and tissue distribution were

<72>

BIOLOGICAL ASPECTS
ANIMALS

<72> CONT.
determined in 3 animals at each aerosol production temperature and found to be influenced by production temperature. At the lower two temperatures, significant translocation of Pu 239 to liver and skeleton occurred whereas at the higher temperatures, only very small quantities of Pu 239 were found in extrapulmonary tissues. Translocation of Pu 239 from lung to tracheobronchial lymph nodes was not affected by aerosol production temperatures. (Auth)

<73>
Newissen, D.J., and J.H. Rust, University of Chicago, Chicago, IL. 1971

Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine. CONF-710809; Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 252-267), 807 p.

A total of about 1,400 newborn male and female pathogen-free C57 Black/6 mice received either tritiated thymidine subcutaneously at one of the following dose levels: 0.3, 0.4, 0.6, 0.9, and 1.5 uCi/g body weight, or cold thymidine (controls). Due to cannibalism and other causes of early mortality, 759 mice were observed through entire life span up to 1,200 days and were routinely autopsied at death. Microscopic studies of selected tissues were performed on all animals. The overall tumor incidence for pooled control groups was found to exceed 70%. Age-specific incidence rates appear to fit a linear Gompertzian regression up to 750 days of age for all tumors, including thymic lymphosarcomas, lymphomas, leukemias, hepatomas, thyroid and lung adenomas, fibro and osteosarcomas, adenocarcinomas of the GI tract, etc. In groups of animals treated with tritiated thymidine, age-specific incidence rates for all tumors were higher in most instances. It is concluded that tritiated thymidine injected postnatally within a dose range of 0.3 to 1.5 uCi/g significantly increases the overall tumor incidence in C57 Black/6 mice. Furthermore tritiated thymidine appears to initiate a triggering rather than an inducing process in tumor production. (Auth) (RAF)

<74>
Moskalev, Yu.I., Not given. 1963

Actual Problems of the Distribution of Radioisotopes and the Kinetics of their Excretion. STI/PUB/65; Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 287-306), 450 p. (Russian, English Abstract)

The character of the distribution of radioisotopes (Cs, Rb, Sr, Ca, Ba, Ra, Ce, La, Pm, Sb, Te, Pu, Y, Zr, Ru, Nb, Po), depending on the way and rhythm of their administration, the physiological state of the organism and physico-chemical factors were discussed. It was shown that 10 to 18% of some radioisotopes (Cs 137, Nb 95, Zr 95, Y 91, Ru 106, and Ce 144) retained in the lungs when administered by inhalation. Cesium and especially strontium are absorbed from the lungs extremely rapidly, while the absorption of ruthenium, cerium and particularly plutonium is slow. The type of distribution of radioactive isotopes did not depend on the species of the animal, as was sometimes the case with the kinetics of their elimination. The rate of Ce 144 removal from canine and feline liver was exceedingly low, unlike that in rats, mice, guinea pigs and rabbits. The amount of the deposited material and the kinetics of its elimination in case of Sr 90 and Pu 239 were determined by the rhythm and duration of the isotope intake. From the data presented it was observed that the results of experiments with a single injection did not always characterize the kinetics of the accumulation of the isotope in cases of its continuous administration. Chelate compounds (EDTA, hexametaphosphate - HMP), isotope and non-isotope carriers, and the pH of the original solution changed the distribution of hydrolyzed elements (cerium, yttrium) and did not affect the type of distribution of elements that were highly-soluble in water. When the pH of the original solution increased the amount of cerium and yttrium deposition also increased in the organs containing much reticuloendothelial elements (liver, spleen) and decreased in the skeleton and kidneys. The acceleration of the Ce 144 and Y 91 excretion caused by the chelate compounds (EDTA, HMP) was delayed with the increase of the pH of the original solution. (Auth) (JTE)

<75>
Moskalev, Yu.I. (Ed.), Not given. 1964

Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes. AEC-tr-7590; 405 p.

Results of comprehensive experimental research by a team of authors are set forth in the three sections of this book. The first section contains data on the pattern of distribution of radionuclides in different species of animals (rats, rabbits, dogs and large livestock such as pigs, sheep and cattle) as related to rate and route of adminstration. The studies include distinctive distribution features of specific radioisotopes administered by inhalation, kinetics of accumulation and excretion following a single administration and chronic intake of Pu 239, Cs 137 and Sr 90 and patterns of transfer of Sr 90 to offspring in dogs, sheep and cows. Section two contains information on the biological effects of various radioisotopes on different animal species. Studies include data on differences of biological effects of Sr 90 as related to the rate of intake, long-term biological effects of Pu 239, Sr 90, Cs 137, Pm 147 and Nb 95 given to dogs in small doses, descriptions of pathological lesions in acute, subacute and chronic radiation exposure and changes in the composition of peripheral blood at different time intervals after radiation exposure. The third section contains studies on the accelerated excretion of radioisotopes from the organism as well as decreased absorption thereof from the gatsrointestinal tract. The effects of chelating agents and the influence of some dietary components on deposition and excretion of radionuclides are discussed. A bibliography of three-hundred and thirty references is given. Thirteen articles have been entered separately into the data base. (RAF)

<76>
Moskalev, Yu.I., L.A. Buldakov, N.A. Koshurnikova, A.P. Nifatov, and G.N. Reshetov, Not given. 1966

BIOLOGICAL ASPECTS
ANIMALS

<76> CONT.
Combined Effect of Strontium 90, Cerium 144 and Plutonium 239 on the Rat Organism (Report 1). AEC-tr-6944; Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 441-452), 718 p.

The elimination of strontium, cerium and plutonium from the critical organs of rats obeys an exponential law during the period from the 16th until the 918th day of observation, regardless of whether the isotopes were administered singly or in a combination. On combined administration of a pair of isotopes with the same or different nature of distribution in the organism, most of the resulting radiation injuries not only are additive (cerium with plutonium) but also manifest themselves earlier (in most cases for strontium with cerium or strontium with plutonium) given the same or even smaller absorbed radiation doses. The RBE of plutonium compared with beta-emitters differs for different criterions and, moreover, depends on the amounts of isotopes incorporated. (Auth)

Table 2 shows the content of Sr 90, Ce 144, and Pu 239 in the skeleton and liver of rats and the rate of elimination of radioisotopes from the organs. Table 3 shows the LD 50 and occurrence frequency of various symptoms of radiation injury in rats treated with Sr 90, Ce 144 and Pu 239 separately and in combination.

<77>
Moskalev, Yu.I., L.A. Buldakov, N.A. Koshurnikova, A.P. Nifatov, and G.N. Reshetov, Not given. 1966

Combined Effect of Strontium 90, Cerium 144, and Plutonium 239 on the Rat Organism (Report 2). AEC-tr-6944; Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 453-462), 718 p.

Separate and combined administration of Sr 90, Ce 144 and Pu 239 increases the frequency of tumors in experimental rats. Combined administration of pairs of isotopes, compared with their separate administration, magnified the osteosarcomogenic and leukosogenic effect when strontium is administered together with cerium or with plutonium, causes these effects to be additive when cerium is administered together with plutonium, and magnifies the cirrhosogenic effect when cerium is administered together with plutonium. (Auth)

<78>
Moskalev, Yu.I., G.A. Zalikin, and A.I. Semenov, Not given. 1974, June

Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body. Gigiena i Sanitariya, 6, 41-43. (Russian, English Summary)

The kinetics of Cm 244 accumulation in case of chronic subcutaneous introduction of the isotope was studied in experiments performed on rats. The data show that an intensive accumulation of Cm 244 takes place for 32 to 64 days. The amount of isotope accumulated was determined in the liver, kidneys, and other organs; however, in the bone it never attained a balanced level during 256 days of the experiment. The possible reasons for the low Cm 244 deposit in the skeleton in case of chronic introduction of the isotope are discussed. (Auth)

<79>
Moskalev, Yu.I., G.A. Zalikin, R.M. Lyubimova-Gerasimova, I.K. Petrovich, and E.I. Rudnitskaya, Institute of Biophysics, Moscow, USSR. 1974

Kinetics of Exchange and Biological Action of Americium 241 in Dogs. AEC-tr-7571; Radiobiologiya, 14(2), 261-265; Part of Radiobiology, (p. 131-137), 214 p. (Russian, English Abstract)

The influence of toxic doses of americium 241 on dogs was studied. It was established that the basic organs of deposition of the radionuclide are the skeleton, liver, and kidneys. In the acute phase of the lesion, hemorrhagic diathesis is the predominant factor, while in the chronic phase of radiation sickness, the entire symptom complex of somatic effects develops, including leukemia and tumors. (tr-auth)

<80>
Moskalev, Yu.I., G.A. Zalikin, V.N. Strel'tsova, A.I. Semenov, I.K. Petrovich, and E.S. Zhorova, Institute of Biophysics, Moscow, USSR. 1974, August

Biological Action of Californium 252. AEC-tr-7571; Part of Radiobiology, (p. 138-143), 214 p.; Radiobiologiya, 14(2), 266-270. (Russian, English Abstract)

The values of acute, subacute and chronic effective doses of nitrate of Cf 252 injected intravenously to white rats, as well as doses not effective on the average life of animals have been experimentally estimated. Changes in the morphological composition of peripheral blood have been studied and the causes of death of animals analyzed. (ND)

<81>
Huntz, J., and E.S.G. Barron, University of Chicago, Chicago, IL. 1945, April 12

Electrophoretic Analysis of Blood Plasma. CN-2786; Part of Barron, E.S.G., et al, Health Problems Relating to Product for Month of March, 1945, (p. 20-24), 34 p. (Declassified January 18, 1956)

Two dog were injected with plutonium citrate (0.286 mg/kg intravenously or 0.404 mg/kg intramuscularly). The blood plasma was dialyzed and electrophoretic patterns were established with 8 serum components. Although there was no significant change in the concentration of total plasma protein up to 21 days after the intravenous injection there was some increase in the concentration of the second two alpha globulin fractions seven days after injection. Fourteen days after injection, the albumin fraction was considerably lowered; and the second two alpha globulins and the beta globulin-fibrinogen fractions were pronouncedly increased. Twenty-one days after injection, the albumin fraction started to increase; the first two alpha globulins fell markedly; the second two alpha globulins came back to normal; the beta globulins -fibrinogen fractions were still elevated; finally the alpha globulin started to increase. The intramuscularly injected dogs showed no significant changes in the concentration of the various protein fractions. Plutonium was found largely in the beta globulin fraction of the plasma proteins. At no time was there a measurable amount of plutonium in the dialyzable

<81>

BIOLOGICAL ASPECTS
ANIMALS

<81> CONT.
fraction. (RAF)

<82>
Nabors, C.J., Jr., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 365-371), 380 p.

Beagle plasma cortisol was measured by a competitive protein binding technique and plasma corticosterone measured by radioimmunoassay. A group of nineteen control and nine radionuclide bearing dogs studied showed higher steroid levels in female beagles than in males. For male animals, the average amount of cortisol in control animals serum is 2300(S)@ng%@@ng% ng/100 ml. The average corticosterone value is 158 ng % and the average cortisol:corticosterone ratio is 15.5 in control beagles. For female animals, the average control plasma cortisol level is 3450 ng % and the average corticosterone level is 361 ng%. The average cortisol:corticosterone ratio is 10.4, lower than the ratio in males. It also appears that both cortisol and corticosterone blood levels are diminished in radionuclide bearing dogs. (Auth) (PNH)

<83>
Nabors, C.J., Jr., and J.S. Hinckley, University of Utah, College of Medicine, Department of Anatomy, Salt Lake City, UT. 1975

Cortisol Metabolism in Skin of Beagles Bearing Americium 241. Radiation Research, 61, 513-518.

Skin from beagles bearing Am 241 with and without tumors and from controls was studied. All of the irradiated animals received 0.3 uCi/kg of Am 241, IV in a single dose, and were injected in young adulthood at about 17 months of age. Full-thickness skin biopsies were obtained from the backs of the beagles, weighed and minced in iced Krebs phosphate buffer, pH 7.4. An equimolar mixture containing 270 p moles of (C 14) cortisol (15,000 dpm) and (H 3) cortisone (150,000 dpm) was added to each incubation flask. Chromatography and liquid scintillation counting were carried out. The net metabolism of cortisol was calculated by adding (C 14) cortisol metabolites and subtracting the amount of (H 3) cortisone reduced to cortisol in the reverse reaction. It was shown that the metabolism of (4-C 14) cortisol was significantly elevated over controls in both Am 241-injected groups. This metabolic alteration may indicate a radioinduced change in cortisol metabolism by skin from Am 241-injected beagles. (Auth) (PNH)

<84>
Nickson, J.J., University of Chicago, Chicago, IL. 1945, February 12

Health Information Meeting, January 16, 1945. CS-1907; 6 p. (Declassified February 15, 1956)

Results of several experiments were presented at the meeting. For Hanford soils, the data showed that fission products were absorbed very well if the soil was not completely wetted. Data on exposure of animals to Pu smoke showed that in 64 days about one-half of the oxide smoke present in the lungs was eliminated. The half-life of Pu chloride and Pu nitrate smoke, was somewhat less. Distribution of Pu in rats at 256 days showed that for Pu (+3) there was 45% in the skeleton, for Pu(+4) there was 49% and for Pu(+6) there was 44%. Detailed studies were done on a dog, weighing 7.4 kg, injected intravenously with 2600 ug of Pu(+6) nitrate (0.38 ug/g body weight). The excretion studies showed a total of 6.58% of the amount injected was excreted in the urine, with 6.22% being excreted in the first 6 hr. The feces excretion totaled 3.5% for 16 days. Analysis of tissues showed the highest activity in the spleen with approximately 6 ug/g being found. The liver contained approximately 3 ug/g, bronchial lymph nodes had 1.2 ug/g and gall bladder 0.9 ug/g. The deposition in bone and activity of blood were discussed. It was shown that the Pu was deposited primarily beneath the endosteum in the bone marrow. For the proteins studied, the albumin and gamma globulin fractions remained unchanged in total gravity while the alpha and beta globulins altered markedly. A comparison was made between Ra and Pu. In mice, Ra had essentially the same toxic levels as Pu. Radioautographs of the spleen, liver and bones of rats injected with Pu were presented. The blood vessels showed no acitivty while much activity was seen in the spleen nodules. Experiments on mice exposed to fast neutrons were also reported as well as investigations on the CD 50 for P 32 in rats, mice and rabbits. (PNH)

<85>
Nolibe, D., and E.R. (Translator) Appleby, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1973, October 25; 1973, January 8

Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used. BNWL-tr-96; 9 p.; Comptes Rendus Academy of Science, Series D, 276(2), 225-228.

Male and female baboon monkeys, weighing 4 to 6 kg, were exposed to plutonium oxide particles with a mean diameter of 0.5 u by inhalation. Pulmonary lavage was carried out with a sterile solution of sodium chloride. The technique and equipment are described. It was found that in a series of 6 lavages, 85 to 90% of the yield was obtained. Inflammatory reactions were discrete and brief; no infection was observed. Efficiency of the lavage was characterized by comparing radioactivity present in the wash water to the pulmonary burden. There was a good correlation between radioactivity eliminated and number of alveolar histiocytes present in the wash liquid. (LR)

<86>
Not given, Argonne National Laboratory, Argonne, IL. 1973, December

Division of Biological and Medical Research, Annual Report, 1973. ANL-8070; 242 p.

Nine major research programs are underway in the Division of Biological and Medical Research. The programs are: Neutron and Gamma Ray Toxicity Studies, Radiation Toxicity in Dogs, Carcinogenesis, Experimental Radiation Pathology, Aging, Biochemistry, Biophysics, Molecular and Radiation Genetics, and Laboratory Animal

BIOLOGICAL ASPECTS
ANIMALS

<86> CONT.
Facilities. In this report the status of individual studies being carried out under each of these programs are presented along with brief summaries of the overall purposes of the programs. Three articles were selected for separate input into the data base file. (JTE) (CTS)

<87>
Painter, E.E., and E.R. Russell, University of Chicago, Chicago, IL. 1945, May 9

Effect of Plutonium on Dogs. CN-2905; Part of Monthly Health Report on Problems Relating to Product for Month of April, 1945, (p. 10), 29 p. (Declassified December 22, 1952)

On the 54th day following intramuscular injection of plutonium(+6) citrate at a dose of 0.404 mg/kg, dog 38 had lost 14% of its initial weight. Dog 39, injected intravenously, had lost 17% of its initial weight. Food and water consumption were reduced compared to controls. Heart rate, rectal temperature and plasma volume were constant over the last month. The red blood cell count continued to fall in dog 39, but rose in dog 38. The total white blood cell count, and primarily lymphocytes, remained low. Heterophils showed some recovery. Approximately 0.01% of the injected dose was excreted daily in the urine and 0.02 to 0.03% in the feces. (ST)

<88>
Park, J.F., E.B. Howard, and W.J. Bair, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1969

Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs. AFWL-tr-69-75; 61 p.

Beagle dogs 43-47 months old were given a single 15-minute exposure to aerosols of Pu238 PuO2. The count median diameter ranged from 0.04-0.06 um, the mean aerosol concentration ranged from 7-53 uCi/l and the estimated total Pu 238 inhaled ranged from 370-3500 uCi. The mean whole body retention half-time for the alveolar-deposited plutonium was about 800 days. The mean lung retention half-time for the alveolar-deposited plutonium was 290 days. The dogs died or were sacrificed when clinical signs indicated death was imminent 27 to 94 days after exposure. The body burden at death ranged from 44 to 261 uCi with 92 percent of the body burden in the lungs, 3 percent in the tracheobronchial and mediastinal lymph nodes, 3 percent in the skeleton, and 1 percent in the liver. The highest concentration occurred in the tracheobronchial lymph nodes followed in descending order by lungs, mediastinal lymph nodes, liver, and skeleton. Respiratory insufficiency, anorexia, body weight loss, and lymphopenia were the primary clinical signs. Pathology in the lungs consisted of extensive vascular damage, hemorrhage, edema with fibrinous transudate filling many of the alveoli and bronchioles, and localized areas of alveolar septal thickening, emphysema, fibrosis, bronchiolar metaplasia, and neoplasia. There was necrosis of the tracheobronchial and mediastinal lymph nodes with few viable lymphocytes remaining and lymphoid tissue was replaced with proliferating fibroblasts and collagen. The trabecular bone and marrow showed localized areas of necrosis, degeneration, osteoclastic activity, and fibroplasia associated with the plutonium. The biological effects in beagle dogs that inhaled acutely lethal quantities of Pu 238 PuO2 were very similar to the effects observed previously in beagle dogs after inhalation of Pu 239 O2 except lesions in the skeleton were more extensive in the Pu 238 PuO2 exposed dogs. Because of the relatively higher rate of translocation of Pu 238, the long-term toxicity of these two isotopes may differ both quantitatively and qualitatively. (Auth) (FHH)

Table 13 shows comparison of the Pu lung burdens at death in dogs and rats after inhalation of Pu 238 PuO2 and Pu 239 PuO2. Figure 15 shows early epithelial tumor formation in a dog. Several radioautographs showing lymph nodes seventy-six days post-exposure are given.

<89>
Rehfeld, C.E., and F.M. Sorenson, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

Environmental and Radiation Effects on the Dental Health of Beagles. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 43-72), 225 p.

The toxicity and control beagles of the Radiobiology Laboratory have exhibited obvious signs of odontopathy throughout most of the period in which the dogs have been closely observed. Study has revealed that periodontal disease is nearly universal in the dogs under observation and is probably caused by a soft diet and/or lack of dental exercise. Distinct from the periodontal disease is a dental disease, apparently due to the presence of radionuclides, which is characterized by the resorption of the roots of the teeth. The study deals primarily with those dogs having burdens of Ra 226 and Pu 239 and in comparison the percentage of tooth loss due to resorption appears to be greater in dogs having a Ra 226 burden than those having Pu 239. Direct relationships between dose of isotope and tooth resorption mortality and between isotope burden time and tooth resorption mortality were found. No such clear cut relationship was found with periodontal ascribed tooth mortality when compared with isotope levels, though a direct relationship between age and periodontal disease losses had been previously shown to exist. (Auth.)

<90>
Retherford, J.C., A.L. Brooks, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission PRoduct Inhalation Program, October 1, 1971 through September 30, 1972, (p. 61-64), 355 p.

Forty-eight Chinese hamsters were intravenously injected with monodisperse 0.3 um Pu 239 PuO2 particles labeled with Cr 51. Twenty-four animals were injected at each activity level of 2 x 10(E-3) and 6 x 10(E-5) uCi Pu 239/gm body weight. Four animals at each activity level were sacrificed at 0, 2, 4, 8, 16 and 32 days post-injection. The Pu 239 was avidly retained with a slight decrease by 32 days to 94% of the initial

<90>

BIOLOGICAL ASPECTS
ANIMALS

<90> CONT.
activity. At all sacrifice times, the liver, spleen and remaining carcass contained about 90%, 2.0% and 8.0% respectively, of the sacrifice body burden. The activity per gram of tissue was about equal for the liver and spleen, indicating equal competence of the reticuloendothelial system in these two organs and an equal dose commitment. These studies will serve as a basis for average and local dose calculation in future pathological and cytogenetic studies using monodispersed Pu 239 PuO2 particles. (Auth)

<91>
Rhoades, R., University of Chicago, Chicago, IL. 1945, March 14

Histological Effects of Product on Mice. CN-2740; Part of Monthly Health Report on Problems Relating to Product for Period Ending February 15, 1945, (p. 7), 16 p. (Declassified January 2, 1952)

The histological effects of Pu, 1.25 ug/g body weight, administered intravenously to ABC mice are reported. The effect on the spleen was the elimination of erythropoiesis between the 10 and 19 day post-injection intervals followed by a return of red cell formation in increasing amounts, until at 42 days most of the organ consisted of closely packed erythroblasts. As the red pulp became depleted of erythropoiesis, the size of the spleen diminished. However, as function was regained, the organ returned to normal size. The lymph nodes were also examined superficially. (FMM)

<92>
Rosenthal, M.W., Agronne National Laboratory, Argonne, IL. 1956, August

The Use of Zirconium and Other Carriers in the Removal of Radioelements from the Body. Comments on the Use of Complexing Agents. ANL-5584; Part of Rosenthal, M.W. (Ed.), Therapy of Radioelement Poisoning, Transcription of a Meeting on Experimental and Clinical Approaches to the Treatment of Poisoning by Radioactive Substances held in Lemont, Illinois, October 20-21, 1955, (p. 100-113), 175 p.

The carrier concept of radioelement removal using studies on the distribution of plutonium and yttrium as affected by zirconium and other hydrolyzable metal carriers is reviewed. The effect of carriers, such as zirconium citrate is on the circulating radionuclide. Reduction of bone deposition is accomplished by the excretion of the blood radionuclide rather than removal of that already deposited in bone. Thus, carriers are effective only if used immediately following contamination. There is no evidence of significant reduction of body burden by carriers if the radionuclide is already deposited in the bone. Studies on the use of other metal carriers and complexing agents are also discussed. (ST)

<93>
Rosenthal, M.W., H. Brown, D.L. Chladek, E.S. Moretti, J.J. Russell, and A. Lindenbaum, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1973

Removal of Plutonium from Mouse Liver by Glucan and DTPA. Radiation Research. 53, 102-114.

Glucan from yeast is additive with DTPA (diethylenetriaminepentaacetic acid) in removal of polymeric plutonium 239 from the mouse liver. At 47 days after administration of plutonium, the net removal was 8.5% of the injected dose by glucan alone, 115% by twice-weekly DTPA treatments, and 19.5% by combined therapy. A 60 mg/kg dose of glucan, given intravenously, was equally effective when given (a) in a single injection, (b) divided into three daily injections, (c) given 5 days or 3 hr before plutonium, or (d) 5 days after plutonium. A 15 mg/kg dose of glucan was almost as effective as higher doses (30-120 mg/kg). Hepatic plutonium removed by glucan was excreted in the urine in the presence of DTPA, or was apparently translocated to the skeleton without DTPA. As shown earlier for monomeric plutonium in the mouse, liver deposits of polymeric plutonium are excreted primarily through the feces, both with and without DTPA, and skeletal deposits removed by DTPA are excreted through the urine. Twice-weekly injections of 100 or 500 mg/kg of DTPA are equally effective in removal of polymeric plutonium from mouse bone and liver, also confirming results with monomeric plutonium. (Auth)

<94>
Rosenthal, M.W., and A. Lindenbaum, Argonne National Laboratory, Argonne, IL. 1967, December

Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice. ANL-7409; Part of Biological and Medical Research Division Annual Report, 1967, (p. 180), 300 p.

The long-term effects of ungraded, midrange polymeric plutonium (about 66% ultrafilterable) and of monomeric plutonium (93% ultrafilterable) intravenously injected into mice are compared, using the bone burden of plutonium 15 days after injection as the basis of reference. Two levels of polymeric plutonium in the total skeleton (0.015 and 0.0087 uCi) and three of monomeric plutonium (0.025, 0.012, and 0.0058 uCi) were compared, the lower levels in each case resulting from DTPA therapy. Extrapolation of the results, to enable comparison of the effects of equal amounts of plutonium in the bone, showed that mice injected with monomeric plutonium, compared to those injected with polymeric plutonium (a) had at least twice as high an incidence of osteosarcomas (twice as many mice with tumors and more tumors per mouse); (b) died with osteosarcomas at approximately the same rate after the latent period; and (c) survived approximately as long. Differences in the microdistribution of the plutonium on bone surfaces and in marrow are considered primarily responsible for these differences; other possible factors are also discussed. (Auth) (Complete Text)

See also CONF-670938, Part of Mays, C.W., et al (Eds.), Proceedings of a Symposium on Delayed Effects of Bone-Seeking Radionuclides, (p. 371-386), 1969.

<95>
Rosenthal, M.W., A. Lindenbaum, D.W. Baxter, G.S. Kalesperis, E.S. Moretti, and J.J. Russell, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1975, August

Removal of Polymeric Plutonium from Dogs with DTPA and Glucan. Radiation Research, 63(2), 253-261.

BIOLOGICAL ASPECTS
ANIMALS

<95> CONT.
A highly polymeric preparation of plutonium 239 was injected intravenously into five groups of adult beagle dogs. An untreated control group was killed at 6 days after injection. The four treated groups, killed at 90 days, received one of the following by intravenous injection: (a) 15 mg/kg of glucan on days 6, 34, and 62; (b) 100 mg/kg of the calcium chelate of DTPA, twice weekly for 12 wk, beginning on day 6; (c) both of these treatments; or (d) saline. Between days 6 and 90, the amount of plutonium in the liver decreased from 92.2 to 85.6% of the injected dose (ID) after saline, to 81.6% after glucan, to 77.8% after DTPA, and to 71.0% after both glucan and DTPA. The decrease to 71.0%, an approximately additive effect, was statistically significant. In dogs treated with either saline or glucan, the plutonium levels of the bones and the soft tissues other than the liver were higher than those in animals treated with DTPA. The 90-day excretion of plutonium in feces was low in all groups (3.3% ID, or less), while urinary plutonium was 3.5% ID after saline, 4.0% after glucan, 13.4% after DTPA, and 21.1% after glucan plus DTPA. These results confirm in dogs, as previously determined in mice, the action of glucan as an adjunct to DTPA in removal of polymeric plutonium from the liver. (Auth)

Table 1 shows the distribution of polymeric Pu in the dog as affected by DTPA and glucan therapy initiated 6 days after Pu injection

<96>
Rosenthal, M.W., Y.E. Rahman, E.S. Moretti, and E.A. Cerny, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1975, August

Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation. Radiation Research, 63(2), 262-274.

DTPA (diethylenetriaminepentaacetic acid) encapsulated within lipid spherules (liposomes) removed more plutonium (Pu) from the liver and femurs of mice (80-100 days old and weighing 25 to 27.5 g) injected with polymeric Pu than conventional nonencapsulated DTPA. A single intravenous injection, 3 days after Pu 239 injection, of 100 mg/kg of the calcium trisodium salt of DTPA encapsulated in liposomes made with phosphatidylcholine and cholesterol (3:1) reduced the Pu in liver to 43-51% of the control level at 10 days, compared to 60% after injection of nonencapsulated DTPA. It reduced the Pu in the femurs to 60.4-62.5% of the control level, compared to 83-113%. Liposomal DTPA was equally effective when given intraperitoneally, or when stored for 3 days before use. Liposomal DTPA at doses as low as 25 mg/kg was not significantly less effective than a higher dose of 100 mg/kg. Four once-weekly injections of liposomal DTPA continued to give improved removal of Pu compared to conventional DTPA. When given 24 days after Pu, liposomal DTPA had a greater advantage over nonencapsulated DTPA in the liver than at 3 days, and removed 22% of the Pu from the femurs, compared to no removal by the nonencapsulated form. DTPA liposomes made with lipids other than phosphatidylcholine and cholesterol, or with different surface charges, thus far offer no advantage for Pu removal. (Auth)

Tables 1 and 2 give the removal of Pu from liver and skeleton.

<97>
Rudnitskaya, E.I., and Yu.I. Moskalev, Not given. 1974, April

Somatic Effects in the Action of Americium 241 on Animals. Gigiena i Sanitariya, 4, 46-50. (Russian)

Death in dogs following acute injury from 0.05 to 0.01 uCi/g doses of AmCl3 is due to an agranulocyte syndrome. With subacute and chronic doses of Am 241 in dogs (in 100% of the cases), cirrhosis of the liver developeded with portal hypertension. Acute and chronic radiation sickness showed cardiovascular insufficiency symptoms. Neoplasias develop, at different times, in 50% of the cases. The microgeometry of Am 241 dispersion in the liver, medullary regions of the kidneys, and hematogenic organs differed in the formation of dense "stars" which played an important role in the development of remote sequelae. (Auth) (Translation)

<98>
Ruhmann, A.G., and D.L. Berliner, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1964, September 30

Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs. COO-119-231; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 85-98), 172 p.

Serum lactic dehydrogenase (LDH) determinations were performed on 101 beagles from a colony used in the study of long range effects of internally deposited radionuclides, namely Th 228, Ra 224, Ra 226, Ra 228, Sr 90 and Pu 239, all of which had been injected intravenously as a single dose of varying levels of radioactivity. Statistical analysis of results revealed no significant differences among groups separated by radioisotope injected, number of days elapsed since nuclide injected, and disease state. Sera from moderately hemolyzed blood samples were significantly higher in LDH level than sera from nonhemolyzed or slightly hemolyzed blood samples. Dogs who received high doses of radionuclides had blood LDH levels significantly higher than those of control dogs. It is concluded that serum LDH is not a consistent indicator of pathologic states in the adult beagle dog. (Auth) (FNM)

<99>
Ruhmann, A.G., and D.L. Berliner, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake, City, UT. 1965

Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides. Radiation Research, 26, 287-294.

Serum lactic dehydrogenase determinations, performed on 110 beagles from a colony used in the study of long-term effects of internally deposited radionuclides, including Th 288, Ra 224, Ra 228, Ra 226, Sr 90 and Pu 239 revealed a mean LDH level of 22.8 units. Dogs receiving high doses of radiation had blood LDH levels significantly higher than those of control dogs. Animals having osteogenic sarcomas and other pathologic states had normal LDH levels. Statistical analysis revealed no significant differences

<99>

BIOLOGICAL ASPECTS
ANIMALS

<99> CONT.
among groups separated by radioisotope or time elapsed after nuclide was injected. Sera from moderately hemolyzed samples were significantly higher in LDH level than sera from nonhemolyzed of slightly hemolyzed blood samples. It is concluded that serum LDH level is correlated with level of internal irradiation but is not a consistent indicator of pathologic states in irradiated dogs. (Auth)

<100>
Russell, E.R., H. Delaney, and E. Hotta, University of Chicago, Chicago, IL. 1945, April 12

Effects of Product Upon Dogs. CN-2786; Part of Barron, E.S.G., et al, Health Problems Relating to Product for Month of March, 1945, (p. 18-20), 34 p. (Declassified January 18, 1956)

One dog (No. 38) received 2.963 mg of product as plus six citrate intramuscularly. The dose corresponded to 0.404 mg Pu per kilo body weight. The second dog (No. 39) was injected intravenously with 1.630 mg of product as plus six citrate in 0.615 ml. This dose corresponded to 0.286 mg Pu per kilo body weight. These dogs were compared with dog No. 33 which received a dose of 0.36 mg/k of Pu(+6) nitrate intravenously. Dog No. 38 excreted 236 ug or 7.95 percent of the injected dose. The total Pu excreted per day decreased rapidly, falling to approximately 0.015 percent of the injected doses at the end of sixteen days. At the end of 24 days the daily urinary excretion was still between 0.01 and 0.015 percent. The total urinary excretion at 16 days in dog 38 was 9.54, in dog 39 was 14.01 and in dog 33 was 6.76% of the injected dose. During comparable 10 day periods total excretion (urinary and fecal) was 15.3% for dog 38, 24.4% for dog 39 and 10.0% for dog 33. In view of the greater excretion, dogs 38 and 39 received a smaller dose of irradiation than did dog 33. The concentration of product in the blood and its distribution between plasma and cells is given. It was found that the rate of removal from blood was greatest with 6+ nitrate administered intravenously, less with +6 citrate administered intravenously and least with 6+ citrate administered intramuscularly. In view of the high initial concentration in the blood and high early excretion in the intramuscularly injected dog, absorption from the muscle must have been rapid. (FHM)

<101>
Sanders, C.L., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1976

Effects of Transuranics on Pulmonary Lymph Nodes of Rodents. BNWL-SA-5056; CONF-740930; Part of Radiation and the Lymphatic System, Proceedings of the 14th Annual Hanford Biology Symposium held in Richland, Washington, September 30-October 2, 1974, (p. 225-229), 258 p.

Pulmonary lymph nodes have been suggested as the "critical" tissue for insoluble, inhaled transuranic compounds owing to the high concentration of transuranics in these lymph nodes. About 800 female Spraque-Dawley or Wistar SPF rats of approximately seventy days of age were given from 0.2 to 3600 nCi of Pu 238 PuO2 or Pu 239 PuO2 by inhalation, intratracheal instillation, intrapleural injection, or intraperitoneal injection. From about 1 to 10% of deposited plutonium was translocated to pulmonary lymph nodes, the amount depending on the time after deposition and the route of administration; Pu 239 PuO2 was cleared from pulmonary lymph nodes faster than Pu 239 PuO2 owing to the greater in vivo solubility of Pu 239 PuO2. No primary tumors of pulmonary lymph nodes were observed, indicating that this tissue was not the critical tissue for carcinogenic induction. (Auth)

Table 1 shows the retention of Pu in pulmonary lymph nodes after administration of PuO2. Table 2 shows the induction of tumors in rodents by Pu compounds.

<102>
Sanders, C.L., and D.H. Meier, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973

Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats. Health Physics, 25, 405-411.

The influence of fasting on the efficacy of DTPA in enhancing the excretion of intraperitoneally injected Pu 238 in female, albino rats was examined. In untreated rats, the Pu 238 was rapidly cleared from the abdominal cavity into the blood. The liver burden increased to 15% of injected dose by the 10th day, falling to about 3% by the 35th day after injection. About 45% of injected dose was found in the skeleton after the first day; about 12% of the injected dose was excreted in the urine and 27% in the feces during the first 29 days after injection. Complete fasting for 10 days had no significant effect on the cumulative excretion of injected Pu 238. In animals given DTPA within the first hour after Pu 238 there was a 2.2-fold increased excretion, and a 1.4-fold increased excretion when DTPA administration was started at 14 days after Pu 238 injection, irrespective of fasting. It was concluded that the distribution of Pu 238 bound to ligands in extracellular fluids and bone, was not significantly altered by fasting so as to influence the chelation of Pu 239 by DTPA. (Auth)

Table 2 shows the distribution of injected Pu 238 in tissues of rats 30 days after injection.

<103>
Sanders, C.L., Jr., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1974, December

Rat Mammary Neoplasia Following Deposition of Plutonium. Health Physics, 27, 592-593. (U.S. Atomic Energy Commission)

Groups of 24-38 Sprague-Dawley CD rats were exposed to an aerosol of Pu 238 or given an intraperitoneal injection of either Pu 238 PuO2 or Pu 239 PuO2 particles at 65-80 days of age. Groups of 19-28 Wistar SPF rats were given either an intratracheal instillation of 30 nCi Pu 239 PuO2 in 0.5 physiological saline alone, or given an intrapleural injection of 800 nCi Pu 239 PuO2 or 0.5 mg 1.3 um diameter latex beads suspended in 0.5 ml physiological saline. The count median diameter of PuO2 ranged from 0.1 to 0.2 um. The pelt and skeleton from most rats, and selected mammary tumors, were analyzed for plutonium contents. Hematoxylin and eosin stained sections of all mammary tumors were examined and classified as either mammary fibroadenoma or adenocarcinoma. The plutonium content of pelt increased with increasing amounts of deposited plutonium,

BIOLOGICAL ASPECTS
ANIMALS

<103> CONT.
irrespective of chemical form or route of administration. From 25 to 70% of the terminal body burdens of Pu for rats given intraperitoneal Pu 238 PuO2 or inhaled Pu 238 was found in the skeleton, as compared to only a few per cent in the skeleton following Pu 239 PuO2 administration. Mammary tumors had sometimes taken up a large fraction of inhaled or injected Pu 238, amounting to as much as 25% of the terminal body burden in individual animals with tumors weighing several hundred grams. No differences were seen in plutonium contents of fibroadenomas and adenocarcinomas. Much greater amounts of Pu 238 were found in mammary tumors following Pu 239 PuO2 injection than of Pu 239 following Pu 239 PuO2 injection due probable to the greater in vivo solubility of Pu 238 PuO2. Incidence of mammary fibroadenoma in all groups was not significantly greater than that seen in untreated controls. The incidence of mammary adenocarcinoma was significantly greater than controls only for rats given an intraperitoneal injection of 3600 nCi of Pu 238 PuO2. It was concluded that deposition of <1 mCi Pu/kg body weight in female rats did not result in an increased incidence of mammary tumors irrespective of the method of plutonium administration or the solubility of the plutonium compound. (FMM)

<104>
Sansom, B.F., Agricultural Research Council, Institute for Research on Animal Diseases, Department of Functional Pathology, Compton, Newbury, Berkshire, England. 1964

The Transfer of Plutonium 239 from the Diet of a Cow to Its Milk. British Veterinary Journal, 120, 158-161.

The possibility that Pu 239 might be dispersed over limited areas of the countryside by a nuclear explosion or reactor accident suggested that some estimate ought to be made of the extent to which this nuclide is transferred from the diet of a cow to its milk. The most probable form in which Pu would occur is as the finely divided oxide, of extremely low solubility. The amount of Pu in this form transferred to milk was expected to be extremely small and possibly difficult to detect So the transfer of soluble Pu (as Pu 239 Cl4) from diet to milk was also investigated. A solution containing 48 mg Pu 239 or 74.8 mg Pu as PuO2 of particle size less than 3 u was administered to two mature lactating Ayrshire x Redpoll cows. The radioactivity found in milk, feces, and urine samples from both experiments was compared with a standard prepared directly from a known sample of the PuCl4. The concentrations of Pu found in the milk samples from the two cows, expressed as a percentage of the dose per liter, are shown. Maximum milk concentrations of Pu were reached on the 2nd and 4th day, 163 and 2.44% dose/1 x 10(E+6) respectively, after feeding PuCl4 and PuO2. The concentration of Pu in urine was about 1000 times that in milk, and the total excretion in seven days was approximately 0.2% of the dose in both cows. Within the limits of accuracy of the simple counting method used for feces samples, essentially all of the Pu administered in both experiments was recovered in the feces. The observed Pu levels in milk may have been due to fecal contamination. (FMM)

Table 1 shows Pu appearing in milk after oral dosing with PuCl4 and PuO2.

<105>
Schlenker, R.A., and J.H. Marshall, Argonne National Laboratory, Center for Human Radiobiology, Argonne, IL. 1974

Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle. ANL-75-3 (Part 2); Part of Radiological and Environmental Research Division Annual Report, July 1973 through June 1974, (p. 73-81), 231 p.

The thickness of the deposit of Pu 239 at endosteal bone surface in a beagle dog, 90 days after injection of monomeric Pu 239, was measured by solid state alpha spectrometry. A preliminary measurement was also made of the thickness of the Ra 226 deposit at endosteal surface of beagle bone 5 hr after injection. For Pu 239 the maximum thickness was found to be < 0.2 um and for Ra 226 the maximum thickness was 6.5 um. If Pu 239 is deposited in uniform concentration to a depth of 0.2 um or less, then the rate of escape of alpha-particle energy from the bone surface is overestimated by 2% or less when the deposit is assumed to be infinitesimally thick. For Ra 224, uniformly deposited to a depth of 5 um, the overestimate is 23 to 32%, depending on the assumption made about daughter product retention, when the deposit is assumed to be infinitesimally thick. (Auth)

<106>
Schubert, J., M.P. Finkel, M.R. White, and G.M. Hirsch, Argonne National Laboratory, Argonne, IL. 1949, May 19

Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration. AECD-2651; 12 p. (Declassified July 19, 1949)

Eighteen Sprague-Dawley female rats, weighing between 236 and 254 g each received an intravenous injection via the tail vein of a 1% sodium citrate solution containing both Pu 239 and Y 91. Each animal received 0.4 ml of the solution. This contained 24.3 ug of Pu 239 (+4) - 1.7 x 10(E+6) cpm and 0.3 uc of Y 91(+3) -4 x 10(E+3) cpm. The animals were sacrificed at 5, 15, 30 and 60 min. and at 2, 6, 12, 24 and 48 hours later. Blood, bone and liver were removed for analysis. It was shown that 5 min after IV injection, about 50% of the Pu and about 80% of the Y had disappeared from the blood, and an appreciable fraction was already deposited in the liver and skeleton. Twelve hours after administration about 20% of the injected dose of Pu was still in circulation, while the Y level had fallen to 0.7%. The Pu content of the skeleton increased regularly until a maximum value of about 45% of the injected dose was reached at 24 hr.; while in 6 hr the Y concentration was near its peak at 45%. After the initial rapid increase of the Pu and Y levels in the liver, the level of Pu continued to rise at a diminished rate until it reached 24% of the injected dose at 48 hr. However, the Y level decreased very slowly after the second hr when the maximum level of close to 10% was attained. It has been shown that the rate of removal of colloids from the circulating blood is related to particle size. In the experiment, fractions of Pu and Y disappeared very slowly, t 1/2=8 and 7 hr respectively. The rate constant determined from the graph for the skeletal uptake of the radionuclide was 1.3 for Pu and 3.6 for Y, thus it was estimated that the diffusion velocity of Y into bone was 7 times greater than that for Pu. (FMM)

<106>

BIOLOGICAL ASPECTS
ANIMALS

<106> CONT.
Figure 2 shows Pu 239 content of blood, liver, and skeleton of rats as a function of time after intravenous injection. See also article in the Journal of Biological Chemistry, 182, 635-642, (1950).

<107>
Sevc, J., Not given. 1969, March

Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust. Pracovni Lekarstvi, 21(2), 49-55. (Czechoslovakian, English Abstract)

The combined effects of fibroplastic dust and alpha emitters in white mice were investigated in two experimental series; repeatedly and in single experiment. Administration of dust was carried out by cristoballit by IV injection in doses of 3.0 mg. As alpha emitter, Pu 239 was used in colloid form of plutonium nitrate by IV injection in doses of 0.005 uCi to 3.0 uCi as well. Three months later the inhibitory effect of the alpha emitter on production of collagenous proteins was proven. The effect of the alpha emitter does not depend on the presence of silicotic fibrosis, however its inhibitory effect on collagen formation in the animals' liver was proven even without the administration of fibroplastic dust. By investigation of incorporation C 14 proline in the collagenous and noncollagenous proteins the increased degradation of the soluble form of hydroxyproline as well as the decreased synthesis of soluble hydroxyproline and proline was proven. The decreased incorporation of C 14 in noncollagenous proteins indicated that synthesis of noncollagenous proteins was inhibited as well and that the changes observed were caused by unspecific effect of the alpha emitter on protein synthesis. The simultaneous effect of fibroplastic dust and the alpha emitter is enabled by cumulation of the alpha emitter in fibrotic modules. It may be presumed (for which arguments are presented), that the changes observed are caused by the effect of the alpha emitter, i.e., in the case of collagenous proteins to fibroblast. Evidence is presented of speeded maturation of collagens in vivo in silicosis. (Auth)

<108>
Shubik, V.M., A.V. Fedorova, and V.V. Borisova, Leningrad Scientific Research Insitute of Radiation Hygiene, Leningrad, USSR. 1973

Early Changes in Certain Immunolcgical Indices in the Case of Plutonium 239 Lesion of Experimental Animals. AEC-tr-7430; Part of Radiobiology, (p. 161-166); Radiobiologiya, 13(1), 119-123.

A study was made on the changes of immunological indices on male white rats when Pu 239 was given orally (20 uCi) or injected intravenously (2 uCi). The indices studied were bactericidal properties, titer of complement and blood lysoxyme, formation of complement-fixing auto-antibodies in liver and bone marrow. During the first week after incorporation of Pu source stimulation of auto-antibodies was observed, in the case of oral administration, the changes were weak and statistically insignificant. After intravenous injection of Pu, by the end of the experiment a significant elevation of the lysozyme titer and a decrease in the production of auto-antitodies were observed. In general, less pronounced changes were observed in the case of oral administration of Pu. The peculiarities of the distribution of formation of the dose in the case of the two modes of Pu administration are thought to determine the differences in the changes in the immunological responses. (RAP)

<109>
Smith, D.D., National Environmental Research Center, Monitoring Systems Research and Development Laboratory, Las Vegas, NV. 1975, June

Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 125-135), 504 p.

A status report on the initial stages of a grazing study initiated in May, 1973, in Area 13 of the Nevada Test Site (NTS) was presented. The accomplishments included the quarterly collection of ingesta samples from fistulated steers, the quarterly sacrifice and sampling of a goat, the semiannual sacrifice and sampling of selected adult and young cattle, and the quarterly determination of digestibility of range plants. Dietary habits were tabulated with favored plant species being: two grasses, Indian ricegrass and galleta; two shrubs, winter fat and four-winged saltbush; and one forb, Russian thistle. Other analytical data are not yet available. The primary objective of this study is to determine the uptake and distribution of plutonium by ruminants maintained in an actual contaminated area. (Auth) (JTE)

This is a preliminary report. There was no data given on plutonium.

<110>
Smith, J.M., R.D. Lloyd, D.R. Atherton, and C.W. Mays, University of Utah, College of Medicine, Radiobiology Division, Salt Lake City, UT. 1976

The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice. CONF-751043; Part of Jee, W.S.S. (Ed.), The Health Effects of Plutonium and Radium, Proceedings of a Symposium held in Sun Valley, Idaho, October 6-9, 1975. J.W. Press, Salt Lake City, Utah, (p. 7-20), 802 p.

The early metabolism of monomeric Pu may depend upon its in vivo concentration, since in higher concentrations it may polymerize forming radiocolloids and be subject to phagocytosis. The early biological behavior of Pu 237(+4) and Pu 239(+4), administered by intraperitoneal injection in citrate solution into C57BL/Do mice, was compared with the in vivo concentrations of these two nuclides differing by a factor of 10(E+5). Plutonium 237 was also used as a gamma-ray tracer of the alpha-emitting Pu 239 in order to determine the latter's biological retention and tissue distribution. The results showed no significant difference in the metabolism of the two nuclides throughout a 91 day serial sacrifice schedule. However, there was a significant sex dependence in the total body retention of Pu primarily due to a factor of 2.7 greater quantity of Pu excreted by the female during the first 24 hours post-injection. Furthermore, the half-time for removal of Pu from the livers of males was 42.7 plus or minus 5.5 days and from livers of females 29.0 plus or minus 2.7

BIOLOGICAL ASPECTS
ANIMALS

<110> CONT.
days. (Auth)

Plutonium distribution tables for various tissues, and retention tables are given.

<111>
Smith, V.H., J.E. Ballou, W.J. Clarke, and R.C. Thompson, Hanford Laboratories, Biology Laboratory, Richland, WA. 1961

Effectiveness of DTPA in Removing Plutonium from the Pig. Proceedings of the Society for Experimental Biology and Medicine, 107, 120-123.

Experiments were done to measure the effectiveness of DTPA when administration promptly following plutonium injection, and when administered after a long interval following plutonium injection. In the prompt treatment experiment 6 miniature swine weighing from 40 to 60 kg were injected intravenously with 25 uc of Pu 239, administered as the tetravalent citrate complex in pH 5 solution. One hour later, 3 of the animals were injected intravenously with 40 ml of a pH 7 solution containing 9 g of the calcium trisodium salt of DTPA. In the delayed treatment experiment two 15 month males weighing 62 and 75 kg, injected 2 months previously with approximately 175 uc of plutonium (+4) citrate, were given 5 consecutive daily intravenous injections of CaNa3 DTPA, one gram the first day and 2 g on each of the succeeding 4 days. Excreta were collected daily in both experiments; daily blood samples were obtained only in the delayed treatment experiment. All animals were sacrificed 6 or 7 days following treatment. Complete tissue analyses were performed on animals from the prompt treatment experiment. The results show that a single intravenous dose of DTPA one hour after plutonium administered resulted in excretion of approximately 90% of the plutonium. As compared with untreated controls, retention of plutonium in the skeleton was reduced by a factor of 10 and retention in the liver was reduced by a factor of 30. Two pigs treated with 5 consecutive daily injections of DTPA excreted 11 and 19% of the plutonium injected 60 days prior to treatment. (Auth) (PMM)

Table 2 shows the effect of a single prompt dose of DTPA on the retention of Pu by tissues of swine.

<112>
Smith, V.H., J.L. Palotay, H.A. Ragan, and B.J. McClanahan, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1966, January

Ingestion of Plutonium Oxide Particles by Swine. BNWL-280; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1965, (p. 40-43), 139 p.

The absorption in swine of ingested particulate, refractory Pu 238 PuO2 is less than 10(E-6) of the dose. No gross pathologic changes were noted from 1 Ci of Pu 238 PuO2 except in one pig where particles became entrapped in the intestinal wall. Passage time for this material was as long as 14 days. (Auth)

Figures 1 and 2 show relative amounts of Pu present in feces, blood and urine versus time post ingestion. Table 1 shows the Pu 238 content of tissues of a pig 14 days post ingestion.

<113>
Snyder, R.H., B. Lawrence, and R.D. Finkle, University of Chicago, Chicago, IL. 1948, July 24

An Apparatus for Maintaining a Slow and Constant Rate of Injection. CN-3542; MDDC-270; 10 p. (Declassified August 29, 1946)

A machine is described which delivers 0.1 ml of solution per hour at a constant rate. The device proved satisfactory for the injection of a Pu solution into the veins of rats. The results of a preliminary trial with three rats suggest that the rate of injection may be a significant factor in the metabolism of Pu. Three rats were given Pu from the same stock bottle but by the rapid method. The rate was equal to or greater than 5.5 x 10(E-6) curies/hr. The liver from the animals sacrificed on the fourth day contained 10.2% of the dose. The Pu used in this tests was manufactured by Hanford rather than the Clinton Engineer Works as in earlier tests. The pH on earlier test was 2. These considerations, as well as the very few animals involved, severely limit the conclusion that a slow rate of administration will yield a minimum uptake or retention of Pu by the liver. (HP)

<114>
Stanley, R.E., E.W. Bretthauer, and W.W. Sutton, National Environmental Research Center, Las Vegas, NV. 1975, June

Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 97-124), 504 p.

The results of tissue uptake in Holstein dairy cows following oral plutonium administration were presented. Two groups of lactating cows were given oral doses of plutonium. Treatment aliquots were placed in gelatin capsules and administered by use of a balling gun. Group 1 cows received an acute treatment of 3 mCi of plutonium citrate per animal while Group 2 cows received 1 mCi plutonium dioxide per animal per day for 19 consecutive days. Samples of blood, milk, urine, and feces were taken during and after dosing, while tissue samples were collected at necropsy; 93 days post-treatment for Group 1, and 42 and 73 days post-treatment for Group 2. The major portion of plutonium activity (approximately 96% in Group 1 and slightly less than 100% in Group 2) was excreted in the feces. However, recovered activity in urine and milk of both groups confirmed the bovine gastrointestinal uptake and transport of this radionuclide. In both groups the total deposition of plutonium was greatest in bone, liver, and skeletal muscle. The liver and bone tissues of cows from Group 1, sacrificed at 93 days post-treatment retained approximately 3.5 x 10(E-3) and 2.4 x 10(E-2)% of the oral dose, respectively. In Group 2 the liver and bone of cows sacrificed at 42 days post-treatment retained approximately 5.4 x 10(E-4) and 3.1 x 10(E-3)% of the dose respectively. Cows from Group 2 sacrificed at 73 days post-treatment showed approximate dose retention percentages of 6.0 x 10(E-4) in the liver and 3.2 x 10(E-3) in bone tissue. Skeletal muscle activity closely approximated the liver activity in some cases, but was based on a

<114>

BIOLOGICAL ASPECTS
ANIMALS

<114> CONT.
much greater mass of tissue. The duodenum and other portions of the small intestine had fairly high concentrations, but unabsorbed plutonium may have contributed to these values. Skin activity values for the plutonium citrate treated animals ranged from 0.2 to 0.4 pCi/g, while values ranging from 5.3 x 10(E-2)% to 3.8 pCi/g were noted for animals that received the dioxide doses. Lymph node activity values ranging from 7.6 x 10(E-1) to 3.3 x 10(E-2) pCi/g confirmed the lymphatic uptake of plutonium following the oral dioxide doses. Plutonium activity in bile at the time of sacrifice ranged from nondetectable to 5.6 x 10(E-1) pCi/g when samples from both groups were compared. Marrow samples from the femurs of the two plutonium dioxide dosed animals that were sacrificed at 73 days post-treatment had concentrations of 0.091 and 0.021 pCi/g. This corresponded to the activity levels of 0.90 and 0.98 pCi/g, respectively observed in the mineralized portion of the bones. Mean blood serum plutonium concentrations reached a peak of 0.94 pCi/g on treatment day 13, while the mean peak formed element activity, 0.36 pCi/g, was reached on day 18, plutonium activity was also observed in the kidneys, spleen, cardiac muscle, rumen and abomasum, and was transported across the bovine placenta. The fetal tissue concentration, excluding placenta and fetal fluid, was in excess of 1.7 x 10(E-6)% of the oral adult dose for the fetus in the plutonium citrate group, and approximately 1.8 x 10(E-5)% of dose for the fetus collected from the plutonium dioxide treated animal. (Auth) (JTE)

Table 4 lists the approximate percentage of oral plutonium dose retained in selected bovine tissues at the time of sacrifice. Appendix 1 contains a tabular summary of the analysis of necropsy tissues from mature Holstein dairy cows sacrificed at 42 and 73 days following ingestion of 19 mCi plutonium 238 dioxide per animal.

<115>
Stannard, J.N., University of Rochester, School of Medicine and Dentistry, Rochester, NY. 1975, April 1

Toxicity of the Transuranium Elements with Special Emphasis on Plutonium. HASL-291; Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-19 - I-37), 227 p.

Biological effects of the transuranic elements reside primarily in their emission of alpha particles during radioactive decay. A component of chemical toxicity cannot be excluded categorically but is difficult to demonstrate independent of radiation effects. The information on plutonium exceeds by far that for the other transuranics and much must be inferred by analogy from plutonium to the others. But there are significant differences in metabolic behavior among the nuclides and thus in the relative importance of effects in different organ systems, particularly in the relative involvement of soft tissues. The transplutonics seem in general to be more mobile and thus more likely to irradiate soft tissues instead of bone. At the low doses of interest in radiation protection, the chief concern is the development of cancer. For many years interest focused primarily on bone cancer in the case of plutonium but it now appears that the risk of cancer may be almost equally divided between lung, liver, and bone under certain conditions. This may be even more likely with the transplutonics. In the case of the "hot particle" controversy current biological data do not support the idea that there is an overwhelming larger chance of lung cancer around a "hot particle." The chance of long-term genetic effects from deposition of transuranics in higher animals has usually been considered negligible However it cannot be ignored completely until the accumulated information on gonadal content has been fully analyzed and preferably some actual experiments completed. (Auth)

Table 1 shows relative risk of selected radionuclides including U 233, Pu 239, Am 241, and Pu 241. Table 2 shows toxicity of selected nuclides (including Am 241, Pu 239 and Cm 244) in rats.

<116>
Stevens, W., and D.L. Berliner, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1963, March 31

Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs. COO-227; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 221), 231 p.

Serum transaminases (glutamic-oxaloacetic and glutamic-pyruvic transaminase) have been shown to be sensitive indicators of tissue damage in humans, dogs, and other animals. Serum transaminase levels, particularly serum glutamic-pyruvic transaminase (SGPT), can be used to detect early active liver damage before any abnormality is shown by other liver function tests. In general, the extent of the rise reflects the severity and extent of hepatocellular damage. Serum transaminase levels were measured in a group of normal non-injected beagles as well as in dogs burdened with Pu 239. The injected doses of Pu 239 range from 0.016 uCi/kg to 2.8 uCi/kg and burden times span a period of 12 to 120 months. The normal mean for serum glutamic oxaloacetic transaminase (SGOT) is 18 Sigma-Frankel units/ml and the normal mean for SGPT is 22 units/ml. A significant number of the Pu 239 burdened animals had elevated SGPT values and a few of the dogs had elevated SGOT values. Two animals, each injected with 2.8 uCi Pu 239/kg and burden times of 24 months had greatly elevated SGPT values. These findings will be related to radiation induced liver necrosis and to the distribution of Pu 239 in these dogs. (Complete Text)

<117>
Stevens, W., and D.L. Berliner, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1964, March 31

Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239. COO-119-229; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 93-110), 209 p.

Serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) were measured in beagles injected with Pu 239 in dose levels ranging from 0.0157 uc/kg (P 1.0) to 2.91 uc/kg (P 5.0). A significant difference in SGPT between males and females of the uninjected control group was demonstrated (28.7 plus or minus 11.1 and 22.1 plus or minus 8.95 units respectively). There was no difference

BIOLOGICAL ASPECTS
ANIMALS

<117> CONT.
between the SGOT values of males and females. There was a correlation between the injected dose of Pu 239 and the per cent of SGOT and SGPT measurements that were elevated. Four per cent of the SGOT measurements were elevated in the control group, 13% in the group injected with 0.0157 uc/kg and 22% in the group injected with 0.04774 uc/kg. Two per cent of the SGPT measurements were elevated in the control group and 31% and 46% were elevated in the two groups injected as above. Two dogs which had been injected with 2.91 mc/kg and 2.72 uc/kg were measured. Both dogs showed elevated values for both SGOT and SGPT with the former showing a very high SGPT value of 600 units at 28 months post injection. The increase in SGOT and SGPT in Pu burdened dogs was attributed to the deposition of the Pu 239 in the livers of these animals. (Auth) (JTE)

See also Radiation Research, 23, 420-429 (1964).

<118>
Stevens, W., F.W. Bruenger, and E.J. Stover, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1968

In Vivo Studies on the Interactions of Plutonium(+4) with Blood Constituents. Radiation Research, 33, 490-500.

The distribution of PU(+4) in blood plasma of beagles was determined as a function of time after injection of Pu(+4) in a citrate buffer solution. The plasma was subjected to gel filtration on G100-G200 columns. Significant amounts of Pu(+4) were found in the regions of low-molecular-weight proteins as well as in the molecular weight range of small molecules or ions. The amount of PuIV bound to protein increased during the first few hours after injection, reached a maximum at about 7 hours, and then decreased steadily. Concomitantly the Pu(+4) found in the region of low-molecular-weight compounds decreased continuously from 5 minutes to 30 days. The decrease in the amount of PuIV in the region of low-molecular-weight compounds occurred more rapidly than did the decrease in PuIV associated with low-molecular-weight proteins. The proteins that bound Pu(+4) were identified as transferrin and albumin. These protein-Pu(+4) complexes were separated by ion-exchange chromatography. Their identity was confirmed by electrophoresis and by Fe 59 labeling. The amount of Pu(+4) bound by transferrin greatly exceeded the amount bound by albumin. (Auth)

<119>
Stevens, W., F.W. Bruenger, and E.J. Stover, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1965

In Vitro Studies of the Interactions of Plutonium(+4) with Blood Proteins. Radiation Research, 26, 114-123.

The binding of Pu(+4) to bovine albumin, canine alpha, beta, and gamma-globulin, and blood cells and plasma proteins of beagle hounds was studied in vitro. Basically, all those roteins tested are capable of interacting with Pu(+4) in vitro. Blood cells exibited a low affinity for Pu(+4). There was no penetration of Pu(+4) through cell membranes, although isolated hemoglobin was albe to bind Pu(+4). In plasma, Pu(+4) was associated primarily with the low-molecular-weight proteins consisting of albumin and a globuin, and to a lesser extent with constituents having a molecular weight greater than 200,000. (Auth)

<120>
Stevens, W., B.J. Stover, D.R. Atherton, and F.W. Bruenger, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT; University of North Carolina, Department of Pharmacology, Chapel Hill, NC. 1975, April

Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle. Health Physics, 28, 387-394.

The early retention and distribution of Pu 239 in the beagle were compared following intravenous administration of Pu 239(+4) (0.9 uCi/kg) as the transferrin complex (Pu-Tf), as a plutonium complex in citrate buffer (Pu citrate) of pH 3.5 and as a particulate Pu(+4) in colloidal form (Pu-P). The early distribution and retention of Pu(+4) at 14 days after injection of Pu-citrate and Pu-transferrin were indistinguishable. There was a difference in urinary excretion patterns. Deposition, microdistribution and retention after administration of a suspension of particulate Pu(+4) differed greatly from those seen in dogs injected with true solutions of plutonium. After injection of Pu-Tf or Pu citrate the nuclide was cleared from circulation at a slow rate. Approximately 30% was deposited in the liver, approximately 50% in the skeleton and approximately 2% in other soft tissues. Pu-P left the circulation at a very fast rate, approximately 70% was deposited in the liver, with only 2% in the bone and approximately 24% in other soft tissue. Only an insignificant fraction of the injected Pu-P was excreted. In the liver, the microdistribution after injection of Pu-Tf and Pu citrate was uniform and Pu(+4) was associated first with soluble protein and later transferred to subcellular liver particles. After injection of Pu-P the microdistribution was heterogeneous; most of the Pu(+4) was located in reticuloendothelial cells and little was associated with soluble proteins. After injection of Pu citrate and Pu-Tf, Pu(+4) was found on bone surfaces, whereas after injection of Pu-P, the small amount of Pu(+4) present was located exclusively in macrophages of the bone marrow. (Auth)

<121>
Stover, B.J., D.R. Atherton, F.W. Bruenger, D.S. Buster, and E. Holt, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 215-220), 225 p.

In comparing the biological behavior of Pu 239 and essentially carrier-free Th 228 in adult beagles some interesting diffferences were observed. The question arose as to whether the observed differences resulted from chemical differences in the two radionuclides or whether they resulted from the differences in amounts injected. To investigate this question three dogs were injected with Th 228 to which varying amounts of long-lived thorium (Th 232) had been

<121>

BIOLOGICAL ASPECTS
ANIMALS

<121> CONT.
added, the doses being 40, 4 and 0.4 mg Th. A significant difference in the relative deposition in the soft tissues and the skeleton was observed. The results suggest that the differences in beagle metabolism of Pu 239 and Th 228 do not result from the difference in the number of atoms. (Auth)

<122>
Stover, B.J., and W.S.S. Jee, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1963

Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone. Health Physics, 9, 267-275.

Comparison of selected skeletal samples from healthy adult beagles and beagles given about 3 uc Pu 239/kg several years prior to sacrifice showed significant differences in relative water, organic and inorganic contents but not in the relative amounts of calcium and phosphate in bone mineral. These differences correlate with histological and microradiographic observations of changes in cellularity, hypo- and hypermineralization, and loss of osseous tissue. A few changes in relative bone composition with age were observed. (Auth)

<123>
Strel'tsova, V.N., Not given. 1961

Comparative Morphology of Chronic Radioisotope Injury. AEC-tr-7512; Part of Lebedinskii, A.V. and Moskalev, Yu.I. (Eds.), Distribution, Biological Effects, and Migration of Radioactive Isotopes, (p. 317-331), 408 p.

The data summarizes 518 cases of chronic radiation sickness in rats (462), rabbits (46) and dogs (10), given single parenteral (intravenous, less often into the abdominal cavity) injections of different doses (from 0.01 to 15 uCi/g) or Y 90, Y 91, Sr 90, Sr 89, Sr 89, 90, Ba 140, Pu 239, Ce 144, Pr 147, La 140, Cs 137, Ru 106 and Nb 95. The animals died after the 200th day. It was observed that chronic radiation injury by radioisotopes proceeds in the form of: a) tumor pathology with various localization of the process; b) systemic hyperplastic-tumor lesion to hemopoietic organs--leukemia; c) vascular pathology of the polyarteritis nodosa type; and death, not due to tumors, is induced, also progressive emaciation with concomitant nonspecific infection. The expression of the above forms of chronic radiation injury is related to the type of distribution and dosage of administered emitter. Intake of skeletal and hepatic emitters in doses of 0.1-2 uCi/gram is associated with development of osteosarcoma. Hepatic emitters, in doses of 0.5-2 uCi/gram (for long-lived beta emitters), 6-15 uCi/gram (for short-lived beta emitters), and 1.125 x 10(E-3) uCi/gram for alpha emitters (plutonium 239) induce cirrhosis and tumors of the liver, and tumors of endocrine glands. Uniformly distributed radioisotopes (cesium 137, niobium 95) induce malignant neoplasms of the gastrointestinal tract in some animals. Leukemia is induced by all emitters. The incidence and time of development of tumors are related to administered dosage of isotopes. The latency period for osteosarcoma (6-10 months) is shorter than for tumors of the intestine, mammary gland, endocrine glands, and leukemia (12-13 months). (Auth) (FHM)

<124>
Swinth, K.L., B.I. Griffin, and J.F. Park, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1965

Whole Body Counting of Plutonium in Dogs. BNWL-SA-11; 12 p.

Thin NaI(Tl) scintillation counters were used for the assessment of body burdens in dogs exposed to Pu 239 aerosol. Experiments were made with both a dog phantom and live dogs. The count rate was affected by changes in dog size, isotopic composition of the plutonium, and by plutonium distribution in the body. A 50% change in dog weight made a change of a factor of two in counting efficiency in some experiments. The sensitivity for a typical dog when counting the x-rays emitted is 2.1 cpm/nCi and 14.0 cpm/nCi when counting both x-rays and 60 keV gamma rays. This sensitivity is based on burdens determined by post-mortem alpha-counting analysis of the tissues of several dogs. To date, 30 exposed dogs have been counted which had body burdens ranging from 0.12 to 2.9 uCi. (Auth)

<125>
Thomas, R.G., Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 55-60), 355 p.

A Pu 239 PuO2 aerosol was labeled with Cr 51 to enable in vivo measurements of initial deposition and early retention following inhalation exposure. A collection foil from a Lovelace Aerosol Particle Separator run was used as the source material for three suspensions of monodisperse Cr 51-labeled particles administered by intramuscular injection into the hind leg of Syrian hamsters and rats. Two animals from each species and three dummies were injected at each particle size (median diameters of approximately 1.0, 0.4, and 0.1 um). A suspension was also made from the back-up filter from an inhalation run with a median diameter of approximately 0.5 um, and a portion of this was injected as with the other suspensions. Animals and dummies were periodically whole-body counted for Cr 51; all animals were sacrificed on day 41. Tissue analyses were done for Cr 51 and for Pu 239. The ratio of radionuclides in the injection site was compared to that in the dummies and although it varied between particle size groups it was consistent within groups. The results indicate that Cr 51 is a good label for Pu 239 PuO2, as long as certain precautions are taken in delivery of aerosol to the animal. (Auth)

<126>
Tregubenko, I.P., Not given. 1966

Inhalation of Plutonium by Rats. AEC-tr-7169; Part of Metabolism of Radioisotopes in the Animal Organism, (p. 124-136).

A solution of Pu (No3)4 in HNO3, containing 4.48 g of Pu/l (280 mCi/l) was diffused in a chamber for inhalation by albino rats, weighing 160 plus or minus 2.92 g.

BIOLOGICAL ASPECTS
ANIMALS

<126> CONT.
Inhalation was administered for 30 minutes. The animals were sacrificed immediately after inhalation and over a period of 32 days: 1, 2, 4, 8, 16, and 32 days after inhalation. The tissues were assayed for radioactivity and the results are given in a table. In rats sacrificed immediately after inhalation about 35% of the inhaled Pu was found in the GI tract. This initial quantity was excreted with feces in the first few days. During the 32 days, about 70% of the inhaled dose of Pu passed through the GI tract of the animals. The skeleton and liver were the main targets of incorporation of Pu. Plutonium aerosol is 25% retained in the respiratory tract. Plutonium reabsorption from the lungs makes up 20% of the quantity initially retained in the respiratory tract. From the toxicological point of view inhalation is the most dangerous means of access into the organism, because of the relatively high degree of reabsorption from the lungs and predominant deposition of the reabsorbed share in the skeleton. (FMM)

Table 1 shows Pu content of rat organs at different intervals following inhalation. Table 2 shows the relative distribution of Pu in the main target organs as related to different means of administration in the organism.

<127>
Tregubenko, I.P., and D.I. Semenov, Not given. 1966

Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism. AEC-tr-7169; Part of Metabolism of Radioisotopes in the Animal Organism, (p. 205-209).

A study was made of the effect of one or two complexing agents (EDTA, sodium hexametaphosphate (HMP) combined with diuretics (diuretin, methylcaffeine, mercuzal) as well as with epinephrine on the behavior of yttrium, cerium and plutonium in rats. Statistically reliable differences were established between the action of EDTA and HMP. Administration of both together has a lesser effect than EDTA alone. Diuretics do not affect the behavior in the organism of yttrium, cerium, and plutonium or excretion thereof. When combined with EDTA methylcaffeine inhibits increase in deposition of cerium in the bones, which is typical for EDTA alone. Mercuzal combined with HMP somewhat increases plutonium deposition in the liver. Epinephrine alone or in combinations with EDTA and HMP mildly increases deposition of yttrium in the liver. The lack of response to diuretics with respect to excretion of yttrium, cerium and plutonium indicates that these elements are not subject to reabsorption in the renal tubules. (Auth)

<128>
Tseveleva, I.A., G.S. Mushkacheva, T.N. Rysina, A.G. Surina, and V.V. Kreslov, Not given. 1971

Mechanisms of Development of Plutonium Pneumosclerosis. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 371-380), 574 p.

Rabbits weighing 2-3 kg were administered with ammonium plutonium-pentacarbonate in a 12% solution of ammonium carbonate by single inhalation. One group received 1.5 uCi Pu 239 (average) and the second received an average of 5 uCi. In animals with a dose of 1.5 uCi, the content of lipids in the lungs was increased after a day up to 133% and by the end of 30 days had attained a maximum value of 180%. In rabbits with a dose of 5 uCi, two weeks of inhalation raised the level to 185% of the control level; by three months it had decreased somewhat, but remained high six months after inhalation. In rabbits receiving a high Pu dose there was an increase in the hydroxyproline level which was up to 143-148% of the control after two to four months. The content of mucopolysaccharides increased in both groups. Investigation of the level of total nitrogen of hexosamine and sialic acids revealed a change in the content of these substances which occurred parallel with the change in the dynamics of weight of the lungs. The relationship between radiation dose and cell damage is discussed. (FMM)

<129>
Twente, J.A., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31; 1960

The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone. COO-220; Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 224-225), 225 p.; Radiation Research, 12, 480-481.

The localized concentration of Pu 239 associated with different histological structures has been measured by microdensitometric analysis of quantitative autoradiograms. The data have been obtained for lumbar vertebrae taken from eighteen dogs sacrificed from 1 to 2059 days after injection of 3.0 uCi Pu 239/kg. There is considerable variation in the actual concentration of Pu 239 associated with any histological structure. The average amount of Pu 239 associated with the endosteal surface of trabecular bone is from 4 to 6 times greater than the average haversian system deposit, from 2 to 4 times greater than the average periosteal deposit, about 2.5 times greater than the average periosteal deposit, about 2.5 times greater than that deposited diffusely in bone formed after injection, and from 1 to 2 times less than punctate spots in the marrow, presumably macrophages. The average endosteal Pu 239 concentration (measured in 6 dogs sacrificed from 3 to 28 days after injection) ranges from 1.25 to 1.40 x 10(E-5) uuCi/u2. This concentration decreases to 0.9 to 1.1 x 10(E-5) uuCi/u2 during the first year after injection and remains relatively constant thereafter. The average dose rate to soft tissue within alpha range of this deposit is 47 to 53 rads per day during the first month after injection and between 32 to 40 rads per day at times greater than one year after injection. The localized dose rate delivered by this deposit does not differ significantly between dogs dying with clinically recognized tumors and dogs dying the same number of days of other causes. (Auth)(Complete Text)

<130>
Twente, J.A., E.G. Butler, and W.S.S. Jee, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1960, March 31

The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs. COO-220; Part of Dougherty, T.F., Research in

<130>

BIOLOGICAL ASPECTS
ANIMALS

<130> CONT.
Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 168-196), 225 p.

The Pu239 concentration associated with various histological structures in the lumbar vertebral centra was measured by microdensitometric analysis of quantitative autoradiograms. The report includes the data obtained on dogs injected with about 3 uCi of Pu 239 per kilogram. The changes in the localized distribution of Pu 239 with increasing time after injection are presented. The concentration associated with the trabecular surface, periosteal surface, and post injection bone is calculated to be about 1.2 x 10(E-5) uCi/u(E+2), 0.3 x 10(E-5) uCi/u(E+2), and 0.09 x 10(E-6) uCi/u(E+3) during the first year after injection. The average dose rate delivered to soft tissue within alpha range of these depcsitions is respectively 46, 12 and 1.9 rads per day. (Auth)

Table 3 shows Pu 239 concentration on periosteal surfaces and average dose rate to cells within alpha range. Table 4 shows Pu 239 concentration in bone formed after injection and the average dose rate to marrow within alpha range.

<131>
Volf, V., Kernforschungszentrum Karlsruhe, Institut fur Strahlenbiologie, Karlsruhe, German Federal Republic. 1975, July

The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat. Health Physics, 29, 61-68.

The effect of direct injection of chelating agents into simulated puncture wounds contaminated with Pu 239 nitrate was investigated. Male albino rats (180-205 g) were injected intramuscularly with 0.5 uCi Pu 239 in 10 ul 3 n HNO3 and treated 1 hr (prompt treatment) or 21 days (delayed treatment) later with single or combined chelates. The ability to stimulate absorption of Pu 239 from the injection site decreases in the order: Desferrioxamine (DFOA) greater than calcium diethylenetriaminepentaacetate (DTPA) much greater than disodium dipicolinate greater than trisodium citrate. Substantially better results were obtained by simultaneous adminstration of mixtures of DTPA + dipicolinate, DTPA + DFOA, DFOA + citrate, and DTPA + citrate, all showing virtually the same effectiveness. The retention pattern of Pu 239 translocated from the wound into body organs after chelation therapy was considered as a measure of the complex stability in vivo. Greatest reduction in the skeleton and liver was achieved by DTPA and by its combination with DFOA or citrate. On the other hand, the Pu 239 transferred from the injection site showed increased proportional deposition in the kidneys by DFOA, in the skeleton by dipicolinate and in the liver and skeleton by citrate. Combinations of DTPA with tartrate, lactate, pyruvate or chinolinate as well as those of citrate with dipicolinate or chinolinate were equally or less effective than DTPA or DFOA alone. Hyaluronidase did not influence the effectiveness of treatment. Up to about 90% of Pu 239 could be removed from the injection site by treatment 1 hr after administration and up to about 30% 3 weeks later. Practical implications of these findings were discussed. (Auth)(FNM)

Table 1 shows effects of early treatment with chelates on distribution of Pu 239 in rats.

<132>
Wilson, R.H., and J.L. Terry, University of Rochester, Rochester, NY. 1965, June 28

Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations. UR-665; 47 p.

Operation Roller Coaster was a joint United States-United Kingdom field exercise undertaken to aid in the evaluation of criteria for the storage and transport of plutonium-bearing weapons. The biological studies performed as a part of the operation consisted of exposing 84 dogs, 84 burros, and 132 sheep to the cloud resulting from the nonnuclear detonation of a plutonium-bearing weapon. Immediately after cloud passage, the exposed animals were recovered and decontaminated, and serial sacrifices according to a 3 year schedule were initiated. Autopsies were performed on all sacrificed animals, and tissues were taken for radiochemical analysis, autoradiography, and pathology. In addition, some exposed animals were followed for Pu excretion. The deposition and retention of Pu in the animals as a result of breathing from the passing cloud were determined and the Pu collected by the breathing animals was compared with that collected by air samplers located with the animals. The first evidence of animal exposure was obtained by alpha survey of the wagons as they returned to the Rad-Safe area. Findings were highly variable, as was to be expected in making field measurements of alpha contamination. Measurements were made with a PAC-3G, and the highest values found on each of the wagons ranged from 450 cpm to 8,000 cpm. The findings of the air sampling program are summarized qualitatively only. Subsequent reports will present results and interpretations. (FNM)

<133>
Yelkina, N.I., and Z.B. Tokarskaya, Not given. 1963, July 2

The Problem of Liver Pathochemistry After Injury with Plutonium 239. JPRS-19995; 8 p.; Voprosy Meditsinskoi Khimii, 9(2), 154-160.

In this laboratory study a solution of Pu nitrate was intravenously injected into 46 rabbits and 28 mongrel dogs. At certain periods post-injection the animals were sacrificed and blood was analyzed for serum protein fractions, total protein, alkaline phosphatase activity and activity of the transaminases. Urea production was studied in liver sections. Pre-cirrhotic changes were noted in the rabbits after three to six months. Between six and eight-months after the injection the rabbits died and cirrhosis of the liver was found in 77.5% of the cases. In only one dog was cirrhosis of the liver found 420 days after the injection. Total protein contents were reduced by 11% after 180 days in rabbits and 15% after 420 days in the dogs. This was caused mainly by a reduction in the albumin of 14% after 180 days in the rabbits and 29% after 420 days in the dogs. A disorder of serum albumin synthesis was said to be the first sign of hepatic deficiency. The second change was a gradual increase in the activity of serum transaminases. The maximum glutamic-alanine transaminase and glutamic-aspartic transaminase activities were noted after 420 days and had increased by 5 and 1.6 times,

BIOLOGICAL ASPECTS
ANIMALS

<133> CONT.
respectively. This was accompanied by major fluctuations in urea production which finally resulted in a reduction of 30% in the rabbits and 75% in the day which develcped cirrhosis. Alkaline phosphatase activity in the serum of the dogs remained normal except for an increase noted after 360 days in the animal which developed cirrhosis. (JTE)

<134>
Barth, J., National Environmental Research Center, Las Vegas, NV. 1975, June

The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastroimtestinal Fluids. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 137-149), 504 p.

Rumen contents of cattle grazing on plutonium-contaminated desert vegetation were incubated in simulated bovine gastrointestinal fluids to study the alimentary solubility of plutonium. Trials were run during November, 1973, and during February, May, July, and August, 1974. During the May and July trials, a large increase in plutonium solubility accompanied by a marked reduction in plutonium concentration of the rumen contents was observed concurrently with a reduction in intake of EUROTIA LANATA and an increase in the intake of ORYZOPSIS HYMENOIDES or SITANION JUBATUM. However, during the November, February, and August trials, comparatively high concentration of plutonium, but low plutonium solubility, was associated with high levels of EUROTIA LANATA in the rumen contents. Plutonium 238 was generally more soluble than plutonium 239 in these fluids. Ratios of the percentage of soluble plutonium 238 to the percentage of soluble plutonium 239 varied from 1:1 to 18:1 on a radioactivity basis. (Auth)

<135>
Blaylock, B.G., and J.P. Witherspoon, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN. 1975

Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle. CONF-750662; IAEA-SM-198; STI/PUB/406; Part of Proceedings of a Symposium on the Radiological Impacts of Releases from Nuclear Facilities into Aquatic Environments held in Otaniemi, Finland, June 30-July 4, 1975, (18 p.) 524 p.

The radiation dose received by aquatic biota from different nuclear processes and the major dose-contributing radionuclides, and the impact of the estimated doses on aquatic biota have been determined. Dose estimates are made by using radionuclide concentration measured in the liquid effluents of representative facilities. Where measurements of concentrations are not available, predicted radioactive releases to the aquatic environment are used for dose calculations. Although radioactive releases from reactors used to generate electrical energy have received the most attention, and are the best documented, this evaluation indicates the potential for a greater radiation dose to aquatic biota from the nuclear fuel supply facilities (i.e., mining and milling). The effects of chronic low-level radiation on aquatic organisms are discussed from somatic and genetic viewpoints. Based on the body of radiobiological evidence accumulated up to the present time, no significant deleterious effects are predicted for populations of aquatic organisms exposed to the estimated dose rates resulting from routine releases from conversion, enrichment, fabrication, reactors and reprocessing facilities. At the doses estimated for milling and mining operations it would be difficult to detect radiation effects on aquatic populations; however the significance of such radiation exposures to aquatic populations cannot be fully evaluated without further research on effects of chronic low-level radiation. (Auth) (ND)

Tables on estimated radionuclide doses to aquatic organisms from nuclear facilities are included. See also Nuclear Safety, 17(3), 351-361 (1976).

<136>
Jacobson, L.O., K.S. Cole, J.J. Nickson, and E. Lorenz, University of Chicago, Chicago, IL. 1945, September 8

Report of Health Activities for Month of August, 1945. CN-3130; 8 p. (Declassified December 22, 1952)

Abstracts are presented for work performed durine the month at the laboratory involving clinical medicine and medical research, biological research section, medical industrial hazards and health physics, the National Cancer Institute studies, and metabolic studies of plutonium. The clinical medicine performs physical examinations and laboratory tests on employees along with other research projects. In the biological research section, work is continuing along several lines in increasing the efficiency of aerosol production in small chambers. Analyses are being completed on an intubation experiment on the effect of citrate on absorption of Pu from the lungs. Citrate is not a satisfactory therapeutic agent, merely succeeding in transferring Pu from lungs to the skeleton. Mice have been injected with doses of 0.05, 0.125, 0.5 and 1.0 ug of Pu/g of body weight and results of blood studies are reported. Most work in medical industrial hazards and health physics section is devoted to developing a method for determining the amount of Pu in large amounts of urine from project personnel. Human tissue containing 2 dpm can now be analyzed for Pu content with 90% recovery. Monitoring of results for personnel and facilities are reported. National Health Institute studies on x and Gamma radiation effects are continuing. In metabolic studies of plutonium, additional radioautographic evidence substantiates the view that plutonium is accumulated principally in the osteoid matrix. Human excretory studies, complete through the 87th day show the elimination rate of Pu averages 0.005% per day. Fecal and urimary excretion is greater in rats. Decrease in surface alpha activity in rats can be effected by decalcification and recalcification of bone. Metabolism of plutonium in plants is described in another report. (BBM)

<137>
Not given, Argonne National Laboratory, Argonne, IL. 1967, December

Biological and Medical Research Division, Annual

<137>

BIOLOGICAL ASPECTS
ANIMALS

<137> CONT.
Report, 1967. ANL-7409; 300 p.

Research activities are reported in the following areas of investigation: biophysical studies of molecular interactions, radiation effects on cultured cells, and factors affecting radiosensitivity; analysis of radiation effects on cells at the biochemical level, and the biosynthesis of macromolecules; biosynthesis and activity of enzymes in various pathways and the effects of ionizing radiation on these phenomena; preparation, detection, analysis, and effects of radioisotopes in tracer studies; investigations of biochemical activities at the ultrastructural level in cells; effects of hormones on phototrophic mechanisms in plants; gravity compensation studies in irradiated and nonirradiated plants; studies in mammalian genetics and the effects of radiation on genetic patterns; microbial genetics and mutagenesis in microbial populations; radiobiological and biochemical studies of developmental phenomena among amphibia and insects; biochemical, biophysical and radiobiological studies of the mechanisms of carcinogenesis in organisms; analysis of phenomena affording protection to tissues against radiation, including endogenous mechanisms; cellular and somatic effects of ionizing radiation on organisms, including factors affecting radiosensitivity and repair mechanisms; studies relating to the medical status of laboratory animals; theoretical studies in cellular and animal biology; radiation dosimetry studies; toxicity and metabolism of radioisotopes in beagle dogs; physiological and medical status of the beagle dog colony; and monitoring of radioisotope content of selected environments. A list of 116 publications is included as well as an author index to the research reports. (ERB)

<138>
Stather, J.W., National Radiological Protection Board, Harwell, England. 1974, October

The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat. NRPB-R31; Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 4-35), 127 p.

The metabolism of the transportable fraction of both 'soluble' and 'insoluble' forms of plutonium following their deposition in the respiratory system of the rat by either inhalation or pulmonary intubation has been investigated. The results have shown that following the deposition in lung of various chemical forms of plutonium (nitrate, citrate, oxalate, dioxide, DTPA complex) the activity deposited in extrapulmonary tissues at one week varied considerably with the chemical form of the plutonium. After one week the amount in extrapulmonary tissue was 69% of the initial pulmonary deposit of plutonium citrate, while for plutonium dioxide the corresponding value was 0.074%. Absorption of both plutonium nitrate and citrate from the pulmonary region was approximately four times greater than from either the tracheobronchial or nasopharyngeal regions. About 13% of the activity entering the blood during the first week after pulmonary administration of plutonium nitrate, citrate or oxide, was retained in the liver at 7 days implying that plutonium was circulating in the blood in a 'monomeric" form. The cumulative excretion of plutonium in the urine in the same period was equivalent to about 4.5% of the total activity transferred to tissues from the blood. The experimental results suggested that this value could be used for calculating the total tissue content from urinary excretion measurements. This study also demonstrated that mixed aerosols of plutonium dioxide and sodium oxide more easily translocated from the lung to blood than aerosols of plutonium dioxide. A maximum transportability was reached at a Pu:Na atomic ratio of about 1:20, when the transportable fraction of plutonium was 45 times that from a plutonium dioxide aerosol alone. (Auth)

Table 6 shows the tissue distribution and cumulative excretion of Pu one week after pulmonary intubation in various chemical form.

<139>
Woodhead, D.S., Ministry of Agriculture, Fisheries and Food, Fisheries Radiobiological Laboratory, Lowestoft, Suffolk, United Kingdom. 1974

The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences. CONF-740529; STI/PUB/375; IAEA-SM-184/11; Part of Proceedings of a Symposium on Population Dose Evaluation and Standards for Man and His Environment held in Portoroz, Yugoslavia, May 20-24, 1974, (p. 555-575), 646 p.

The disposal of radioactive waste into coastal waters, rivers and lakes may produce localized conditions in which fish experience radiation dose rates in excess of that from the natural background. Reasonably realistic estimates of these dose rates may be obtained by combining data on the levels of radioactivity in the water, sediments and fish with simple dosimetry models. Where the dose rates are sufficiently high it has been possible to provide confirmation of the estimates, using in situ thermoluminescent dosimeters. A knowledge of the radiation regime, together with information on the effects of irradiation on fish, provides a basis for assessing the consequences for fish populations in contaminated environments. (Auth)

Tables on natural and discharged radioactivity in freshwater and seawater are presented.

<140>
Arnold, J.S., Argonne National Laboratory, Chicago, IL. 1951

Progress Report: Radioautography. ANL-4625; Part of Brues, A.M. (Ed.), Division of Biological and Medical Research Quarterly Report, February, March, April, 1951, (p. 72-84), 229 p.

The status of radioautographic studies of the deposition of calcium 45, radium, and plutonium 239 in bones of rats, mice, and dogs is given. Calcium 45 appears to be deposited in bones of rats in 5 ways: (1) diffuse, uniform, and light deposition in all bone both cortical and trabecular, (2) concentrated deposition in areas where bone growth is occurring, (3) concentrated in areas of epiphyseal cartilage, (4) concentrated around blood nutrient vessels in cortical bone, and (5) moderate concentration above diffuse light deposition in bone recently formed prior to injection. Calcium of the plasma (extracellular fluid) appears

BIOLOGICAL ASPECTS
ANIMALS

<140> CONT.
to be exchanging continually with that of bone. In radioautographs of a biopsy specimen from the metaphyseal areas of the femur of a dog 24 hours after IV injection, radium was deposited in 2 ways: (1) diffuse, uniform, light deposition in both cortical and trabecular bone, and (2) highly localized concentrations. Perivascular deposition of radium in dog bone resembled that of Ca 45 in the rat. The distribution of radium in the amputated lower leg of a patient who, 25 years previously received an unknown amount of radium, is underway. The distribution in the patient is very different from the initial distribution in the dog. Plutonium 239 is at no time diffusely deposited in the bone. Its initial distribution in the rat, mouse, and dog is restricted to endosteal, periosteal, perivascular, and epiphyseal concentrations. It is concentrated in macrophages of the bone marrow and its effect on hematopoietic cells is evident. (JTE)

<141>
Bair, W.J., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1970, December

Toxicology of Inhaled Plutonium. CONF-700816 (Vol. 2); Part of First, M.W. and Morgan, J.M., Jr. (Eds.), Proceedings of the 11th AEC Air Cleaning Conference held in Richland, Washington August 31-September 3, 1970 (p. 697-720) 869 p.

A 14 yr study of the inhalation of Pu compounds by beagles was reported. It was demonstrated that Pu particles could be concentrated into "hot spots" by macrophages and epithelial cells. The maximum whole body retention (half times of 3440 days) occurred in beagles which inhaled an oxide prepared by heating Pu metal to 450 degree C, the least (half times of 200 days) occurred in those which inhaled PuF4. The greatest pulmonary retentions were obtained from a 1000 degrees C oxalate and 2 oxides prepared from Pu metal (half times 600-1000 days). In a nine year study of Pu oxides the tracheobronchial lymph nodes accumulated 40% of the inital deposition, abdominal lymph nodes had accumulations of 8%, the liver burden reached 15-20% and translocation to the bones reached 3-4% after 4-5 yrs. Pulmonary retention of Pu F(4) was less than the oxides, but greater than Pu(NO3)4. Of all the compounds studied, urinary excretion of Pu was greatest after inhalation of PuF4. Plutonium nitrate showed a translocation to other tissues as high as 52% of the alveolar deposition. Pathology occurring in the PU(NO3)4 and Pu oxide experiments due to high doses included lymphopenia, cellular changes in lung and tracheobronchial lymph nodes, respiratory insufficiency and pulmonary necplasia. Dogs depositing more than 0.1 uCi/g of lung after Pu 239 oxide inhalation died within one year. Those which deposited 6-74 uCi of Pu after Pu(NO3)4 inhalation died within 75-303 days. (JTE)

<142>
Bair, W.J., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1974

Considerations in Assessing the Potential Harm to Populations Expcsed to Low Levels of Plutonium in Air. CONF-740529; STI/PUB/375; IAEA-SM-184/14; Part of Proceedings of a Symposium on Population Dose Evaluation and Standards for Man and His Environment held in Portoroz, Yugoslavia, May 20-24, 1974, (p. 435-449), 646 p.

Results from experimental animal studies have provided extensive knowledge of the disposition and biological effects of plutonium. While these laboratory studies involved levels of plutonium much higher than the predicted dose commitments from nuclear power plant operation, the results of these experiments along with the limited data from accidental human exposures can provide a basis for preliminary assessment of the harm to populations from plutonium that might be released to the environment. Experimental animal studies have identified lung and bone cancer as the most sensitive effects of plutonium exposure. Drawing upon the results from experiments with several animal species and several plutonium compounds the possibility of deriving risk estimates for plutonium-induced lung cancer on a toxicological basis was explored, thus avoiding the need to consider the spatial distribution of absorbed radiation dose in lung, latent period for cancer induction, etc. Values for the risk of lung cancer resulting from inhaled plutonium average about 2 x 10(E-3) per nCi/g lung times days for Pu 239. A value of 2 x 10(E-4) was calculated for Pu 238 from the results of one experiment with rats. (Auth)

<143>
Barron, E.S.G., et al, University of Chicago, Chicago, IL. 1945, June 15

Monthly Health Report on Problems Relating to Product for Month of May 1945. CN-2992; 47 p. (Declassified January 4, 1956)

This monthly progress report contains investigations by several authors on the biological, biochemical and medical aspects of Pu. Phospholipid turnover studies in rats given intravenous injections of 2 mg Pu/bg showed evidence that the intestinal absorption of P 32 was not impaired by this amount of Pu and that the transport of P in the phospholipid molecules in the liver was not affected by Pu poisoning. However, the rate of removal of phospholipids from the liver was significantly inhibited. Data are presented on lung absorption and liver deposition in rats given various Pu salts in the 4 and 6 valent states by tracheal intubation; on hemoglobin, leucocyte and erythrocyte determinations in rats given Pu (+4) intravenously; and on radiation effects of mice given Ra intraperitoneally from 6 hrs to 40 days after injection. Other studies include tissue metabolism tests on spleen, thymus, adrenals, liver and kidneys of rats previously injected with Pu. The size and respiration of spleen and thymus were greatly diminished in all animals examined. Respiration of the adrenals was also diminished. Among the alterations of liver metabolism were some inhibition of pyruvate and butyrate oxidation, and of anaerobic glycolysis. Changes in kidney metabolism resulted in a rise of blood NPN and an inhibition of glutamate oxidation. A procedure was developed to determine the proportion of inhaled PuO2 aerosols retained by rats. Seventy-five percent was found to be deposited in the animals and 25% exhaled. Sixty-four days after inhalation showed a 10% deposition in the lungs and 12% in the skeleton. The route of excretion from the lungs was by way of the bronchial tree after the 16th day following exposure. Some over exposure to radiation of personnel is reported at this time according to urine assays. Difficulties are experienced in

<143>

BIOLOGICAL ASPECTS
ANIMALS

<143> CONT.
routine analysis of human feces. (RAF)

<144>
Fradkin, G.Ye., V.F. Ushakova, and J.T. (Translator) Greaves, Not given. 1963

Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body. Part of Balabukha, V.S. and Barnes, J.H. (Eds.), Chemical Protection of the Body Against Ionizing Radiation, The MacMillan Company, New York, New York, (p. 147-162), 168 p.

Results of the analysis on the effectiveness of a number of complexing agents for accelerating the elimination of Y 91 and Pu 239 from the animal body were presented. The complexes were adiminstered to white rats intraperitoneally or orally, and at certain times afterward the isotope contents of the femur, liver and kidneys of the rats were assayed and evaluated under the assumption that the greater the stability of the complex the smaller the amount of isotope retained in the organs. The stability of the complexes was also expressed quantitatively by means of an instability constant which was the ratio of the product of the concentrations of the components of the complex ion to the concentration of the whole complex ion. Cyclohexanediaminetetraacetic acid (CDTA) with an instability constant of approximately 10(E-23) formed the most stable complexes with Y 91. Others tested were ethylenediaminetetraacetic acid (EDTA) with a constant of approximately 10(E-18), nitrilotriacetic acid (NTA), aminomethylphosphinic acid (AMP), cyclohexenediaminotetraacetic acid (CHDTA) and cyclopentanediaminetetraacetic acid (CPDTA). CDTA and CPDTA formed more stable complexes with Pu (constant approximately 10(E-29)) than did EDTA (contant approximatley 10(E-24)). It was concluded that retention of Y 91 and Pu 239 in the body would be decreased significantly only when the instability constants of the complexes were decreased to 10(E-28) and (E-35), respectively. Of the agents tested, the most effective were CDTA and CPDTA used in treatment of Y 91 contamination. (JTE)

This is a translation of the original Russian book, "Khimicheskaya Zashchita Organizma ot Ioniziruyushchikh Izluchanii".

<145>
Hamilton, J.G., University of California, Radiation Laboratory, Berkeley, CA. 1951, February 27

Medical and Health Physics Quarterly Report, October, November, and December, 1950. UCRL-1143; AECD-3200; 61 p. (Declassified July 16, 1951)

Data obtained from tracer studies using At 211, carrier-free Bi 206, carrier-free Mn 52, carrier-free Mo 93,99, Np 237, Ta 182, carrier-free Sc 46, and Tm 170 are presented. The Np 237 study covered 64 days with rats being given 1.3 milligrams of Np 237 in solution as NpO2(E+2) with 85 mg of ammonium citrate and 20 mg of ammonium chloride. It was adminstered by intramuscular injection. Five percent of the Np was retained at the injection site after 64 days. The date indicated that the skeleton is the major site of deposition receiving 27.5 of the dose. It is noted that this is appreciably less than values previously obtained with Pu .. more nearly resembles U. The urinary excretion (37.1%) is much greater than fecal elimination (20.1%). This characteristic is also more like U than Pu. The percent deposited in the various organs is presented in tabular form. A report on a study of "The Movement of Sodium and Potassium in the Tissues of the Rat Following Acute Radiation Injury Using Na 22 and K 42,43 as Tracers", is included. (JTE)

<146>
Hamilton, J.G., J.H. Lawrence, P. Weymoth, C.A. Tobias, R.S. Stone, E.R. Miller, B.V.A. Low-Beer, N.B. Garden, and B. Moyer, University of California, Radiation Laboratory, Berkeley, CA. 1947

Medical and Health Physics Section, Progress Report for May 1947. BP-97; 18 p. (Declassified December 13, 1955)

The status of the following studies was given. (1) Radioautographic Studies, the deposition in bone of thorium, plutonium, americium, barium, and element 61 was being studied. Experiments with curium, U 233 and Np 235 were planned. (2) Tracer Studies, summaries of La 140 experiments in tissues of rats and one day experiments with element 61 was similar and it was noted that deposition of these rare earths is similar to cerium, preaseodymium, americium, and curium. Studies of the absorption of beryllium were also performed. The efficiency of the Jones reductor procedure for isolation of U 233 from animal tissue was increased up to 50%. (3) Decontamination Studies, the absorption of Pu from injection of 15 micrograms of Pu+6 in rats was reduced by pre-treatment with BAL(2,3-dithioglycerol). Zirconium did not reduce absorption of Pu after intramuscular injection, but urinary excretion increased 5 x and skeletal retention decreased 3 x. Rachitic rats retained significantly less radium than controls, but a massive dose of phosphate increased retention. (4) Uranium Distribution Studies, the liver and spleen removed 80-95% of the injected U in mice. Other studies were (5) Radio-chemical Isolations, (6) Operation Crossroads, (7) Total Body Irradiation X-ray and P 32, (8) Radioiodine Studies, (9) Health Physics-Chemistry Section Studies on monitoring, decontamination, disposal, and research and development, and (10) Health Physics Radiation Field Studies on personnel monitoring, shielding, and neutron absorption. (JTE)

<147>
Jacobson, L.O., and K.S. Cole, University of Chicago, Chicago, IL. 1945, November 13

Report of Health Activities for Month of October, 1945. CH-3313; 7 p. (Declassified February 16, 1956)

Abstracts are provided for work done during the month at the Health Division. The clinical medicine and medical research division performed physical examinations on personnel and noted changes in animals used for research studies. The biological research section is continuing studies on hematological effects of radiostrontium, chronic effects of injected Sr 89, and histological effects of radium. All experimental animals in the study on hemotological effects of plutonium have died and a final report is nearing completion. Eighteen mice in a study on the chronic effect of injected plutonium have died with

BIOLOGICAL ASPECTS
ANIMALS

<147> CONT.
gross evidence of chronic liver disease and osteogenic tumors. A dog, in the study of subacute clinical effects of plutonium, died and data collected on the dog are reported. Death was probably due to liver dysfunction. Excretory studies on a human subject who received 5 ugm of Pu 238 have been completed through the 127th day. No changes are noted during the past month. The National Cancer Institute is continuing studies on x and gamma radiation studies on mice, guinea pigs, and rabbits. Results in the medical industrial hazards section do not indicate a high exposure to plutonium for personnel at Chicago and Clinton. The terminal cancer patient injected with Pu died and autopsy results showed a 33% retention of Pu in the liver. Bone marrow from a rib gave the highest specific activity. Monitoring of personnel and facilities are continuing. (BbM)

<148>
Jacobson, L.O., K.S. Cole, J.J. Nickson, E. Lorenz, B.V. Low-Beer, and J.G. Hamilton, University of Chicago, Chicago, IL. 1945, July 9

Report of Health Activities for Month of June, 1945. CN-3076; 22 p. (Declassified December 22, 1952)

Abstracts are given for reports on clinical medicine and medical and industrial hazards, and blood studies on total body irradiated patients. These reports have been published separately. The monthly report is presented for National Cancer Institute studies and metabolic studies of fission products performed at the laboratory. The National Cancer Institute program is studying biological action of x and gamma rays on mice, guinea pigs and rabbits. A final report is being prepared on plant and soil studies for metabolism of fission products. Aerosol studies are continuing. Retention of plutonium by lungs of rats exposed to PuO2 smoke was found to be about 5% of the orginally inhaled activity 256 days after exposure. The rate of elimination for 8 months was approximately 0.5% per day. Similar behavior was noted after 64 days for plutonium and fission products. A terminal cancer patient received intravenous injections of 5 ugm of PuO2(NO3)2 enriched with Pu 238. Four days later, as a result of surgery, specimens of bone, spleen, tumor, omentum, and skin were obtained. The distribution pattern of Pu was very similar to that observed in rats. The greatest deposition in bone was in the trabecular portion of the marrow. Urine elimination was below 0.01% per day after 16 days. A new method for relatively rapid analysis of large specimens of urine and feces has been developed to permit detection of 2 x 10(E-6) ugm of Pu in daily output of urine or feces. (BBM)

<149>
Kunzle-Lutz, M., H. Metivier, D. Nolibe, A. Simon-Vermot, J.L. Gimbert, P. Jockey, and A.A. (Translator) Horvath, Lovelace Foundation for Medical Education and research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1970, September

Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide. LF-tr-53; 5 p.; Archives des Maladies Professionnelles de Medicine du Travail et de Securite Sociale, 31, 513-516.

In this laboratory study baboons of an average weight of 3 kg were allowed to inhale dust contaminated with particles of Pu oxide with an average diameter of 0.5 u. Subsequent to Nembutal anesthesia the ventilation of each lung was separated by a sound. A rinsing solution (a sterile, isotonic 37% solution of NaCl) was introduced into the sound with a syringe, and at the same time the other lung was supplied with oxygen. This lavage was repeated 5 times. One group of baboons was treated by rinsing on the 5th day, another group was treated on the 5th, 11th, and 18th days. An average of 90% of the injected fluid was recovered. The data indicated that one treatment of 5 rinses lowered the pulmonary change by 10-15% while three treatments lowered the pulmonary charge by 50 to 55%. (JTE)

<150>
McClellan, R.O. (Ed.), and F.C. (Ed.) Rupprecht, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

Fission Product Inhalation Program Annual Report, 1971-1972. LF-45; 355 p.

The prime objective of the inhalation toxicology research program is to develop knowledge that will improve the understanding of the biological consequences of inhaling radionuclides particularly as it is related to man. Papers in this annual report are grouped into six sections which correspond to programmatic areas that have been delineated for budget purposes. Section 1 reports research directed toward developing an improved understanding of radioactive aerosols, and their production and characterization for use in animal exposures. Section 2 papers describe research directed toward obtaining an improved understanding of the radiation dose pattern resulting from inhalation of radioactive aerosols. Section 3 reports a series of studies aimed at establishing the relationship between exposure to various levels and types of aerosols and the resulting biological effects. Section 4 relates research underway to develop an improved understanding of the pathogenesis of radiation-induced disease, especially from internal exposure. Section 5 reports continuing research directed toward developing effective therapeutic procedures for treating individuals accidentally exposed. The sixth section reports a new effort in the laboratory. Respiratory Tract Deposition Models. Eight articles were separately abstracted for the data base. (JTE) (CTS)

<151>
Richmond, C.R. (Comp.), and H.L. (Comp.) Voelz, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973

Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972. LA-5227-PR; 144 p.

This report summarizes research activities of the Los Alamos Scientific Laboratory's Biomedical Research Group for calendar year 1972. Information on organization of the group, research interests of the staff, and supporting facilities available at the Los Alamos Scientific Laboratory are included. Although for administrative purposes the group is comprised of seven sections, the technical portion of this report is based upon major areas of research and reflects the

<151>

BIOLOGICAL ASPECTS
ANIMALS

<151> CONT.
multidisciplinary approach to problem solving, which is a basic ingredient of the research philosophy. The areas of research are the hot particle project, molecular radiobiology, cellular radiobiology, biophysics, isotope applications and animal colony activities. The format is akin to that of Science with the goal of transmitting a maximum of information in a concise manner with a minimum of technical detail. Work which has been published or submitted for publication has not been duplicated in this report. Additional specific technical information is included in the appendix. Three articles were separately input into the data base. (Auth) (JTE) (CTS)

<152>
Spalding, J.F., Los Alamos Scientific Laboratory, Los Alamos, NM. 1974, May

Mammalian Radiobiology Group (H-4). LA-5633-PR; Part of Richmond, C.R. and Sullivan, E.M. (Comps.), Annual Report of the Biomedical and Environmental Research Program of the LASL Health Division, January-December 1973, (p. 1-19), 165 p.

Current activities of the Groups consist of research on effects of both external and internal sources on mammals and appropriate extrapolations to man. Investigations on external sources are largely concerned with injury and repair of bone marrow with emphasis on low dose rates. Rodents, dogs, and monkeys are used in studies oriented toward civil defense, manned space flight, military, and emergency exposures. Research on internally deposited radioactive materials with the same animals includes interspecies correlations of uptake, deposition, and excretion of radioisotopes. Current emphasis is on response of body tissues, especially the lungs, to high specific activity radionuclides such as Pu 238 and Pu 239 oxide. An additional objective is to establish radiation protection guides for internally deposited radioisotopes in man. Other research is related to animal radiobiology studies of negative pions for preclinical therapy work. Individual studies are underway concerning exposure of hamsters by inhalation of Pu loaded Zr oxide spheres, retention and survival of hamsters injected with Pu 238, the approximate distribution of lung cells with respect to radiation dose after inhalation of Pu laden microspheres, computer support, biological results of Pu inhalation and injection, microradiography in the lungs, recovery rate and persistent injury in monkeys given large doses of gamma rays by fractionation, comparative hematopoietic effects of dose protraction by fractionation in beagles and monkeys, and recovery and residual injury observation of dogs and monkeys after serial 100 rad gamma-ray exposures. Studies are also underway concerning mammalian metabolism of Cs 137 and As 74, and animal colony observations. (JTE)

<153>
Stather, J.W., F.E.H. Crawley, D.S. Popplewell, G.N. Stradling, J. Brightwell, B.L. Loveless, L. Watts, and R.J. Purrott, National Radiological Protection Board, Harwell, England. 1974, October

The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board. NRPB-R31; 127 p.

The status and some results of 8 investigations concerning radiological protection problems associated with the production and use of Pu and the higher actinides in the nuclear power industry are presented. Some papers describe completed experimental work, the results of which will appear in the open literature, while others describe work in progress. Two papers are not included as most of the material presented has already been published in report NRPB-R-29 (1974). Included are studies concerning the effect of chemical form on the tissue distribution and excretion of Pu 239 following its deposition in the respiratory system of the rat, comparative studies on the clearance of Pu 238, Pu 239, Am 241, and Cm 242 from the respiratory system of the rat, the chemistry of Pu incorporated in humans, a rapid method for determination of Pu in urine by ultrafiltration, the efficiency of bronchopulmonary lavage as a therapeutic procedure for removing insoluble radioactive particles from the lung, the removal of intracellular Pu, analysis of data on the clearance of insoluble compounds of Pu in the lung, and chromosome aberrations in lymphocytes after Pu intake by humans. The eight papers have been selected for separate input. (JTE)

<154>
Stewart, K., D.M.C. Thomas, J.L. Terry, and R.H. Wilson, United Kingdom Atomic Energy Authority, Atomic Weapons Research Establishment, Aldermaston, England; U.S. Department of Defense, Defense Atomic Support Agency, Washington, DC; University of Rochester, Rochester, NY. 1965, July 8

A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments). AWRE-O-29/65; 33 p.

A biological measurement program was carried out during the Roller Coaster experiments to obtain information which would assist in the assessment of the radiological hazard to man from the inhalation of particulate material resulting from the detonation of a nuclear weapon containing Pu metal. Three hundred and twenty sheep, dogs, and burros were exposed in the Double Track and Clean Slate 2 experiments. The animals were then decontaminated and a program of serial sacrifices extending from a few hours after exposure to 3 years was initiated. The particle size distribution and air concentrations were based on data obtained with cascade impactors. Only particles in the size range up to 10 u were considered significant, however, the effect of extending this to 20 u was examined. The early clearances in the dogs, burros and sheep showed half-times of about 60, 20 and 2 days, respectively,. After 7 and 14 days, respectively the dogs and burros showed increased values, however, the sheep experienced a large increase to a half-time of about 20 days lasting for 60 to 80 days. The residual fraction amounted to about 3/4 of the initial lung burden in the dogs, 1/3 in the burros and 1/13 in the sheep. Removal was slow and was represented by a half-time of about one year. It was concluded that the data were comparable and compatible with the existing data for man, and coud aid in forming a common assessment of the hazard to man. (JTE)

Double Track animal studies are shown in numerous tables and figures.

BIOLOGICAL ASPECTS
ANIMALS

<155>
Taysum, D.H., F.G. Evans, W.M. Hammer, W.S.S. Jee, C.E. Rehfeld, and L.W. Blake, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1962

Radionuclides and Bone Strength. Part of Dougherty, T.F., et al (Eds.), Proceedings of a Symposium on Some Aspects of Internal Irradiation held at The Homestead, Heber, Utah, May 8-11, 1961. Pergamon Press, New York, New York, (p. 145-162), 529 p.

The tibiae of beagles which had been used in the chronic toxicity program of a radiobiology laboratory were removed at autopsy and subjected to tensile stresses to determine the effects of age and internal radiation doses upon the strength of bone tissue. Test specimens were produced on a jeweler's lathe from defleshed, deep frozen (-20 degrees C) tibiae and were refrozen until two hours before testing. The testing machine was a standard Baldwin 120,000 lb capacity machine with a Tate Emery load cell, accuracy plus or minus 0.5 lb in the range used. Tests were carried out at room temperature. The rate of loading was approximately 15 lb/min with stress and strain readings taken at 2 lb increments. A plot was then made for each specimen and the proportional limit determined. There was no significant correlation in change of stress or energy with increasing age or dose. However, it was pointed out that the tests demonstrated trends and all indicated weakening with increasing dose. It was concluded that radiation fractures were the result of local weakening rather than a uniform loss in bone strength. A short discussion of the topic by several researchers was included. (JTE)

Tables 1-3 give the calculated values obtained from the measurements of the three experiments.

<156>
Vaughan, J., Medical Research Council, Churchill Hospital, Bone Seeking Isotopes Research Unit, Oxford, England. 1962

Bone Disease Induced by Radiation. Part of Richter, G.W. and Epstein, M.A. (Eds.), International Review of Experimental Pathology, Vol. 1. Academic Press, New York, New York, (p. 243-369), 453 p.

A comprehensive review of radicinduced bone disease is presented. Certain points of general biological interest were stated. The first is that although there was often an association between radiation dysplasia and radiation neoplasia the evidence showed that the relationship was not necessarily a causal one. Secondly, it was stated that radiation dose was only an effective factor in promoting radiation neoplasia in bone if other tissue conditions were favorable. Finally, in the case of bone, the tissue at risk, as far as neoplasia was concerned, was probably the osteogenic connective tissue, particularly on endosteal surfaces. The review was organized into several sections, the titles of which included sources of skeletal irradiation, radiation dosimetry, the bone-seeking radioactive isotopes (giving the physical characteristics of Sr 90, Y 90, Ca 45, Pu 239, Ra 226, Ra 228 and Th 228), pathological changes produced in bone by irradiation, external and internal irradiation describing the clinical and experimental studies of bone damage and the character of tumors produced by skeletal irradiation. (FNM)

Table 2 shows incidence of osteosarcomas in Utah beagles as of March, 1961.

<157>
Watts, L.M., National Radiological Protection Board, Harwell, England. 1974, October

Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung. NRPB-R31; Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 103-115), 127 p.

The rate at which an inhaled radioactive substance is cleared from the lungs by physiological mechanisms is an essential parameter in determining the radioactive dose delivered to the lung. It is usually assumed that insoluble compounds of plutonium are cleared from the lung in two exponential phases. A review of the relevant literature has been carried out, from which it appears that a third exponential phase may be present in the clearance process with a half-time intermediate between those of the other two phases. Best estimates of the half-times of the three clearance phases are given as 1 day, 30 days and 500 days, and the implications of the presence of an intermediate lung clearance phase are discussed. (Auth)

Table 1 shows a summary of experiments and accidents involving plutonium 239 inhalation with clearance halftimes as calculated from the present study.

<158>
Jacobson, L.O., and K.S. Cole, University of Chicago, Chicago, IL. 1945, December

Report of Health Activities for Month of November, 1945. CN-3358; 7 p. (Declassified January 18, 1956)

Abstracts for monthly Health Activities reports from the University of Chicago Metallurgical Laboratory update work currently in progress. The clinical medicine and medical research section performed physical examinations and laboratory tests on personnel. Biological research section studies involved the effect of dose on retention of injested Y 91 in the rat and plutonium studies. Rats given Pu by stomach tube were sacrificed at intervals and femurs were ashed and analyzed. The femurs contained 2.9 to 8.4 x 10(E-5)% of the dose. Calculations for the entire skeleton determined the total percent of dose in the skeleton,. With data from other studies, 9.7 to 28 x 10(E-4)% of the injected plutonium would be absorbed and retained. All mice in the study on hematological effects of plutonium have died. Results are reported. The Medical Industrial hazards section curtailed routine analysis of urine for Pu during the past month to initiate the new assay program. Other routine monitoring programs continued. National Cancer Institute studies have continued on radiation of mice. (BBM)

<159>
Not given, University of Chicago, Chicago, IL. 1944, April 3

Report for Month Ending February 29, 1944. CH-1459; 64 p. (Declassified July 26, 1974)

<159>

BIOLOGICAL ASPECTS
ANIMALS

<159> CONT.
The main sections of this monthly progress report deal with radiation hazards, clinical biochemical studies, biological research, health physics and radiation measurements, and meteorology. Among the topics discussed are hand and glove contamination studies with increased attention to methods of prevention; the expansion of pocket meter service; and the proposed use of acid resistant cloth for protective clothing. Progress is reported in the areas of personnel health surveys; film meters; laundry monitoring; Lauritsen electroscope calibration; and product monitoring. Clinical biochemical studies include liver function tests of personnel exposed to radiation; pigment metabolism studies; kidney function tests; phosphorus studies; and initial blood protein research by electrophoresis. The biological research section includes reports on the toxicity of mixed fission products in rats; the effect of Ba 140-La 140 in mice; fast neutron survival in mice; x-ray survival in mice; effects of external beta radiation in rabbits; stable isotope toxicity (Ce, Ba) in goldfish and mice; histopathological findings in mice injected with Ba 140-La 140; hematological and histopathological findings in rabbits exposed to 100 r and 400 r x-rays; radioautographic studies of lungs of U and La dusted mice; mice studies on the protective action of nicotinamide; food intake and weight changes in rabbits when given single doses of 400 r and 800 r x-rays; accumulation and distribution of Sr 89 and Ba 140-La 140 in goldfish; and tissue metabolism studies in rats. A large section is devoted to mouse and guinea pig breeding experiments showing possible irradiation effects in reduced litter sizes. Meteorological work deals with dilution studies from stack emissions by means of SO2. (RAP)

BIOLOGICAL ASPECTS
PLANTS

<160>
Adriano, D.C., A.L. Boni, J.C. Corey, J.H. Horton, K.W. McLeod, J.E. Pinder, and M.H. Smith, Savannah River Ecology Laboratory, Aiken, SC; University of Georgia, Athens, GA; Savannah River Laboratory, Aiken, SC. 1975

A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area. CONF-750847; DP-MS-75-40; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 122).

A field study was initiated in the fall of 1974 at the U.S. Energy Research and Development Administration's Savannah River Plant, near Aiken, South Carolina, to determine the spatial and temporal variation of plutonium in soil-plant systems, with wheat (TRITICUM AESTIVUM) as the crop of interest. The study was conducted on a field 30 m x 250 m, with somewhat elevated levels of plutonium. The plutonium had been deposited as a consequence of atmospheric releases through a stack of chemical reprocessing plant and fallout thereby providing a true industrial source for study purposes. In addition to evaluating the relative importance of uptake and resuspension on the plutonium content of wheat, the effect of seed-bed preparation on the redistribution of plutonium in the soil profile was measured on the 0.75-hectare (1.85 acres) field. Analytical techniques; relationships among soil, air, and vegetation plutonium concentrations, and environmental implications are discussed. (Auth)

<161>
Au, F.H.F., and W.F. Beckert, National Environmental Research Center, Las Vegas, NV. 1975, June

Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 187-195), 504 p.

Studies were carried out on the influences of different chemical forms and concentrations of plutonium at two hydrogen ion concentrations of the malt agar culture medium on uptake and transport of plutonium to the spores of ASPERGILLUS NIGER. Plutonium 238 nitrate and citrate complexes were added to aliquots of buffered agar media (pH 2.5 and 5.5) to obtain plutonium concentrations of 112, 224, and 448 pCi/g. Plutonium 238 dioxide spheres of 0.3 um were added to aliquots of the buffered agar media to obtain plutonium concentrations of 224, 2,240, and 22,400 pCi/g. High concentrations of the dioxide form were used because of expected very low transport to spores and the necessity to obtain sufficient activity for analysis. Results indicated that plutonium, when added to the culture medium as dioxide microspheres, nitrate, or citrate complex, was transported to the spores, and that an almost linear relationship existed between transport and concentration. Raising the pH of the culture medium from 2.5 to 5.5 generally increased transport of plutonium to spores for all three chemical forms. At plutonium concentrations of 224 pCi/g in the culture media, and for both pH 2.5 and 5.5, transport of plutonium to spores was approximately three times as high from the nitrate or citrate form as from the dioxide microspheres. (Auth) (JTE)

Table 1 shows the transport ratios for nitrate to oxide and citrate to oxide at pH 2.5 and 5.5 at a plutonium concentration of 224 pCi/g of agar.

<162>
Cataldo, D.A., and B.E. Vaughan, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport. BNWL-1950 (Part 2); Part of Annual Report for 1974, (p. 52-56), 238 p.

In this initial laboratory study, primary leaves of a 10 day old bean plant (with the rest of the plant protected by polyethylene films) or the entire foliage of 5 week old bean plants (with the bean pods bagged) were exposed to Pu 238 aerosols. The relative mobility of Pu 238 following dry aerosol deposition onto leaf surfaces is shown in tabular form. The biological availability of the foliar Pu deposits appears to be minimal with concentration factors in unexposed tissues of 10(E-5) to 10(E-6) and transport factors of 10(E-4) to 10(E-8). The transport factor is said to evaluate availability on the basis of the total amount of radioactivity or material presented to foliar tissue and the proportion of this material that is removed from the contaminated tissues. It seems that little Pu is transported to growing points such as buds and seeds. Availability of the various Pu forms studied is as follows: aged oxide greater than citrate, greater than nitrate, greater than fresh oxide. The concentration factor for the accumulation of Pu 238 in reproductive structures for foliarly applied Pu compounds is of the same magnitude as found in root uptake. However, the relative insolubility of the compounds may affect biological availability. More complete data will be published later. (JTE)

<163>
Cataldo, D.A., B.E. Vaughan, and R.E. Wildung, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975

Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 123).

Foliage of 20-day-old plants (PHAESEOLUS VULGARIS) were exposed to aerosols containing Pu 238-nitrate, citrate, oxide, and aged oxide using a low-windspeed, aerosol, plant exposure chamber. Particulates having a mean aerodynamic equivalent size of 1 um were generated and deposited onto foliage to study deposition parameters, the extent of chemical and physical entrainment of particulates at the leaf surface, the potential of these particulates for leaching from the leaf, and the availability of Pu for foliar uptake and translocation to edible plant parts. Deposition rate and velocity were calculated from measured parameters, and were in agreement with calculated theoretical values. The leachability of foliar-deposited Pu using a synthetic rain water was dependent on the form and chemical reactivity of the Pu species deposited and time following deposition. The availability of dry-deposited particulates for translocation (to roots and seed) was minimal (CF less than

<163>

BIOLOGICAL ASPECTS
PLANTS

<163> CONT.
1 x 10(E-5)). The presence of a solution vector (i.e. simulated precipitation) resulted in increased Pu translocation from foliage (CF 1 x 10(E-5) to 1 x 10(E-3)). The magnitude of the increase was dependent on the chemical reactivity of the Pu species supplied and the timing of precipitation with respect to seed development. (Auth)

<164>
Folsom, T.R., V.P. Hodge, and M.E. Gurney, Scripps Institution of Oceanography, Mt. Soledad Laboratory, La Jolla, CA. 1975

Plutonium Observed on Algal Surfaces in the Ocean. Marine Science Communications, 1(1), 39-49.

Some rates at which plutonium deposits upon surfaces of giant algae have been measured in the field and in small seawater baths. Evidence is given that plutonium concentrates mainly in extremely thin outer surface layers. The observed rates imply that kelp beds may remove each day as much as 10% of the plutonium present in the water that bathes them. It is suggested that other algae including the main phytoplanktonic biomass may play an important part in turning plutonium into the chemical and physical forms predominant in the ocean. (Auth)

<165>
Gromov, V.V., V.I. Spitsyn, and M. (Translator) Gerrard. 1974; 1975

Assimilablity of Plutonium, Ruthenium, and Technetium by Phytoplankton. ORNL-tr-2907; 5 p.; Doklady Akademii Nauk SSSR, 215(1), 214-217.

The results are given of studies on the absorption of Pu 239, Ru 106 and Tc 99 by cultures of unicellular green algae---Platymonas viridis---and natural colonies of phytoplankton taken from the surface along with seawater in the southeastern region of the Pacific ocean (July 31, 1972, 9 degrees 18' 1" S, 78 degrees 54" 2" W. It was seen that Pu 239 and Ru 106 more rapidly ossimilated by the plankton cultures and after 20 hr a steady state was reached. No more than 5% of the original amount of Tc was absorbed. After 7 days there was still no release of the absorbed isotopes into the nutrient medium. The natural phytoplankton colony accumulated Pu, Ru, and Tc better than the single culture. Also the uptake was greater for Ru 106. After 15-17 days release of the absorbed isotopes into the seawater began by bacterial decompostion cf the debris. Pu was removed from the dead plankton more rapidly than Ru since Ru 106 was probably reabsorped more by the debris. The involvement of Pu and the isotopes of Ru in the biological cycle is an effective methed for converting them to physio-chemical forms in equilibrium with seawater, for example Pu is partially hydrolyzed to the ions PuO2(OH) +, PuO2(OH)2 and PuO2(OH)3(E-1). As a result of biochemical tranformations different organic complexes with Pu are formed and these pan from the dead cells to the water. This may be a deciding factor in the migration of Pu, Ru, and Tc in the ocean. (FNM)

<166>
Robinson, A.V., T.R. Garland, H. Drucker, and R.E. Wildung, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form. BNWL-1950 (Part 2); Part of Annual Report for 1974, (p. 28-30), 238 p.

The possibility that the form of Pu in soil may be altered by microbial activity has been suggested. Selected exocellular media from Pu-resistant cultures were analyzed by thin layer chromatography (TLC) and thin layer electrophoresis (TLE) to ascertain the presence or absence of Pu compounds different from the Pu-DTPA added to the incubation media. Autoradiography was employed to visualize the position of Pu after TLC and TLE. One unknown compound was found which appeared to be labile and unstable at room temperature. Chemical techniques will later be employed to characterize and positively identify Pu metabolites. (FNM)

See also CONF-750847, Part of Proceedings of the 67th Annual Symposium of the American Society of Argonomy held in Knoxville, Tennessee, August 24-29, 1975.

<167>
Robinson, A.V., R.E. Wildung, T.R. Garland, and H. Drucker, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975

Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124).

To determine if the form of soluble (less than 0.01u) Pu 239(+4), initially present as a DTPA complex, was altered during enrichments to isolate Pu-resistant microorganisms from soil, the microbial cells and exocellular media were chemically characterized using Sephadex and thin-layer chromatographic (TLC) techniques and thin-layer electrophoresis (TLE). TLC and TLE were applied using various conditions of pH (pH 3.3, 6.6, 8.6), solvent composition (range in polarities) and support type (silica gel, cellulose, alumina). Autoradiography was employed to visualize the position of Pu on the chromatograms. The presence of Pu-containing compounds with TLC and TLE characteristics different than Pu-DTPA was ascertained in a tertiary enrichment culture containing 100 ug Pu/ml. The Pu compounds differed in R sub F, charge and stability at room temperatures. Thus, it appears likely that alteration of Pu form occurred during growth of Pu-resistant soil microorganisms. (Auth)

See also report BNWL-1950 (Part 2), Annual Report for 1974, (p. 28-30), 1974.

<168>
Romney, E.M., and A. Wallace, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1975

Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124-125).

Several safety tests were conducted between 1954 and 1963 at the Nevada Test Site and the Tonopah Test Range wherein small amounts of plutonium were dispersed into the surrounding

BIOLOGICAL ASPECTS
PLANTS

<168> CONT.
environment by chemical explosives. Findings from field studies in these fallout areas by the Nevada Applied Ecology Group indicated relatively low uptake of Pu 239, 240 by vegetation through plant roots. Results from plant uptake experiments under glasshouse conditions supported these findings. Discrimination factors ranging from 10(E-4) to 10(E-3) for Pu 239, 240 were obtained with barley grown on soil that had been contaminated with the source materials in 1957. The Pu/Am ratios for soil and barley samples also indicated greater root uptake of the ingrowth product, Am 241, relative to Pu 239, 240 from the aged source materials. (Auth)

<169>
Schneiderman, G.S., T.R. Garland, H. Drucker, and R.E. Wildung, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity. BNWL-1950 (Part 2); Part of Annual Report for 1974, (p. 25-28), 238 p.

Resistance to Pu as a chemical may occur by three general mechanisms including 1) inability of Pu to produce a toxic effect on cell metabolism at the levels of cytoplasmic processes or extracytoplasmic processes, 2) inability of organisms to transport Pu, or 3) ability of the organism to convert Pu to a form that is either incapable of entering the cell or is not toxic to the cell. The third mechanism was investigated. A noncalcareous Ritzville silt loam of pH 6.8 was separately amended with Pu 239 DTPA, Pu 239 as the soluble nitrate, Pu 238-DTPA, Pu 238 as the soluble nitrate, and with starch, N, and water to provide optimal microbial activity. Subsamples of soil were periodically removed to determine changes in numbers of fungi and actinomycetes. Using CO2 evolution as an index for microbiological activity, enrichment culturing of Pu resistant fungi and actinomycetes was performed. The enrichment procedures resulted in the isolation from soil of 14 fungal cultures and 13 cultures of actinomycetes, all distinct in colony morphology. The Pu compounds tested produced little or no effect on release of CO2 from the soil. However, fungal numbers were observed to drop markedly as compared to the controls after 11 days incubation on soils containing Pu 238-DTPA (0.62 ug/g) and Pu 239 DTPA (145 ug/g) at the 10 uCi/g level. Since the same effect was not observed at the 10 ug/g or 1 ug/g levels of Pu 239 DTPA, the observed reduction in fungal numbers is likely a result of radiation toxicity. Furthermore, since the Pu 239 (NO3)4 and Pu 239(NO3)4 at the 10 uCi/g level did not show a corresponding reduction in fungal numbers, and since the solubility and possible availability of the nitrate form of Pu is lower by a factor of 100 to 300, ir would appear that toxicity is related to Pu solubility in soil. (FNM)

Table 4 shows effect of Pu and Pu complexes on population of microorganisms in soil. See also CONF-750847, Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975.

<170>
Schneiderman, G.S., R.E. Wildung, T.R. Garland, and H. Drucker, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975

Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 125).

Microbial resistance to the chemical effects of Pu may be indicative of an ability to alter Pu chemical form in soil. The effects of Pu form and solubility on soil metabolic activity and on the types, numbers, and resistance of soil fungi and actinomycetes were measured in a silt loam soil (pH 6.8) separately amended with Pu 239 (1-145 ug/g) and Pu 239 (0.6 ug/g) in soluble NO3 and DTPA complex forms, and with C, N, and water to provide optimal microbial activity. Subsamples of soil were removed over a 95-day aerobic incubation period to determine changes in numbers of fungi and actinomycetes and relative water solubilities (less than 0.01 u) of the Pu forms. To isolate resistant organisms, enrichment culturing was performed at logarithmic and stationary growth phases. Solubility of Pu in soil influenced Pu toxicity to microorganisms with the more soluble Pu-DTPA forms resulting in greatest reductions in numbers. Comparisons of soil microbial numbers in the presence of Pu 238 and Pu 239 at common radioactivity levels, but at different mass concentrations, indicated that Pu toxicity was due to radiation rather than chemical effects. Enrichment culturing resulted in the isolation from soil of fungi and actinomycetes distinct in colonial morphology and exhibiting resistance to Pu at levels as high as 100 ug/ml. (Auth)

See also report BNWL-1950 (Part 2), Annual Report for 1974, (p. 25-28), 1974.

<171>
Schulz, R.K., G.A. Tompkins, L. Levanthal, and K.L. Babcock, University of California, Berkeley, CA; LFE, Environmental Analysis Laboratories, Richmond, CA. 1975

Uptake of Plutonium and Americium by Plants from Soils. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 125).

Plant uptake of Plutonium 239, 240 and Americium 241 from two soil samples collected from widely separated areas of the Nevada Test Site was studied. Each area had been previously contaminated with plutonium and americium by a separate high explosive (non-nuclear) detonation of a device containing plutonium. Barley plants were grown on 3 kg soil sub-samples in a controlled environment chamber. The plutonium distribution ratio (D.R. equals plutonium in plant tissue divided by plutonium in soil) was in the order of 10(E-5) for the plant vegetative material. The plutonium D.R. for the grain was 20-100 times lower than that in the vegetative material. Similar distribution ratios for americium were in the order of 10(E-4) for vegetative growth and were 25-75 times lower for the grain. These results imply that americium is much more available to plants than is plutonium. Plutonium bearing particles were separated from a soil sample and contained about 30% plutonium by weight. The particles were quite irregular, with a very large surface area which would be

<171>

BIOLOGICAL ASPECTS
PLANTS

<171> CONT.
expected to enhance solubility and plant uptake. (Auth)

<172>
Thomas, W.A., and D.G. Jacobs, Oak Ridge National Laboratory, Oak Ridge, TN. 1969

Curium Behavior in Plants and Soil. Soil Science, 108(4), 305-307.

Young bean plants (PHASEOLUS VULGARIS) were grown in polyethylene bottles containing 200 ml of Knop's nutrient solution tagged with Cm 242 (5000 dpm/ml). Some plants were grown in loam soil with tagged nutrient solutions. A common forage grass, tall fescue (FESTUCA ARUNDINACEA) was grown with the root mat in 200 ml of the tagged Knop's solution. Samples of plant tissue were later dried, ashed and counted. It was found that the grass did not contain activity in excess of that in the control samples. All bean plants grown in solution and most of them (81%) in soil exhibited significant activity in foliage and stem tissues. Absence of Cm 242 in grass leaves probably resulted from physiological or physical barriers to curium. Significant differences in the Cm 242 content of entire bean plants existed among treatments with intact roots in solution, 135 plus or minus 4 pCi (0.030 %); with roots in soil, 306 plus or minus 22 pCi (0.068%); and with severed roots in solution, 387 plus or minus 14 pCi (0.086% of total inoculum). The greater uptake of Cm 242 by plants with severed roots confirms that the transpiration stream can transport Cm and suggests that the site of any "discrimination" against this heavy metal is in the roots. Translocation of curium to foliage is so limited that introduction of hazardous quantities of Cm 242 into food chains by plants is unlikely unless foliage becomes contaminated after a release of this element to the atmosphere. Should this occur, the affinity for curium of bone, liver and the gastrointestinal tract of any animals in the food chain between plant and man would reduce the quantity that might be ingested by man. (FMH)

<173>
Wallace, A., and E.M. Romney, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1975

Americium Uptake by Plants from Soil. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 126).

The ability of some synthetic chelates, especially DTPA (diethylene triamine pentaacetic acid) to increase plant uptake of Am 241 has been further studied in a calcareous soil of pH 7.5 (Hacienda loam) and a noncalcareous soil of pH 6 (Yolo loam). There were plant species differences in both uptake and distribution of Am 241. With bush beans and corn, the Am 241 was concentrated in the upper parts of the plants. About 2.5 times as much Am 241 was in the leaves of bush beans grown in Hacienda loam as in Yolo loam; with corn the ratio for Am 241 in shoots for the same two soils was from 9 to 20. Barley was different in that more Am 241 was in plants at the low soil pH than in the high, and there was more uniform distribution throughout the plants. The discrimination ratio for Am 241 when plants were grown in soil was as high as 7 when DTPA was present. An experiment was conducted in which four new Fe chelates were compared with Fe DTPA in ability to increase Am 241 uptake. Three of these Fe chelates had very little effect, but an Fe chelate of the phosphine type was about 2.5% as effective as was Fe DTPA. (Auth)

<174>
Wildung, R.E., T.R. Garland, and D.A. Cataldo, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975

Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity. CONF-750847; BNWL-SA-5393; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 126).

To provide an assessment of the potential for plant uptake of Tc, a product of the nuclear fuel cycle, soybeans (GLYCINE MAX cv. Clark) were grown using a split-root (soil/nutrient solution) uptake technique in a Ritzville silt loam (pH 6.8) amended with Tc 99 (0.7 and 5.1 ug/g) as pertechnetate. Plants were harvested 10, 13, and 25 days after emergence. Within 5 days of plant emergence, phenotypic responses to Tc were observed. After 25 days, plants exposed to Tc exhibited reduced internode elongation and irregular leaf blade expansion. Toxicity symptoms resulted from marked accumulation of Tc in the plants. The calculated accumulation ratios (ug Tc/g dry plant tissue per ug Tc/g oven-dry soil) varied depending on soil Tc concentration, plant component, and harvest time, but ranged from 65 to 1,000. Plants accumulated 95% of Tc originally applied to soils at the low concentration level. Highest levels of Tc occurred in the stems and cotyledons. The results of preliminary ion competition studies indicated that Tc as pertechnetate may function as a nutrient analog accounting, in part, for the marked uptake of Tc observed. (Auth)

<175>
Rickard, W.H., E.L. Klepper, W.T. Hinds, J.F. Cline, J.D. Hedlund, R.G. Schreckhise, D.G. Watson, F.B. Brauer, J.K. Soldat, and J.E. Fager, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

Radionuclides in the Environment. BNWL-1950 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1974, (p. 192-202), 238 p.

The uptake of Pu 238 by cheatgrass, mustard, barley, and peas was investigated using a lysimetric technique in the field. Rangeland species, cheatgrass and tansy mustard, exhibited relatively low concentration of plutonium in shoot tissues, averaging about 2 pCi g(E-1) dry weight in stems and leaves and about 2pCi g(E-1) in cheatgrass seeds. The uptake into plant tissues was 1 to 3 ppm in relation to the soil activity. Crop species, barley and peas, exhibited a wide difference in uptake. Barley had uptake values comparable to cheatgrass, about 20 pCi g(E-1) in the stems and leaves and about 2 pCi g(E-1) in the grain. The peas, however, were nearly an order of magnitude greater in their uptake, about 200 pCi g(E-1) in the vegetative organs, but only about 3 pCi g(E-1) in the seed. The uptake from the soil inventory by crop plants was about twice that of the wild plants (due to barley's productivity only) and about 10 times as high in peas, due to greater uptake, not productivity. Included in this section of the report are studies on concentration

BIOLOGICAL ASPECTS
PLANTS

<175> CONT.
factors for radioiodine in belowground plant parts, I 129 in litter and soil from grass and forest communities, I 129 in freshwater aquatic organisms, measurements of I 127 and I 129 in pig tissues, Cs 137 in Anaktuvuk Pass Native residents and Cs 137 in a nesting population of American Coots. (PHH)

Table 81 shows the uptake of Pu 238 by Cheatgrass, mustard barley and peas from a silt loam soil with 0.084 ci m(E-2).

<176>

CHEMICAL ASPECTS

<176>
Akatsu, J., and T. Ishimori, Japan Atomic Energy Research Institute, Tokai, Japan. 1974, July 15

Evapoation Of Alpha Bearing Aqueous Wastes On a Laboratory Scale. Radiochemical and Radioanalytical Letters, 18(2), 51-59.

Various gamma radioactive aqueous wastes from the Pu handling laboratory in JAERI (Japan Atomic Energy Research Institute) are evaporated under infrared heaters. A simple evaporator was installed in a glove box. The ventilating air of the glove box always passes through the evaporator, in which various alkaline aqueous wastes are evaporated under electric heaters. The water vapor is carried off by the ventilating air, and discharged from the ventstack after having been filtrated. The residue in the evaporator is transferred to waste vessels and solidified with anhydrous gypsum. The soidified wastes are sent to the waste disposal section in JAERI and cemented in waste vessels. The solidified wastes containing Pu will be stored virtually forever. During 2 years, about 400 liters of the aqueous wastes were treated in the evaporating system and the present procedure has been carried out safely without such troubles as explosion and alpha-radioactive contamination of the air released to the environment. (Auth) (FMM)

<177>
Ballada, J., L. Jeanmaire, and P. Nauche, Centre d'Etudes Nucleaires, Departement de Protection, Service de Recherches Toxicologiques et Ecologiques, Section de Radiotoxicologie, Fontenay-aux-Roses, France. 1973, October

Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium). CEA-N-1667; 7 p.

A technique based on the use of glass fiber filters was developed for the determination of alpha-emitters such as Pu, Am, Cm, in feces. The activity of the radionuclides present is determined by alpha spectrometry. (Auth) (FMM)

<178>
Bruenger, F.W., B.J. Stover, and D.R. Atherton, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1962, September 30

Solvent Extraction of Plutonium with Primary Amines. COO-226; Part of Dougherty, T.F., Research in Radiobiology, Semiannual Report of Work in Progress on the Chronic Toxicity Program, (p. 58-65), 135 p.

An accurate and simple procedure for the determination of plutonium in biological materials has been developed. Concentrated urine, or a solution of bone ash, is made at least 1M in H_2SO_4, and plutonium is extracted with a mixture of C 18 to C 23 highly branched primary amines in xylene. Plutonium is then extracted from the organic phase with 8M HCl, and measured by alpha counting. (Auth)

<179>
Doher, L.W., and J.D. McBride, Dow Chemical Company, Rocky Flats Division, Golden, CO. 1970

A Control Design for Plutonium Counting Systems. RFP-1528; CONF-700541; Part of Proceedings of the 11th Annual Symposium of the Institute of Nuclear Materials Management held in Gatlinburg, Tennessee, May 25-27, 1970, (20 p.).

Thwas paper describes a design which assures control of the plutonium counting systems used at Rocky Flats to measure solid plutonium in waste and process materials, while establishing measurement bias and variability information for process control and inventory management. Plutonium was assayed by non-destructive, radiometric techniques. (RAF)

<180>
El-Ezaby, M.S., and B.J. Stover, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1966, March 31

Solvent Extraction of Neptuminum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes. COO-119-234; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Progress in the Internal Irradiation Program, (p. 277-296), 326 p.

Bis-(di-n-hexylphosphinyl) alkanes with n=1,2,3 or 4 dissolved in O-dichlorobenzene were used to extract the hexavalent oxidation state of neptunium ($NpO_2(+2)$) from agueous perchloric acid solutions. It was found that bis-(di-n-hexylphosphinyl) methane(HDPM) extracted neptunium(+6) more effectively than the compounds with n=2,3, or 4 over a tenfold range of perchloric acid concentrations. Findings showed also that as the ratio of HDPM concentration to that of neptunium increased, the distribution ratio increased. From the partition data it was calculated that the extracted species was a one to one Np-HDPM complex. The extraction with these organophosphorus compounds was compared with that of uranium(+6). (RAF)

<181>
Geue, P.J. (Comp.), Australian Atomic Energy Commission, Research Establishment, Lucas Heights, Australia. 1973, December

Uranium (III), A Bibliography 1965 to 1973. AAEC-LIB/BIB-4071; 20 p.

Sixty-five references on the chemistry of uranium are given. Nuclear Science Abstracts and Chemical Abstracts were searched during the time period 1965 to November 15, 1973 and 1965 to 1972, respectively. (RAF)

<182>
Labeyrie, L.D., H.D. Livingston, and V.T. Bowen, Woods Hole Oceanographic Institution, Woods Hole, MA. 1975

Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides. CONF-751105; IAEA-SM-199/115; COO-3563-37; COO-2379-6; STI/PUB/410; Part of Proceedings of a Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p. 121-137), 724 p.

Data are presented showing the distribution of Fe 55 radioactivity in marine sediment cores taken from a large range of water depths; these data are compared with the Pu 239, 240 analyses of the same or similar cores. The report is preliminary in that only a small part of the world's oceans have yet been studied. Evaluation of the results available suggests: in a good deal of their marine geochemistry, iron and plutonium move

<182> CONT.
separately; b) in the open Atlantic Ocean, Fe 55 has sedimented in association with a mixed population of particles, exhibiting a mean sinking rate of about 350 m per year. Thirdly, part of the iron in coastal sediments is redissolved, probably by reduction associated with decaying organic matter; this process affects a higher proportion of the Fe 55 than of the total iron. The solubilized iron should reprecipitate, after return to the overlying water and oxidation, as microparticulates. These very fine particles, dispersed by currents, may translocate Fe 55 toward the open sea, only slowly becoming associated with larger, faster-sinking, mineral particles. It is suggested that this process may be important in the translocation of other insoluble trace elements, and even of part of the Pu 239, 240. (Auth)

Table 2 shows Fe 55 in sediment cores and the ratios Fe 55 to Pu 239, 240.

<183>
Maxwell, E., R. Fryxell, and W.H. Langham, Los Alamos Scientific Laboratory, Los Alamos, NM. 1948

Determination of Plutonium in Human Feces. Journal of Biological Chemistry, 172, 185-190.

A detailed description is given of a method for determining plutonium in human feces. The dried sample is ashed in a muffle furnace and the ash dissolved in 4 m HCl. The reduced plutonium is carried from an aliquot of the feces ash solution with calcium oxalate. The calcium oxalate precipitate is digested with fuming HNO3 and taken up in 4 m HCl. Ferric iron is added and the plutonium is extracted into CHCl3 as the cupferride. The cupferride complex is destroyed with HClO4. The plutonium is carried with LaF3, transferred to a platinum plate, and counted in an alpha-counter. Results with solutions of both artificial and actual human feces ash show the recovery of plutonium by this method to be 80 per cent or better. (Auth) (RAF)

<184>
Raabe, O.G., H.A. Boyd, J.A. Mewhinney, J.J. Miglio, and C.J. Wilkinson, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October, 1, 1971 through September 30, 1972, (p. 21-28), 355 p.

Monodisperse aerosols of Pu 239 PuO2 labeled with Cr 51 were prepared by nebulizing an aqueous preparation containing both Pu 239 and a small mass of Cr 51, heat treating the resulting aerosol to form a polydisperse aerosol of particles of Pu 239 PuO2 labeled with Cr 51, separation and collection of the particles into monodisperse size groups using the Lovelace Aerosol Particle Separator, and resuspending the monodisperse particles on small segments of the collection foil from the particle separator to provide aqueous suspensions for nebulization to form monodisperse aerosols or for other studies. During an 11 1/2 hour continuous separation, monodisperse particles of Pu 239 O2 labeled with Cr 51 were prepared for injection into Chinese hamsters for cytogenetic studies, test inhalation exposures with Syrian hamsters and in vivo solubility studies in rats and hamsters for in vitro solubility studies. The in vitro solubility studies showed that the monodisperse aerosols had a readily soluble fraction possibly associated with small contaminating particles of Cr 51 in that over 11% of the Cr 51 was readily dissolved in the first two days of the dissolution study. Near the end of the 24-day study, dissolution stabilized somewhat and the PuO2 dissolution based on the Cr 51 label had a rate constant of specific solubility of about 6.8 x 10(E-8) gm/cm2-day as compared to a value of about 1.9 x 10(E-10) gm/cm2-day based on dissolved plutonium. Clearly, the Cr 51 was leaving the plutonium particles much faster than they were dissolving with a half-time of about 2 years as compared to about 700 years for the plutonium particles themselves. (Auth)

<185>
Raabe, O.G., H.A. Boyd, G.M. Kanapilly, and R.K. Latven, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

A Study of the in vitro Solubility of Plutonium 239 Dioxide. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 29-36), 355 p.

The solubility rates of submicrometer particles of Pu 239 PuO2 under non-equilibrium conditions are being studied using an in vitro system. A continuously flowing stream of serum simulant (at 37 C) passes over and around a sample of particles which is sealed between membrane filters. Dissolved plutonium is carried off in the stream and measured to determine the rate constant of specific solubility, which for Pu 239 PuO2 prepared at 1100 C was usually found to be of the order of 10(E-11) gm/cm2-day. A study of sampling of an accidentally produced aerosol of unknown chemical form or particle size distribution showed a marked solubility for the Pu and Am in the sample with about 10% of the total alpha activity of the sample being removed by dissolution in the 20 days of the study. This demonstrates the potential usefulness of the in vitro solubility system for rapid range finding of the possible in vivo solubility of aerosol samples collected in accidental releases. (Auth) (FHM)

<186>
Schwendiman, L.C., and J.W. Healy, Hanford Atomic Products Operation, Richland, WA. 1956

Nuclear Track Technique for Low Level Plutonium in Urine. Part of Proceedings of the 1st Annual Health Physics Society Symposium held in Ann Arbor, Michigan, June 25-27, 1956, (p. 53-60).

A method for analyzing urine samples for very small quantities of plutonium has been developed. The method requires evaporation of the urine sample, muffling, precipitation, and an extraction with thenoyltrifluoroacetone (TTA). The plutonium is subsequently electrodeposited on a 7 mm diameter area. The disc so prepared is held against a nuclear track emulsion for 168 hours. Techniques were perfected for preparing, processing, and microscopic examination of the emulsion. The detection limit of less than 0.05 d/m per sample

<186>

CHEMICAL ASPECTS

<186> CONT.
currently achieved on a routine basis is low enough to permit early recognition of incipient plutonium deposition. (Auth)

See also Nucleonics, 16(6), 78-81 (June, 1958).

<187>
Stover, B.J., F.W. Bruenger, and W. Stevens, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1968

The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum. Radiation Research, 33, 381-394.

When human blood serum that had been tagged in vitro with monomeric Pu(+4) was subjected to gel filtration, most of the Pu(+4) was found in two molecular-weight ranges, that of the low-molecular-weight serum proteins and that of small molecules and ions. The distribution of Plutonium(+4) between the two peaks was variable. In addition, a small amount was eluted in the highest-molecular-weight fraction. By a combination of gel filtration, ion exchange, and electrophoresis the Pu(+:) protein complex was isolated, and the protein was identified as transferrin, the protein that transports iron. Pu(+4) appeared to be bound at the iron-binding sites, and the reaction between Pu(+4) and transferrin was shown to be reversible. The stability constant of the complex is high but less than that of the very stable FeIII transferrin complex. The variation in distribution of PuIV between transferrin and the low-molecular-weight region thus is related to the variation in the amount of iron bound by the transferrin. (Auth)

<188>
Thomas, C.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples. BNWL-1950 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1974, (p. 153-154), 238 p.

A procedures was developed to determine naturally occurring radionuclides of uranium, thorium, and radium as well as pollutant radionuclides of plutonium and americium in soils. This method allows accurate measurement of low concentrations of radionuclides through chemical separation and alpha energy analysis. The procedures begins by thoroughly drying the soil sample and then a 30 g aliquot is weighed and placed in a container of suitable counting geometry. The gamma emitting radionuclides including Am 241, Ra 226, and Ac 228 are measured using a low background anticoincident shielded Ge(Li) diode that has the capability of separating the radionuclides with coincidence gamma photons from those radionuclides that emit non-coincidence gamma photons. The soil sample is then removed from the counting container and Pu 236 and Am 243, as tracers for chemical yield, are added. Following chemical separation, Pu, Th, and U are electroplated onto stainless steel discs at 1.1 amps for 2 hr. Individual isotopes are measured using alpha energy analysis. (FMM)

<189>
Volchok, H.L., Health and Safety Laboratory, New York, NY. 1975, April 1

Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report. Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-127 - I-144), 227 p.

All of the available analytical results from the 8 sediment cores and 16 water samples obtained from water bodies in the vicinity of Mound Laboratory during July, 1974, are reported here. These include Pu 238 in both sediment and water, Am 241 in sediment and H 3 in water. The quality of these analyses was found to be acceptable with the exception of an approximately 30% bias in the accuracy of the Pu 238 data. (Auth)

<190>
Lindenbaum, A., and W. Westfall, Argonne National Laboratory, Argonne, IL. 1965

Colloidal Properties of Plutonium in Dilute Aqueous Solution. International Journal of Applied Radiation and Isotopes, 16, 545-554.

The colloidalproperties of Pu(+4) in solutions suitable for injection were investigated as a function of pH, time after pH adjustment, and relative concentrations of Pu and complexing citrate ions. Polymerization is increased with increasing pH and depressed by a large molar excess of citrate. The rate of depolymerization is directly proportional to citrate concentration, time and acidity. Differences in the rates of polymerization and depolymerization are demonstrated. The polydisperse nature of Pu (+4) colloids is shown by kinetic dialysis studies which demonstrate a mixture of diffusible species. Apparent discrepancies between values for the fraction of diffusible Pu obtained by ultrafiltration and by dialysis are related to reversible polymerization. Techniques are described for the preparation of Pu-citrate solutions of minimal colloidality and for rapid estimation of colloidal formation by the ultrafiltration procedure. The relation between the colloidal properties of Pu and its distribution in animal tissues is discussed. (Auth)

Table 1 shows distribution of Pu in mice 3 days after IV injection.

ECOLOGICAL ASPECTS
AQUATIC

<191>
Cohen, L.K., and T.J. Kneip, New York University, Medical Center, New York, NY. 1971

Environmental Tritium Studies at a PWR Power Plant. CONF-710809; Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 623-639), 807 p.

In the aquatic environment, there is significant incorporation and retention of tritium in the bound state of bottom sediments and biota. Tritium expressed in terms of pCi/l was found to be, on the average, ten times higher in sediment, four times higher in fish, and three times higher in rooted aquatic plants than the ambient tritium concentration in water. In some instances the tritium content of the free or loose water of these components was also one to two times higher than ambient water. The exchange of tritium and the incorporation of tritium by metabolic processes in organic and mineral materials will depend on the specific activity of the source of tritium, the form of tritium, and the magnitude and direction of the "isotope effect" in particular reactions. It will also depend on the amojnt of exchangeable hydrogen and growth stage of the organism. The greatest mass of tritium compared to protium will affect chemical equilibrium and rate constants where molecules are labeled with tritium. The stability of the tritium-carbon bound in organic compounds will result in greater retention of tritium in these comoounds. In the environment, the exposure to tritium has been chroni and at levels that have been four to eight times higher than present concentrations. This permitted nonexchangeable sites to be labeled by tritium by formation, producing an "inheritance" of tritium that has persisted in sediment, detritus, fish and plants. This tritium, bound in an organic or mineral matrix, provides an additional source of tritium in the ecological cycle. In this form, it appears to be an effective source of tritium to be synthesized in new organic material. Thus, rooted aquatic plants can acquire tritium from the sediment and fish can aquire tritium through the food web in addition to the tritium obtained from the water. In this way, it is possible that tritium can be accumulated in biota above current ambient concentrations. (Auth)

<192>
Smith, D.D., J. Barth, and R.G. Patzer, Environmental Monitoring and Support Laboratory, Monitoring Systems Research and Development Division, Las Vegas, NV. 1975

Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site. IAEA-SM-199/73; CONF-751105; STI/PUB/410; Part of Proceedings of a Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p. 325-336), 724 p.

In this continuing grazing study on a plutonium-contaminated range on the Nevada Test Site, cattle are confined to an area of known plutonium contamination. Their entire diet consists of native plants growing in the contaminated soil. The primary objective of this study is to determine the uptake and tissue distribution of the plutonium by ruminants. Steers with surgically prepared rumen fistulas serve as biological samplers to determine grazing habits as a function of seasonal plant availability and preference, to estimate intake of actinides over specified periods of time, and to determine the actinide ratios within the ingesta. Tissue samples have been collected from three cows, two calves, and one fetus in October 1973; three cows and two feti in July 1974; and one cow and two yearling calves in June 1975. Other animals sampled from the study area included three goats, three foxes, one jackrabbit, and one coyote. All animals sacrificed were necropsied and selected tissue and organ samples collected for histopathological examination and actinide analyses. No significant lesions have been found and actinide accumulations in the tissues have been relatively minimal. Using activity levels found in the rumen contents of fistulated steers, it was estimated that a study cow ingested 100 uCi prior to sacrifice. Of this, 16.4 uCi was in fluids from which a combined retention factor of 0.0034% was calculated for the bone, muscle, and liver. Comparisons of Pu 239/238 ratios in ingesta and tissues indicate that the plutonium 238 is more readily absorbed and retained. Analysis of ingesta from the fistulated steers indicates that the favored plant species were two shrubs, EUROTIA LANATA and ATRIPLEX CANESCENS; and one forb, SALSOLA PAULSENII. Grasses are preferred in the late spring and early summer months, with shrubs making up the bulk of the diet the rest of the year. Plutonium activity in rume contents was higher when EUROTIA LANATA was the preferred shrub species. Studies on labeled particles indicate that ingested particles from 75 to 500 um in size have a half-time of 3.5 to 5 days in the intestinal tract, while particles of 15 to 25 um in size have a half-time of about 1.4 days. (Auth) (JTE)

<193>
Baturin, G.N., Institute of Oceanography, Moscow, USSR. 1973, September

Uranium of the Contemporaneous Sedimentary Cycle of the Sea. Geokhimiya, 9, 1362-1372. (Russian, English Abstract)

During the weathering of rocks and in river run-off, uranium is divided into the dissolved and the suspended fractions at an average 1:1 ratio. The average uranium content in the sum of dissolved and suspended matters of river run off corresponds to its average content in the Earth's crust; that determines the uranium content in sea and ocean sediments. The share of hydrogenous uranium being concentrated in sediments. The share of hydrogenous uranium being concentrated in sediments of sea basins and in the peripheric zones of the ocean up to (10 to 60) x 10(E-4)% plays a secondary role in the total balance. This concentration is favored by the enrichment of sediments of organic matter and phosphorus, by the increased uranium content in waters, by the reducing conditions near the boundary of water--bottom divide, by the lowered sedimentation rate, and by the renewal of the near-bottom waters. Uranium transition from the solid phase to intersitial waters, where its concnetration reaches n x 10(E-4) g/l, is a precondition of its redistribution during diagenesis. (Auth)

<194>
Cherry, R.D., and L.V. Shannon, University of Cape Town, Physics Department, Rondebosch, Cape Province, South Africa; Division of Sea Fisheries, Sea Point, Cape Province, South

<194>

ECOLOGICAL ASPECTS
AQUATIC

<194> CONT.
Africa. 1974

The Alpha Radioactivity of Marine Organisms. Atomic Energy Review, 12(1), 3-45.

The important role played by alpha-radioactive nuclides in the marine radiation environment were discussed. Detailed surveys of the alpha-emitting nuclides and their relevant nuclear properties, and of the concentration and distribution of these nuclides in seawater, in marine organisms and in the organs thereof were presented. Data were compiled in tabular form to show that the total alpha activity in seawater is typically about 3.2 pCi/liter. Of this, the uranium series nuclides contribute about 96%, while the three uranium nuclides contribute about 76%. It was also shown that Po 210 is by far the dominant contributor to the alpha radioactivity of all the categories of marine organisms included, except phytoplankton where it is replaced by Ra 226. However, in this category the Po 210 contribution is substantial also. Brief comments were made on experimental techniques, the biochemical balance problem and radiation dosimetric considerations. Suggestions for future lines of research were included. (Auth) (JTE)

One-hundred fifty references are contained in this article.

<195>
Marshall, R.P., University of Washington, Seattle, WA. 1975

Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon. Ph.D. Thesis, University of Washington; 167 p.

The concentrations and distributions of Pu 239+240, Pu 238, Am 241, Bi 207, Eu 155, Cs 137, and Co 60 in the sediments of Bikini atoll lagoon were investigated by radiochemical and radiometric analyses of 33 surface sediment samples and 9 sediment cores collected in 1972. The total alpha values obtained for a Bravo crater sediment were greater (ca. 13%) than the sum of Pu 239+240, Pu 238, Am 241 and the natural radionuclide concentrations measured or estimated indicating the possibility of other alpha emitting radionuclides which were bomb produced. Whereas the highest concentrations of Pu 239+240, Am 241, Eu 155, and Cs 137 were measured in surface sediments collected from lagoon stations, the highest concentrations of Pu 238 (19 pCi/g, Bi 207 (432 pCi/g) and Co 60 (306 pCi/g) were measured in below surface crater sediment samples. The shape of the major distribution of Pu 239+240 and Am 241 concentrations in the lagoon may be described as roughly elliptical. The highest concentrations of Pu 239+240 (120 pCi/g) and Am 241 (103 pCi/g) measured in any samples, occur at the focus of the "ellipse" at a location in the northwest quadrant of the lagoon about 6 km SSE of the Bravo crater. In the northwest quadrant of the lagoon, a layer of fine sediments from 8 to 11 cm in depth was found covering the normal sedimentary deposits. Measurements of U 234:U 238 and Ra 226: U 234 ratios in samples of these finely divided sediments show them to be very old corals, presumably from the detonation craters. In two cores collected from this region of high radionuclide concentrations, the concentrations of Pu 239+240, Am 241 and Eu 155 decrease linearly with depth at a rate of about 50% through the layer of finely divided sediment. (Auth) (FMM)

<196>
Robison, W.L., Lawrence Livermore Laboratory, Livermore, CA. 1973, October

Dose Estimates for the Marine Food Chain. NVO-140 (Vol. 1); Part of Enewetak Radiological Survey, (p. 526-541), 736 p.

The data bank contains analytical results from slightly over 800 fish and approximately 50 edible invertebrates collected during the 1972 Enewetak survey. Data from the analysis of the radionuclide concentration in fish muscle were summarized in several different ways to help in the interpretation and the assessment of the values used in the dose code. Elements other than Cs 137, Co 60, Sr 90, Pu 238, 239, 240, and Fe 55 were for the most part nondetectable. The doses via the marine and terrestrial food chains were estimated using a differential equation to describe intake and retention by man. Integral doses calculated from the marine survey data were listed for the whole body and bone for 5, 10, 30 and 70 yr. The major contribution to the whole-body dose came from Cs 137 and Co 60, while the same dose came from Sr 90, as well as Cs 137 and Co 60. The 30-yr integral whole-body dose was 47 mrem from Cs 137 and Co 60 and only 6 mrem additional whole-body dose was constructed by other radionuclides (including Pu 238, Pu 239, Am 241 and U 235). For bone, the total dose from all radionuclides was 840 mrem, with 94% contributed by Sr 90 and 6% by all other nuclides. Dose estimates for C 14 and I 129 were made and included in the summary of the marine pathway. (FMM)

Tables 156 a, b, c and d give summaries of radionuclide (including Pu 239, 240, Pu 238, Am 241 and U 235) concentrations for the entire Atoll for mullet, surgeion, goatfish and other fish.

<197>
Hauschildt, W.H., Dow Chemical Company, Rocky Flats Division, Golden, CO. 1971

Administrative Procedures and Controls in Plutonium Production Areas. CONF-710401; Part of Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities held in Golden, Colorado, April 13-16, 1971, (p. 293-296), 457 p.

Prior to the fire at the Rocky Flats Plant on May 11, 1969, the specific procedures for handling, storing, and processing, within product specifications, was the responsibility of the managers of each functional plutonium processing group. Immediately following the fire management philosophy and operational concepts were reviewed. It had determined that the standard Safety Practice Manual offered an excellent foundation for the administration and control of handling and storing techniques of Pu process areas. The introduction of the manual describes it as: (1) a compilation of current general standard safety practices for the Rocky Flats division, (2) a source of information that will prevent injury to personnel and damage to property, and (3) it directs itself toward those practices which have plant wide application or which are related to interfaces between departments. The standard procedures were established by analyzing information submitted by each group on their

ECOLOGICAL ASPECTS
AQUATIC

<197> CONT.
operating procedures, and determining a number of common denominators. This information was then codified for each physical or chemical form of Pu involved; the type of container, type of packaging and other information concerning the handling and storage operation was recorded. Tighter controls and more restrictive procedures were established in many cases. (JTE)

<198>
Koide, M., J.J. Griffin, and E.D. Goldberg, Scripps Institution of Oceanography, La Jolla, CA. 1975, October 20

Records of Plutonium Fallout in Marine and Terrestrial Samples. Journal of Geophysical Research, 80(30), 4153-4162.

In coastal marine sediments from western North America there is a continuing increase in Pu 239 and 240 concentration from the early 1950's to the present. Most of these transuranic isotopes have entered our surroundings following nuclear weapons testing from direct stratospheric fallout which went through a maximum around 1963. Since no maximum level in the sediments corresponding to the maximum stratospheric fallout was observed, another source of plutonium to these deposits was sought. It has been identified through the analyses of atmospheric aerosols as crustal rock debris transferred from the continents to the oceans by winds. A transport of soil debris, containing sorbed artificial radionuclides, to the oceans by winds and/or by rivers may explain the greater Sr 90 fluxes to the marine environment, compared to those of the continents, after the fission product is produced in nuclear explosions. (Auth)

Tables on lead, thorium, and plutonium basin sediment concentrations are given. A table on the lead and plutonium concentration in atmospheric dust samples is given.

<199>
Not given, Deutscher Hydrographisches Institute, Hamburg, German Federal Republic. 1973, November

Bibliographies in Nuclear Science and Technology. AED-C-25-03; Maritime Radiology, Section 25; 65 p.

About 200 references to publications from the world literature on the radioactivity in ocean sediments and waters are presented in the bibliography. Sampling and measuring methods are given, and keywords in English are provided for each item. Subject, author, and location indexes are included. (CH) (JTE)

<200>

ECOLOGICAL ASPECTS
TERRESTRIAL

<200>
Beatley, J.C., University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1973, May

Russian-Thistle (SALSOLA) Species in Western United States. Journal of Range Management, 26(3), 225-226.

Russian-thistle populations in western United States consist of either of two species, or both, and are distinguishable at all stages in the field. A summary is given of the characters by which they may be distinguished. SALSOLA PESTIFER is now replaced by an earlier name, S. IBERICA. The second species, S. PAULSENII, prevails in many areas, especially in the southwest. Where growing together they appear to hybridize freely, resulting in populations exhibiting varying degrees of genetic introgression. (Auth)

<201>
Beatley, J.C., University of Cincinnati, Department of Biological Sciences, Cincinnati, OH. 1975, January

Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada. American Midland Naturalist, 93(1), 53-70.

Plant communities of the transition between the Mojave and Great Basin deserts of southern Nevada are under the primary control of climatic variables. Rainfall increases and temperature decreases according to large increments of increase in elevation of the drainage basins frm South to North. Within the basins, the climates and vegetatin pattern are primarily under the control of patterns of air circulation and nocturnal cold air accumulations and secondarily, of edaphic factors. Minimum temperature and maximum mean rainfall tolerances of Mojvae Desert LARREA (creosote bush) communities are exceeded across this transition as, apparently, are the mean maximum temperature and minimum rainfall tolerances of the Great Basin ARTEMISIA (sagebrush) communities. In those communities which characterize the transition (COLEOGYNE, GRAYIA-LYCIUM ANDERSONII, LYCIUM PALLIDUM-GRAYIA, LYCIUM SHOCKLEYI), the Mojave and Great Basin Temperature and rainfall regimes occur in various definable combinations. Only ATRIPLEX CONFERTIFOLIA (shadscale) communities cannot be so defined; these occur along topographic gradients in both Mojave and Great Basin Desert climates. Contrasts in temperature regimes and their effects on vegetation in the lowlands of closed basins are illustrated by air temperature and plant data from two adjacent sites, with only 1.5 m elevation difference, near the playa of Frenchman Flat. All relationships are inferred from data collected during 10 years on a network of study sites on the Nevada Test Site of central-southern Nevada, whose drainage basins encompass the transition from the Mojave to the Great Basin Desert. (Auth)

<202>
Bradley, W.G., and K.S. Moor, University of Nevada, Las Vegas, NV. 1975, June

Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 151-185), 504 p.

Ecological studies of vertebrates in plutonium-contaminated areas of the Nevada Test Site (NTS) were initiated in March, 1972, and have continued to date. In September, 1973, standard census methods were also employed to derive a qualitative and quantitative inventory of vertebrate biota of four Nevada Applied Ecology Group (NAEG) study areas of the Tonopah Test Range (TTR). A checklist of vertebrates of NAEG study areas of NTS and TTR is presented. Data are presented on vertebrate composition, relative abundance, and seasonal status in the study areas. More detailed data on rodent populations are included for Clean Slate 2 and Double Track, TTR, and Areas 11 and 13, NTS. Concentrations of Pu 239 and Am 241 were determined in pelt or skin, GI tract, and carcass of 13 lizards and 16 mammals resident on Clean Slate 2, TTR, and Area 11, NTS. A total of 71 animals were collected for radioanalysis. However, complete data were not available at the time this report was written. Plutonium tissue burdens were highest in lizards from Area 11 GZ. Maximum values obtained in nCi/g ash were 30.9, 42.2 and 0.43 for the pelt, GI tract, and carcass, respectively. Maximum Pu 239 values in tissues of small rodents from Area 11 (not from GZ) were 11.4, 6.49, and 0.20 nCi/g ash for pelt, GI tract, and carcass, respectively. Plutonium/Americium ratios were relatively consistent in tissue samples of lizards and small mammals from Area 11 (approximately 6:1, Plutonium/Americium). Pu/Am ratios were not consistent in vertebrates of Clean Slate 2, TTR, and appeared to be lower in carcass (28:1, Pu/Am in mammals) than GI tract (9:1, Pu/Am in mammals). Although this trend was more conspicuous in mammals, it was also evident in reptiles. Average discrimination factor of Pu 239 in GI tract and carcass of small vertebrates was in the order of magnitude of 10(E-2) in most instances. Although sample numbers were small (N-4), reptiles from Clean Slate 2 exhibited an extremely low discrimination rate (5.2 x 10(E-0). (Auth)

Numerous taxa of lizards and other reptiles, rodents, mammals and other life on the Nevada Test Site and Tonopah Test Range are given in several tables.

<203>
George, A.C., L. Hinchliffe, and R. Sladowski, Health and Safety Laboratory, New York, NY. 1975, June

Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres. American Industrial Hygiene Association Journal, 36(6), 484-490.

The size distribution of radon daughters was measured in several uranium mines using four compact diffusion batteries and a round jet cascade impactor. Simultaneously, measurements were made of uncombined fractions of radon daughters, radon concentration, working level and particle concentration. The size distributions found for radon daughters were log normal. The activity median diameters ranged from 0.09 um to 0.3 um with a mean value of 0.17 um. Geometric standard deviations were in the range from 1.3 to 4 with a mean value of 2.7. Uncombined fractions expressed in accordance with the ICRP definition ranged from 0.004 to 0.16 with a mean value of 0.04. The radon daughter sizes in these mines were greater than the sizes assumed by various authors in

ECOLOGICAL ASPECTS
TERRESTRIAL

<203> CONT.
calculating respiratory tract dose. The disparity may reflect the widening use of diesel-powered equipment in large uranium mines. (Auth)

<204>
Holm, E., and R.B.E. Persson, University of Lund, Department of Radiation Physics, Lasarettet, Lund, Sweden. 1975, July

Fallout Plutonium in Swedish Reindeer Lichens. Health Physics, 29, 43-51.

The fallout of Pu 239 and Pu 238 has been investigated by studying samples of various species of lichen collected during 1947-1961 at different places in Scandinavia and between 1961 and 1972 (CLADONIA ALPESTRIS) at Lake Rogen in Sweden, which lies at 62.3 degrees N, 12.4 degrees E. The maximal Pu 239 level in the lichen carpet, which occurred in 1963, was about 300 pCi per kg dry weight, and it decreased tc about 200 pCi per kg dry weight in 1970. The mean residence time for Pu 239 in the whole lichen carpet was estimated to 6.1 plus or minus 0.5 yr and in the 3-cm top layer to 4.3 plus or minus 0.5 yr. The Pu 238 concentration showed a maximum value during 1963 corresponding tc about 12 pCi per kg dry weight. This concentration decreased to about 7 pCi per kg dry weight in 1967. During 1966-1970 the Pu 238 concentration increased and resulted in an increase of the Pu 238/Pu 239 activity ratio from 0.026 plus or minus 0.003 to 0.046 plus or minus 0.003. The total area-deposition of Pu 239 at the sampling place (62.3 degrees N, 12.4 degrees E) was estimated to 1.0 plus or minus 0.1 mCi km(E-2) in 1972. The corresponding value for Pu 238 was 0.036 plus or minus 0.004 mCi km(E-2) of which 0.013 plus or minus 0.002 mCi km(E-2) was due to SNAP-9A. The vertical distribution of the plutonium isotopes in the lichen carpet has also been studied. Results of the Pu 239 activity concentrations in reindeer liver and bone indicate a fractional gastrointestinal absorption of plutonium in reindeer in the order of (3 plus or minus 2) x 10(E-5). (Auth)

Plutonium concentrations in lichens, soils and reindeer are tabulated.

<205>
Johnson, L.J., M.A. Rosenthal, and J.E. Cason, Los Alamos Scientific Laboratory, Los Alamos, NM. 1974, May

Environmental Studies Group (H-8). LA-5633-PR; Part of Richmond, C.R. and Sullivan, E.M. (Comps.), Annual Report of the Biomedical and Environmental Research Program of the LASL Health Division, January through December, 1973, (p. 34-41), 165 p.

The Los Alamos Scientific Laboratory's radioecology program was initiated in 1972 to supply information on the environmental impact of the radioactive liquid waste disposal practices. A summary is presented to report progression two research activities, the environmental resources inventory and radioecological studies. Current environmental resource data include a map of vegetation types and infrared aerial photographs supplemented with field observations used in identification of at least seven major vegetation types in the country. Many of the woody and herbacious species have been identified and 300 have been placed in the herbarium. A proposal was drafted to desigmate LASL properties as a National Environmental Research Park. A feature of the park would be preservation for study of ecosystems that contain plutonium of various environmental age in which studies of changing mobility of the element may be sustained. Core samples of soil were taken for a study of the characterization of soils. These have been characterized as to particle distribution, cation, exchange capacity and soil pH. In radioecological studies, experimental results demonstrated that honeybees do not concentrate tritium above the levels measured in a supplied food. Bees which exhibited unexpectedly high tritium concentrations in body moisture probably acquired the radionuclide from a source which was at least equally contaminated with tritium. The insects rapidly reflected changes in tritium content in response to a measured biological half time of about one day. Radiation ecology studies of liquid waste disposal areas show stream channels are the major reservoir of waste plutonium and the degree of mixing of plutonium with alluvial sediment is associated with the presence or absence of surface water. Grass to sediment concentration ratios of 0.03-0.08 were from 1-3 orders of magnitude higher than some values reported for root uptake of plutonium in experimental plant-soil systems. Cesium 137 determinations showed maximum concentrations in upper canyon areas with most deposited within 2560 m from the discharge point. A survey of plutonium concentrations in soils, vegetation, and rodents was conducted along the fallout pathway of the atomic bomb detonated at Trinity Site. Plutonium concentrations were highest in the Ground Zero area and lowest about 24 km, and generally increased from 24-56 km. Pu levels were as much as 10(E+4) times greater than the 0.01-0.1 pCi Pu 239/g which have been reported for several New Mexico area soils. A maximum of 260 pCi/g was observed at Gz. Verticle distribution was relatively uniform to a sampling depth of 7.5 cm. Pu concentrations in grasses were consistently higher than in other areas of New Mexico, but not in forb and shrub tree samples. The maximum in Grasses (0.77 pCi/g wet sample) was observed at Gz and decreased to 0.005 pCi/g at 24 km, then increased to the 56 km sampling station. Rodent lungs had the highest mean Pu concentration of all small mammals. This suggests resuspension is an important mechanism. An increased migration into soils has occurred over the last 20 years. Hydrological characterizations of the soils at Trinity site showed soils which had a rapid water uptake rate exhibited a 50% increase in Pu concentration at 0-25 cm depth over that found at the 7.5-30 cm depth. (BBM)

<206>
Koch, J., University of Copenhagen, H.C. Orsted Institute, Physical Laboratory II, Copenhagen, Denmark. 1968

A Preliminary Report on the B-52 Accident in Greenland on January 21, 1968. CONF-680507; Part of Proceedings of a Symposium on Radiological Protection of the Public in a Nuclear Mass Disaster held in Interlaken, Switzerland, May 26-June 1, 1968, (p. 39-45), 688 p.

A brief survey of the administrative and radiological aspects related to the B-52 crash in northern Greenland is presented. The plane caught fire and, after the crew bailed out, crashed on the ice of Bylot Sound. Danish and United States scientific

<206>

ECOLOGICAL ASPECTS
TERRESTRIAL

<206> CONT.
and military personnel were dispached to the sceme after a four day delay because of a heavy storm. Operation Crested Ice was carried out to clean up the site of radioactive contamination. Eskimos in the area were warned of the danger and after the area of contamination was determined clean-up measures were undertaken. The fire from the crash spread plutonium into the atmosphere and the radiological survey indicated that surface contamination was confimed to the immediate area. All pieces of debris and as much of the contaminated snow and ice as possible was removed and brought to the United States. Core samples and air samples were taken. None of the air samples showed activity above background for airplane routes to Thule or across Greenland on ordinary traffic routes. Water samples of Bylot Sound showed activity levels below limits considered hazardous to humans by passage through the food chain. Biological samples from animals of the area were also obtained. No Eskimos in the area became contaminated and the Danish AEC will conduct an ecological program and a search for floating debris. The area was determined to be safe for the future. The scope of the report did not include figures for the amount of plutonium released by the accident. (BBM)

<207>
Mellinger, P.J., and V. Schultz, Washington State University, Department of Zcology, Pullman, WA; NUS Corporation, Rockville, MD. 1975, May

Ionizing Radiation and Wild Birds: A Review. CRC Critical Reviews in Environmental Control, 5(3), 397-413.

The literature on wild birds and ionizing radiatin is reviewed and brief descriptions of selected papers are included. Literature on domestic birds is not included. Two hundred and twenty-six papers have been cited and many were briefly discussed in three primary sections. The sections on radionuclide concentration and radiation effects iclude studies in nature as well as in the laboratory. Observations on world-wide fallout and at weapons considered. It was reported that plutonium released by the noncritical destruction of nuclear weapons in an aircraft accident in Greenland was nt significantly concentrated by the eider duck (SOMATERIA sp.) as the levels observed were not significantly different from background. In a radiological survey of Enewetak Atoll when the USAEC was obtaining data on the possibility of rehabilitating the atoll by man, the concentrations of K 40, Fe 55, Cs 60, Sr 90, Cs 137, and Pu 239, 240 were analyzed in birds. The predominant radionuclides in the atoll environment were Co 60, Sr 90, Cs 137 and Pu 239. In a study on Chukar partridges (ALECTORIS GRAECA) collected near Haines Pond at the Nevada Test Site, it was shown that a gram Chukar muscle contained 110 pCi of I 131 and 0.17 uCi of H3. The final section is on the use of radionuclides in conducting studies on wild birds and includes studies of behavior, physiology, and the use of neutron activation as well as muscellaneous techniques. The review should be useful to persons preparing nuclear power plant environmental impact statements as well as a source of information for the general public. (FHM)

<208>
Not given, Colorado Committee for Environmental Information, Colorado. 1970, May

Damage. Environment, 12(4), 15.

The role of the Colorado Committee for Environmental Information in monitoring and publicizing environmentally significant activities of the Army and the Atomic Energy Commission is presented. Specific reference is made to the storage of nerve gas, Project Rulison, and the activities of the Rocky Flats plutonium plant. (JTE)

<209>
Romney, E.M., A. Wallace, R.O. Gilbert, and J.E. Kinnear, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1975, June

Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas. NVO-153; UCLA-12-986; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 43-87), 504 p.

Data on the Pu 239-240 and Am 241 contents of vegetation samples collected in conjunction with the Nevada Applied Ecology Group (NAEG) soil sampling program in aged plutonium fallout areas on the Nevada Test Site (NTS) and the Tonopah Test Range (TTR) were reported. Radiochemical analyses essentially have been completed on samples collected from the GMX site in Area 5 and the Project 57 site in Area 13. About 60 percent of the vegetation samples collected from the Area 11 sites at NTS and Roller Coaster sites at TTR have undergone radiochemical analysis. Preliminary data indicated definite variations in contamination levels from sample to sample collected within a given activity stratum defined by the FIDLER survey instrument. Variations also occurred in contamination levels on different plant species and can be attributed to differences in amounts of resuspendable particulate material superficially entrapped upon plant foliage. In spite of these variations, there were some indications of reasonable agreement between the mean activity levels of Pu 239-240 in vegetation and soil samples collected across the different activity strata within each fallout area. In addition, there were indications that the ratio of vegetation Pu to soil Pu increases as one proceeds from higher to lower activity strata. A limited particle size range of resuspendable material superficially deposited upon vegetation could account for some of the variations in activity levels and ratios noted when comparing vegetation and soil data. Sufficient data have been acquired to indicate a reasonably constant Pu/Am ratio for vegetation samples collected from a given fallout area. This ratio, however, varied among separate events as the result of differences in the ingrowth of Am 241 within aged fallout source materials. The Pu/Am ratios tended to be lower in vegetation than in soil samples for each event studied, except for the Area 5-GMX site where multiple tests were conducted. The lower ratios in vegetation samples were presumed to result from a preferential uptake by plant roots of the more biologically available Am 241 as compared to Pu 239-240 in these aged fallout areas. The Pu 239-240 inventory estimates for Area 13 indicate that standing vegetation contributes a rather insignificant portion of the total contaminant present in aged fallout areas.

ECOLOGICAL ASPECTS
TERRESTRIAL

<209> CONT.
(Auth)

Table 1 shows the Pu 239-240 contents and Pu 239-240/Am 241 ratios for different plant species in aged Pu-fallout areas of the Nevada Test Site and Tonopah Test Range. Table 2 gives the Pu 239-240 contents of vegetation and soil samples and the vegetation/soil ratios for samples from aged Pu-fallout areas on the Nevada Test Site and Tonopah Test Range. Table 3 shows the Pu 239-240 and Am 241 contents and ratios for vegetation and soil in aged Pu-fallout areas on the Nevada Test Site and Tonopah Test Range.

<210>

ENERGY

<210>
Eggers, P.E., and J.L. Ridihalgh, Battelle Columbus Laboratories, Columbus, OH. 1974, October

Cost-Effective Radioisotope Thermoelectric Generator Designs Invclving Curius 244 and Plutonium 239 Heat Sources. Journal of Spacecraft and Rockets, 11(10), 704-709; CONF-730811; Part cf Proceedings of the 8th Intersociety Energy Conversion Engineering Symposium held in Philadelphia, Pennsylvania, August 13-16, 1973 (6 p.).

A comparative analysis is presented of some of the technical considerations surrounding the use of Cm 244 and Pu 238 heat sources in radioisotope thermoelectric generators (RTGs). The principal considerations include radiological shielding, ground handling, and generator performance characteristics. A novel approach to RTG design and qualification is described which would facilitate the use of Cm 244 heat sources. This approach, which involves hermetically sealed bellows-encapsulated thermoelectric elements, also features the potential for increased generator output power stability and reliability and lower converter costs accruing from the advantages of a standardized approach to generator design, fabrication, and qualification. (Auth)

<211>
Enomoto, S., and N. Wada, Japan Atomic Energy Research Institute, Tokyo, Japan. 1974, April

Recent Status of Practical Application of Transuranic Elements. Genshiryoku Kogyo, 20(4), 15-26. (Japanese)

The use of transuranium elements as heat and radiation sources is reviewed. Topics discussed include Pu 238 and Cm 244 as heat sources for thermoelectric generators; Am 241 and Cf 252 as neutron sources; and radiometric gages. (TDF)

<212>
Engstrom, D.E., Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV. 1975, June

Environmental Sciences Information Storage and Retrieval System. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 471-472), 504 p.

Reynolds Electrical and Engineering Company, Inc. (REECo), has since 1970 accumulated information relating to the AEC's Nevada Applied Ecology Group (NAEG) programs at the Nevada Test Site (NTS). These programs, involving extensive soil, vegetation, and small-animal studies, have generated informational data concerning the collecting, processing, analyzing, and shipping of sample materials to various program participants and contractors. Future plans include incorporation of Lawrence Livermore Laboratory's resuspension study data, REECo's onsite air data, and EPA's large-animal offsite air, and offsite soil data. (Auth)

<213>
Hunt, S.E., University of Aston, Birmingham, England. 1974

Nuclear Power and the Environment. Part of Hunt, S.E., Fission, Fusion and the Energy Crisis, Chapter 10. Pergamon Press, Oxford, England, (p. 109-118), 164 p.

Radioactive material represents two possible biological hazards: as a source of Alpha, beta or gamma rays it can subject the body to these radiations from outside, or it may be inhaled or swallowed, subjecting the body to irradiation from within. A table of the maximum permissible body burdens for the most significant isotopes produced in reactors is given. In the United Kingdom the maximum dose permitted for personnel actually employed in the nuclear industry is ten times that for the general population and no worker should accumulate a dose of more than 5 rems each year. The potential hazard represented by the accumulation of radioactive fission products in the normal operation of the reactor program is considered. These fission products build up in the reactor fuel elements during operation of the reactor and after some 40% or so utilization of the fissile material the fuel elements must be removed from the reactor and treated to separate the Pu 239 'bred' in the reactor and the residual U from the fission products. The chemical separation of the spent fuel elements and storage of the concentrated waste is described. The purfication plant at Windscale is not capable of extracting the last 0.01% of the fission product activity in a form suitable for concentration, and this is diluted and discharged into the sea off Windscale. Very extensive measurements on the resulting activity of seawater, plants and fishes are carried out and these show that the increase in the level of radioactivity to which the local population is exposed is less than 1% of the maximum permissible level. Methods of storage for radioactive waste are mentioned such as disused mines, underground salt strata and craters. The effects of waste left from nuclear power stations on the environment and the effects of power generation on the climate as a whole are also discussed. (PNM)

<214>
Oen, C.J., H.A. Pfuderer, and C.T. Sanders, Oak Ridge National Laboratory, Nevada Applied Ecology Information Center, Oak Ridge, TN. 1975, June

Information and Research: An Essential Partnership. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 491-497), 504 p.

Information support provides the link between the relevant literature and the current research and administrative activities of the Nevada Applied Ecology Group (NAEG). A data base consisting of information relevant to the NAEG environmental interests is maintained. The scope of coverage has been expanded, particularly into the transplutonic elements and their environmental aspects. In addition to the building of the data base, services from it are available in the form of publications, computer searches, and customized services. (Auth)

<215>
Richmond, C.R. (Comp.), and E.M. (Comp.) Sullivan, Los Alamos Scientific Laboratory, Los Alamos, NM. 1974, May

Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973. LA-5633-PR; 165 p.

This report summarizes research and development activities of the Los Alamos Scientific Laboratory's Biomedical and Environmental Research Program for calendar year 1973. Information on organization of the participating groups within the Health Division, research interests of the staff, and supporting facilities available at the Los Alamos Scientific Laboratory are included. In February 1973, the Biomedical Research Group was disbanded and reorganized into four new groups. Previous annual reports of this series related to the now defunct Biomedical Research Group are LA-4923-PR (1971) and LA-5227-PR (1972). This report is the first to reflect the overall activities of all the research and development conducted by all six groups within the Health Division that are supported by the Division of Biomedical and Environmental Research of the U.S. Atomic Energy Commission. Although the technical portion of this report is based upon major areas of research conducted by each group, the total effort reflects the multidisciplinary approach to problem solving which still represents a very basic ingredient of the research philosophy. The six groups are concerned with: mammalian radiobiology, industrial hygiene, environmental studies, cellular and molecular radiobiology, biophysics and instrumentation and organic and biomedical synthesis. The format is akin to that of Science with the goal of transmitting a maximum of information in a concise manner with a minimum of technical detail. Work which has been published or submitted for publication has not been duplicated in this report. A list of publications for 1973, which follows as an appendix, allows the reader to consult the published literature for additional specific technical detail. Three articles were selected for separate input into the data base. (Auth) (JTE) (CTS)

<216>

ENVIRONMENTAL ASSESSMENT

<216>
Shalmon, E., and J. Chanteur, World Health Organization, Geneva, Switzerland. 1972

Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources. CONF-720453; Part of Proceedings of a Symposium on the Disposal of Radioactive Wastes held in Paris, France, April 12-14, 1972, (p. 205-223), 290 p.

Environmental pollution is said to exist whenever any substance that does not serve a useful function is present. The sources of nonradioactive pollution are discussed in relation to their effects on the air, water and land environments. The health implications of radioactive wastes are discussed under the following headings: sources and characteristics of wastes (the largest quantities being from nuclear reactors, particularly from the reprocessing of nuclear fuels); radionuclides of global importance (tritium, I 129 and Kr 85), health effects of radioactive contamination (genetic and somatic effects); impact on man and his environment resulting from operating nuclear plants; and the role of health authorities. (FMM)

<217>
Stewart, G.L., University of Massachusetts, Department of Plant and Soil Sciences, Amherst, MA. 1971

The Behavior of Tritium in Soil. CONF-710809; Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 462-470), 807 p.

A continuing search for an ideal water tracer and a better understainding of the isotope effect in tritium tracer techniques and its consequent use as a scientific tool to study clay-water interaction and other natural processes occuring in the clay-water system are the basis of this investigation. Because of the characteristics of the clay-water system, tritium fractionation occurs as tritium in bulk pore water exchanges with water in different physical states and with hydroxyl groups. Both thermoydnamic theory and experimental data suggest that tritium fractionation is small as isotopic exchange occurs between the bulk pore water phase and the tenaciously adsorbed water phase. Isotopic exchange occurs between hydrogen in adsorbed water and crystal lattice hydroxyls for all clay minerals and soils studied. A few samples of illite and Davidson clay showed high exchange rates and suggested that considerable tritium fractionation may occur. The conditions and/or factors responsible for this high exchange are not known. Many practical hydrologic investigations will not require that corrections be applied to experimental data for the isotope effect of tritium because other factors associated with water flow are more significant. (RAP)

<218>
Thomas, C.W., and R.W. Perkins, Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1975, April 1

Transuranium Elements in the Atmosphere. HASL-291; BNWL-1881; Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-80 - I-103), 227 p.

The main release of transuranium elements to the atmosphere has been a result of nuclear weapons testing, particularly the high yield fusion bomb tests beginning with the Ivy Mike test in 1952. It has been estimated that approximately 300 kCi of Pu 239-240 were deposited on the earth's surface through 1972. Approximately 17 kCi of Pu 238 was injected into the atmosphere of the southern hemisphere in April 1964 when a satellite containing a power source failed to achieve stable orbit. Analysis of the debris of Ivy Mike and subsequent high yield nuclear weapons debris has shown transuranium elements to mass 257. The amounts of these heavy radionuclides compared with Pu 239-240 drop off rapidly with mass. However, there are very considerable amounts of Pu 241 and Am 241, and the Am 241 after total decay of Pu 241 will actually exceed the Pu 239-240. On comparing the airborne Pu 239-240 to Cs 137, it is found that their ratio has been relatively constant for the last several years, thus one can use the atmospheric models which describe the behavior of the fission products in describing the movement of the transuranium elements. Thus, it is possible to predict what the deposition pattern of the transuranium elements has been from past nuclear tests on the surface of the earth. It has been estimated that the nuclear power industry will generate approximately 10(E+9) curies of transuranium elements during the remainder of this century. While it is highly unlikely that a significant amount of this material can enter the atmosphere, this source needs consideration, particularly in view of the much higher levels of some of the transuranium elements than that of Pu 239. (Auth)

<219>
Ulrikson, G.U., Oak Ridge National Laboratory, Information Division, Information Center Complex, Oak Ridge, TN. 1975

Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory. CONF-750967 (Vol. 1); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 442-488), 1015 p.

The organization and operation of the Information Center Complex (ICC) of Oak Ridge National Laboratory are discussed. The primary function of ICC is to develop and correlate the information activities of the energy and related environmental research projects at ORNL and to systematize operations to achieve maximum response to the information needs of funding agencies and the user community. The development of new data bases and information services as need arises is a major responsibility of ICC. Interactions among segments of ICC provide for a wide range of analysis and synthesis of knowledge, resulting in a synergistic effect. The ICC provides information in several major active research areas, energy, human health, environmental impact, radiation research, trace contaminants, land use and planning, and ecosystems modeling and analysis. (Auth)(JTE)

Seven major types of services supplied to users of the Information Center Complex are listed in Table 1.

<220>
Volchok, H.L. (Ed.), Health and Safety

<220> CONT.
Laboratory, Environmental Studies Division, New York, NY. 1975, April 1

Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975. HASL-292; 77 p.

From October, 1958, to January 1, 1975, the Health and Safety Laboratory (HASL) has published a series of reports of data on environmental contamination. In keeping with HASL's broadening involvement in non-fallout environmental matters under the new U.S. Energy Research and Development Administration (ERDA) the new series will continue under the title "Environmental Quarterly." HASL reports (citations only) are organized with respect to chronological, subject, and author listings. (ND) (CSF)

<221>
White, M.G. (Ed.), and P.B. (Ed.) Dunaway, Nevada Operations Office, Las Vegas, NV. 1975, June

The Radioecology of Plutonium and Other Transuranics in Desert Environments. NVO-153; Nevada Applied Ecology Group Progress Report for 1974; 504 p.

A status report on the activities of the various components of the Nevada Applied Ecology Group (NAEG) was presented. The previous report, "The Dynamics of Plutonium in Desert Environments", NVO-142 (July, 1974), reviewed the history and organization of the NAEG. Data generated since that time are included in this, the second report. The stated objectives of NAEG are as follows: 1) delineation of locations of contamination, 2) determination of concentrations in ecosystem components, 3) quantification of rates of movement, 4) evaluation of radiological hazards of plutonium on the Nevada Test Site, 5) identification of areas which need to be cleaned up or treated, and 6) development of techniques for cleanup or treatment. Twenty-one papers related to these objectives were individually input into the data base. Most projects are moving at an accelerated rate, a few have been delayed by the necessity to meet new requirements concerning release of radionuclides in the environment, and unexpected large logistical and radioanalytical costs. (JTE) (HP)

<222>
Wireman, D.L., and C.E. Rosenberry, Jr., Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV. 1975, June

Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 465-469), 504 p.

Activities and sample logistics of Reynolds Electrical and Engineering Company, Inc. (REECo), in support of the Nevada Applied Ecology Group (NAEG), were discussed in this summary report. Plutonium intensive study areas include Double Track, Clean Slate 1, Clean Slate 2, and Clean Slate 3 at the Tonopah Test Range (TTR); and Area 13 (Project 57), Area 5 (GMX), and Area 11 (Plutonium Valley) at the Nevada Test Site (NTS). REECo activities include: collection, preparation, and shipment of soils, vegetation, and small animals; support of NAEG field investigators; and computerization of the NAEG analytical data bank. As of September 1, 1974 the NAEG data bank contained approximately 5,000 results of radiological analyses of soil, vegetation, and small animals in addition to associated identification, collection, preparation and shipment data. (Auth) (JTE)

<223>
Brackenbush, L.W., C.L. Brown, and L.G. Faust, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, October

Future Considerations in the Shipment of Plutonium. BNWL-1847; 13 p.

By 1985, plutonium production from LWR's will increase from 2 metric tons (MT)/year to about 43 MT/year. The specific activity of this plutonium will be a factor of about four higher than today's production grade plutonium. At the same time heat generation per gram of plutonium will increase by a factor of about four. It is concluded that heat loads and radiation levels associated with high exposure plutonium will require many changes in future shipping practices for this type materials. Incorporation of neutron shielding in packaging is expected to be required as will redesign to accomodate increased heat loads. Moreover, safeguards considerations are expected to bring about the use of specially designed trucks for plutonium transport. These trucks will incorporate special features to further help prevent theft while in transit. Limitations imposed on package and vehicle loadings for criticality safety will remain essentially the same as in the past. An estimate of how much plutonium could be shipped in a truck, under the above mentioned conditions, was found to be about 1.5 MT plutonium (as PuO_2) per truck. This quantity would represent about one months production from a large separations plant. (RAF)

<224>
Not given, Chicago Operations Office, Chicago, IL; Argonne National Laboratory, Argonne, IL. 1975

Proceedings of the Third Environmental Protection Conference. CONF-750967 (Vols. 1-2); ERDA-92; Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975; 1015 p.

Papers on a broad range of topics related to environmental protection activities of the U.S. Energy Research and Development Adminstration facilities are presented. The reports are separated into sections dealing with interagency relationships, environmental surveillance, environmental monitoring and evaluation, effluent reduction and monitoring, coal technology, and waste management and treatment. Seven papers have been selected for input. (JTE) (CSF)

<225>

EXPLOSIVE DEVICES

<225>
Not given, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC. 1973, May

Reported Nuclear Detonations, April 1973. Radiation Data and Reports, 14(5), 331.

A brief report of underground nuclear explosions in the Soviet Union and the United States during April, 1973 was reported. The signals of the nuclear explosion at the Semipalatinsk nuclear test area were equivalent to those of an underground nuclear explosion in the yield range of 20-200 kilotons and the explosion at the Nevada Test Site registered at a low intermediate yield range of 20-200 kilotons. (JTE)(CTS)

<226>
Willrich, M. (Ed.), American Society of International Law. 1973

International Safeguards and Nuclear Industry. Johns Hopkins University Press, Baltimore, Maryland; 307 p.

The IAEA/NPT Treaty on the Non-Proliferation of Nuclear Weapons) safeguards system is intended to ensure that nuclear material destined for use in peaceful activities, such as the generation of electric power, is not diverted to use in nuclear weapons or other explosive devices. The book contains an extensive study of the IAEA/NPT safeguards system and the problems which must be dealt with. In Chapter 2, the history of the development of international safeguards is traced from the far-reaching Baruch Plan in 1946 to the 1971 revision of IAEA safeguards after conclusion of the NPT. In Chapter 3 the nuclear industry is described in terms of the cycle of operations involved in the use of nuclear fuel to generate electric power, its implications for international and internal security, and the present and projected civilian nuclear capabilities of nations throughout the world. Following this basic introduction, safeguards against nuclear diversion are described and analyzed. Subsequent chapters deal with the development of a national system of safeguards in the United States, possibilities for nuclear diversion by national governments or by non-governmental groups, the industrial implications of safeguards and the overall political implications. (PHM)

<227>
Kurtz, S.T., Lawrence Livermore Laboratory, Livermore, CA. 1975, December 15

Medium Properties and Total Energy Coupling in Underground Explosions. UCRL-51975; 43 p.

A phenomenological model is presented that allows the direct calculation of the effects of variations in medium properties on the total energy coupling between the medium and an underground explosion. The model presented is based upon the assumption that the shock wave generated in the medium can be described as a spherical blast wave at early times. The total energy coupled to the medium is then simply the sum of the kinetic and internal energies of this blast wave. Results obtained by use of this model indicate that the energy coupling is more strongly affected by the medium's porosity than by its water content. These results agree well with those obtained by summing the energy deposited by the blast wave as a function of range. (Auth)

Appendix A describes an alternate approach to determining total energy coupling. Appendix B disscusses and illustrates by the use of numerous graphs the phenomenon of energy coupled to the ground shock by an explosion in silicate rock.

<228>
Dai Pra, G., and G. Magri, Comitato Nazionale per Energia Nucleare, Rome, Italy. 1973

Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements. RT/PROT-73-24; 4 p. (Italian, English Abstract)

Dating of a coral sample with the Th 230/U 234 method has demonstrated that about 125,000 years ago the sea level was situated at an elevation of between 21 and 35 m, above the present sea level. Taking into account that 13-14,000 years ago the sea level was located about 100 m below the present level, it follows that in about 110,000 years a sea level drop of over 120 m occurred with respect to the continent. The information gathered represents a contribution to the estimation of the maximum geological change resonably foreseeable; this knowledge is necessary to insure the geological isolation of possible long-lived alpha emitting radioactive waste, chiefly plutonium 239. (Auth)

<229>
Fried, S., A.M. Friedman, and R. Weeber, Argonne National Laboratory, Chemistry Division, Argonne, IL. 1974, April

Studies of the Behavior of Plutonium and Americium in the Lithosphere. ANL-8069; Part of Chemistry Division Annual Report, July 1972 through June 1973, (p. 10-12), 176 p.

A series of prototype experiments have been performed to test the best methods of obtaining information on the rate and extent of penetration of radionuclides in rock. The larger purpose is to acquire quantitative data on the fate of radioactive species deposited as wastes in rock strata. In the first set of experiments a pressurized reservoir of solution was set up to force a flow through the pores of solid plugs of Niagra limestone--Plutonium 238 was used as the tracer. The intensities of the L sub 1 and L sub 3 x rays of the Pu were measured relative to the L sub 2 x ray as a function of rock thickness, and were found to be acutely sensitive to the thickness of rock between the source and the detector. The migration coefficient for Niagra limestone and a pure H2O eluent was determined to be 0.3 um/ml-cm2. The second set of experiments devoted to measuring the equilibrium constant between surface absorption on the rock and dissolution in the contracting solvent, showed the constants to be very sensitive to the concentration of other ions. It was concluded that Pu(+4) neutral aqueous solution is strongly retained by Niagra limestone. (JTE)

<230>
Horst, T.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Resuspension from a Uniform Area Source. BNWL-1950 (Part 3); Part of Simpson, C.L., et al, Annual Report for 1974, (p. 243-246), 287 p.

The air concentrations resulting from resuspension from a horizontally uniform area source are calculated as a function of atmospheric stability, deposition velocity, and distance from the upwind edge of the source. The resulting horizontal flux of material and the implied resuspension factor are discussed, as well as limiting values for the air concentration, horizontal flux and resuspension factor at distances large enough so that resuspension is balanced by deposition. (Auth)

<231>
Horst, T.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

The Resuspension Ratio for a Gaussian Plume. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 240-242), 287 p.

The surface flux model is used to calculate the resuspension ratio (the air concentration due to resuspension divided by that due to direct atmospheric transport from the source) for the Gaussian diffusion plume from a single source. Assuming 1) a steady state situation during constant atmospheric conditions, and 2) that all deposited material is available for resuspension, the total air concentration is found to be the same as would be calculated by simply ignoring both deposition and resuspension. The value of this point is reduced by two factors. First the results ignore the contribution of precipitation scavanging in creating a ground deposit as a source of subsequent resuspension, also the steady state solution will actually reflect an analgam of stabilities and wind directions rather than a single stability and direction. (Auth) (JTE)

<232>
Horst, T.W., and C.E. Elderkin, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

An Assessment of the Long-Term Exposure Due to Resuspension. Part 2. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 237-239), 287 p.

An earlier model for the ratio between the exposure by inhalation due to resuspension from the soil, and the exposure due to direct atmospheric transport from a source is extended to account for radioactive decay of the hazardous material, and for a lower limit to the resuspension factor. These modifications are shown to affect the evaluation of the hazard of environmental release of plutonium only for a source which emits continuously for thousands of years. (Auth) (JTE) (CSF)

<233>
Landa, E.R., L.J. Hart, and R.G. Gast, University of Minnesota, Department of Soil Science, Minneapolis, MN. 1975

Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124).

Technetium 99 is a long-lived radionuclide released to the environment by activities associated with the nuclear fuel cycle, by fallout from nuclear weapons and by medical users of this material or its radiogenic parents. Studies involved sorption of Tc 99 from aqueous solution by eleven soils. Over 97% of the Tc 99 was sorbed during a 2 to 5 week period by 8 of the soils in sealed containers. Lack of sorption by low organic matter soils, reduced sorption following

<233>

GEOLOGICAL ASPECTS

<233> CONT.
hydrogen peroxide digestion and high recovery of sorbed Tc 99 by NaOH extraction suggest a role for organic matter. Sorption in the presence of excess Cl(E-1) or PO4(E-1) indicates anion exchange and/or certain specific adsorption mechanisms are not involved. Lack of sorption following steam sterilization indicates the disappearance of Tc 99 from solution is related to microbial activity. Continued sorption on aeration further suggests that this is probably not an anaerobic process. (Auth)

<234>
Nooteboom-Beckman, Z.M., and B. Verkerk, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Frequency and Diurnal Variation of Dust in the Continental United States. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 226-231), 287 p.

Frequency of dust periods indicated by visibility less than 11 km were determined by analyzing existing weather data for 343 stations throughout continental United States. Contours of annual dust frequency are shown. Diurnal variation of resuspended dust often shows an afternoon maximum for a majority of stations. (Auth)

<235>
Nyhan, J.W., and F.R. Miera, Jr., Los Alamos Scientific Laboratory, Los Alamos, NM. 1975

The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124).

The soils of four intensive study sites located along the fallout pathway of Trinity, the first nuclear detonation, were sampled to determine plutonium distributional relationships and correlations with soil physical-chemical properties. Concentrations of Pu 238 and Pu 239, 240 were determined for whole soil samples and for soil particles with diameter ranges of less than 53 um, 53-105 um, 105-500 um, 0.5-1.0 mm, 1-2 mm and 2-23 mm as a function of soil depth and distance from ground zero. The horizontal and vertical natural variation of plutonium in these soils was determined by replicated sampling of soils from 9 depths (to a maximum of 47 cm) and from 9 locations within each hectare-sized study area. Soil physical, chemical and morphologic properties were compared with the distribution of plutonium in these soils. The radionuclide data from this study were compared with similar data obtained at the Trinity Site nearly 20 years ago.

<236>
Patterson, J.H., G.M. Matlack, and G.B. Nelson, Los Alamos Scientific Laboratory, Los Alamos, NM. 1974

Plutonium 238 Release in Simulated Natural Environments. CONF-740921; LA-UR-74-1590; Part of Engelmann, R.J. and Sehmel, G.A. (Coords.), Proceedings of a Symposium on Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants (1974) held in Richland, Washington, September 4-6, 1974, (p. 780-790), 988 p.

The effects of various environmental conditions on fuel by exposing Pu 238 PuO2 RTG fuel component samples to simulated weather conditions in environmental test chambers has been studied. The samples were placed on the surfaces of soils in deep trays, and were subjected to diurnal humidity and temperature cycling to simulate summer and winter conditions in humid temperature climates. A spray system was used to simulate rain, with 32-mm rains occuring once a week. The fragments from an impact test of a sphere of sintered plutonium dioxide, 80% enriched in Pu 238, were used in two experiments. The larger fragments, 224 g of pieces greater than 6 mm in diameter, were placed on humus soil. The finer fraction, 28 g of material with diameters between 0.01 and 6 mm was also placed on humus soil in a separate chamber. The condensate from the chamber dehumidifiers (a measure of airborne particulates), the rain water that percolated through the soil, and core samples of the soil were analyzed for Pu 238. In the large-particle experiment the Pu release rate to air increased in four months from about 0.04 uCi per month to a constant value of about 4 uCi per month. In contrast, the initial rate of about 0.8 uCi per month for the fine-particle experiment decreased to approximately 0.4 uCi per month. The thermal shock when the cold rain water struck the large pieces, which have surface temperatures above 250 C, caused spallation of very fine particles. The fact that condensates collected after a rain contained more plutonium than other condensates confirmed this explanation. Determination of this plutonium in particulate samples collected from the air in the chamber during a rain sequence on the larger pieces showed a great increase in the average air concentration over the prerain concentration during the first five minutes of rain, in agreement with the spallation mechanism suggested. Within an hour after the end of the rain, the concentration had returned to the prerain value. Size studies of the plutonium oxide particles in soil core samples indicated that there was comminution of the finer material also. (Auth) (ND)

Tables on air concentrations of PuO2 during rain sequence and soil concentrations of Pu are included.

<237>
Relyea, J.F., and D.A. Brown, University of Arkansas, Fayetteville, AR. 1975

The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124).

Movement of Pu 238 in aqueous salt solutions and soil systems was studied by measuring the diffusion coefficients in both phases and the adsorption-desorption relationship between the phases. Aqueous diffusion coefficients were measured using the capillary tube technique. The diffusion coefficient in soils was determined by the quick-freeze method. Adsorption-desorption relations were studied by adding Pu 238 as the nitrate to 5 ml of H2O at a pH of 2.0 and allowing it to equilibrate with one gram of soil. The effectiveness of Ca and Ce in replacing Pu 238 from the soil were subsequently studied. Aqueous diffusion coefficients of Pu 238 were several times lower than the values found for exchangeable soil cations (order of 5 x 10(E-6) cm2/sec). The ratio of Pu 238 adsorbed by the soil to that in the

<237> CONT.
equilibrium solution was greater than 99:1. Diffusion of Pu 238 in four different soils was also found to be much slower than for exchangeable soil cations as would be predicted from aqueous diffusion and adsorption data. (Auth)

<238>
Routson, R.C., G. Jansen, and A.V. Robinson, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975

Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 125).

Sorption of Np 237 and Am 241 was determined on a sand from a low weathering intensity area of eastern Washington and a high weathering intensity area of South Carolina. Sorption was measured in a batch system over Na(+1) and Ca(+2) macroion concentration ranges of 0.015-3.0 and 0.002-2.20, respectively. The distribution coefficient (Kd) was selected as a sorption parameter. KdNp ranged from 0.36-3.90 and 0.16-0.66 ml/g on the Washington and South Carolina subsoils, respectively. KdAm ranged from 1200-6000 and 1.0-280 ml/g on the Washington and South Carolina subsoils, respectively. (Auth)

<239>
Routson, R.C., G. Jansen, and A.V. Robinson, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, May

Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas. BNWL-1889; 15 p.

Distribution coefficients (Kd values) were determined on subsoils from Washington and South Carolina for Am 241, Np 237, and Tc 99 as a function of equilibrium solution concentration of calcium (Ca(E+2)) and of sodium Na(E+1). Kd values decreased in all cases with increasing solution concentrations of Ca(E+2) and Na(E+1). For the South Carolina subsoil Kd values ranged from 1.0 to 67 for Am 241 as a function of Ca(E+2), 1.6 to 280 for Am 241 as a function of Na(E+1), 0.43 to 0.66 for Np 237 as a function of Ca(E+2), and 0.16 to 0.25 for Np 237 as a function of Na(E+1). For the Washington soil Kd values were less than 1200 for Am 241 and ranged from 0.36 to 2.37 as a function of Ca(E+2) and from 3.19 to 3.90 for Np 237 as a function of Na(E+1). Kd values for Tc 99 were essentially 0 at all NaHCO3 concentrations on the South Carolina subsoil. (Auth)

<240>
Sehmel, G.A., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Airborne Dust Size Distributions as a Function of Wind Speed. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 213-215), 287 p.

Airborne dust size distributions were measured as a function of wind speed increments, using particle cascade impactors. Airborne dust concentrations increased nonlinearly as wind speed increased. Increases are proportional to the 0.6 to 3.2 power of wind speed. For wind speeds above 4 m/sec, concentrations increased to about the third power. Concentrations of 1.1 um ranged from (5 to 50/cm(E+3)/um); 1.9 um particles ranged from 0.5 to 8/cm(E+3)/um; 3.6 um particles ranges from 0.02 to 0.5/cm(E+3)/um. In each case particle concentrations increased in order of magnitude with increases in wind speed from 1.3 to 9 m/sec. Number distributions when converted to total mass loading of respirable particles range from 13 to 360 ug/m3. These mass loadings during short time intervals indicate that resuspended dust loadings during high winds can exceed annual and 24 hr ambient air quality standards for particulates. (JTE)

<241>
Sehmel, G.A., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height. BNWL-1950 (Part 3), Part of Annual Report for 1974, (p. 209-212), 287 p.

Particle resuspension rates from a smooth surface were experimentally measured for 10 um monodispersed uranine particles as a function of time. Resuspension rates ranged from 10(E-6) to 10(E-3) fraction resuspended/sec., but were dependent upon air flow rates and resuspension time. Rates decreased from 10(E-4) to 10(E-5) fraction resuspended/sec. After 121 min. under a constant friction velocity of 1.24 m/sec. This nonexponential decrease suggests that the concept of a resuspension, weathering exponential half-life may be questioned under some conditions. Resuspension rates increased with increasing velocities. The increased resuspension rate for a friction velocity of 0.97 m/sec suggests that turbulent eddies are penetrating to within at least 10 um of the wall and resuspending particles. An attempt is made to grossly correlate resuspension rates determined in previous studies with aerodynamic roughness heights ranging from a smooth surface to that for a forest. An approximate correlation is indicated but caution is recommended in its use since many variables have been assumed constant. (JTE)

<242>
Sehmel, G.A., and F.D. Lloyd, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 207-208), 287 p.

In this preliminary report, the design for a resuspension study is presented. Equipment is being installed in the field to determine tracer resuspension rates as a function of both wind speed increments and atmospheric stability. The tracer source area is annular with radii of 15 and 45 m, located around a central air sampling tower 37 m in height. Two sets of air sampling towers radiate out from the central tower. One set is located so as to determine the resuspension rates for the high wind speeds from about 225 degrees. The other set is located in a position to determine resuspension rates for lower speeds of the prevailing winds which come from about 300 degrees. This experiment will permit

<242>

GEOLOGICAL ASPECTS

<242> CONT.
evaluation of resuspension rate reproducibility and determination of upward diffusion parameters for resuspending particles. (JTE)

<243>
Sehmel, G.A., and F.D. Lloyd, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Resuspension of Plutonium at Rocky Flats. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 216-221), 287 p.

Some time between 1958 and 1968, 5000 gallons of oil containing 86 g of plutonium 239 leaked out at Rocky Flats. In 1969 fill was applied and the area of the spill was covered with asphalt. Thus, the ground source for airborne Pu consists of that which was resuspended prior to covering. In a July, 1973 field experiment, vertical airborne Pu 239 concentration profiles were determined as a function of respirable particle size. The principle sampling site was a 30 m meteorological tower which was instrumented at several heights with self-orienting, high volume cascade impactor-cowl systems. Wind speed instrumentation activated selected impactors as a function of wind speed. Airborne Pu concentrations and concentrations on airborne soil were measured as a function of both height and wind speed. Below 10 m, concentrations decreased with height. Above this height to 30 m, an increase suggested that an elevated upwind source could be contributing to the airborne concentration. The maximum airborne concentration measured was 3.7 x 10(E-15) Ci/m3. The maximum concentration per gram of gross airborne soil was 50 pCi/g. Significant deviations in the air concentration profiles with both distance and height occurred and was attributed to sampling "hot" particles which contained more Pu than average. All concentrations were far below the maximum permissible concentrations. (JTE)

<244>
Sehmel, G.A., and M.M. Orgill, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Resuspension of Radioactivity Induced by Burning Crop Stubble. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 223-225), 287 p.

Airborne particulates from burning fields and background clean air outside the Hanford reservation were sampled with an aircraft-mounted air filter at an altitude of 150 to 180 m. Radioactivity concentrations in air samples collected from the smoke plume were determined and compared to concentrations in the ambient background air samples. Airborne concentrations of Be 7 and Nr 95-Nb in the smoke were 1.2 to 4.6 times the ambient background levels. (Auth) (JTE)

<245>
Sehmel, G.A.: Lloyd, F.D., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles. BNWL-1950 (Part 3); Part of Annual Report for 1974, (p. 203-207), 287 p.

Resuspension rates of a submicrometer calcium molybdate particle were measured. The area onto which the particles were "seeded" was a lightly vegetated area about 23 m in radius. The average surface concentration was 0.62 g of Mo per m2. Airborne concentrations were measured vertically over the center of the plot up to a height of 6.1 m. Measurements indicated that the trace particles reached higher elevations. Resuspension rates were calculated from true fluxes, ground surface concentration, and sampling time and showed values 10(E-10) to 10(E-8) fraction per second. Resuspension factors were calculated using respirable airborne concentration at 1.8 m height divided by the ground source concentration and fell within the same range. Both resuspension rate and resuspension factor increased rapidly with an increase in wind speed. (JTE)

<246>
Leaf, A.C., Hanford Engineering Development Laboratory, Richland, WA. 1974, October

The Use of Americium Dioxide as a Primary Standard for the Determination of Americium 241. HEDL-TME-74-57; 30 p.

The use of americium dioxide as a primary standard in both gamma and alpha counting procedures for the determination of Am 241 is described. The results obtained using the two methods are compared, and the precautions required during the preparation and counting of the standard are discussed. (Auth)

<247>
Moss, W.D., and E.E. Campbell, Los ALamos Scientific Laboratory, Health Division, Los Alamos, NM. 1965

The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting. CONF-651008; LA-DC-7483; Part of Proceedings of the Annual Bioassay Symposium held in Albuquerque, New Mexico, October 7-8, 1965, (p. 184-186).

Two bioassay methods of detecting low level plutonium are compared: the nuclear track technique and scintillation counting. Data were comparable, however, scintillation counting required 7 days less time to complete an analysis with less associated human error involved. In addition there is complete control of contamination to the counters. (LR)

<248>
Tyree, W.H., R.B. Falk, R.W. Liskey, and C.B. Wood, Dow Chemical Company, Rocky Flats Division, Golden, CO. 1975, February 3

Operating Parameters and Limitaticns of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241. RFP-2328; 10 p.

The body counter facility at the Rocky Flats Plant provides for the detection of Americium 241, as a tracer for plutonium, which is present in some plutonium mixtures. A germanium-lithium drifted system is described and application for the in vivo measurement of americium 241 is discussed. The operating parameters and limitaticns of the germanium-lithium drifted system for low-energy photon detection with particular attention to the entrance window response of one of the detectors are presented. Future development of germanium systems for the detection of low-energy photons in vivo will use hyper-pure germanium fabricated as thin-window planar detectors. (Auth)

<249>
Fellows, M.H., L. Clark, Jr., J.J. O'Toole, D.B. Kinnel, and W.S.S. Jee, Massachusetts Institute of Technology, Department of Nuclear Engineering, Cambridge, MAl Ames Laboratory, Ames, IA; University of Utah, College of Medicine, Radiobiology Division, Salt Lake City, UT. 1975, July

An Improved Technique for Neutron-Induced Autoradiography of Bone Containing Plutonium. Health Physics, 29, 97-101.

A technique for neutron-induced autoradiography (NIAR) of bone containing small amounts of Pu 239 (0.015 uCi Pu 239/kg body weight or less injected intravenously), which insures both a bone image and fission fragment tracks using beagle specimens, is described. It calls for (1) irradiation of a specimen attached to a Lexan polycarbonate detector to produce adequate numbers of Pu 239 fission fragment tracks in the Lexan, (2) annealing of the detector to erase most background damage, (3) re-irradiation to the detector with specimen still attached to regenerate a bone image, and (4) etching of the detector to accent and fix the tracks and bone image. This method (anneal-re-irradiate-etch or ARIE) has proven over 90% successful in generating neutron-induced autoradiographs with both a bone image and fission fragment tracks. (Auth)

<250>
Hodge, V.F., and M.E. Gurney, Scripps Institution of Oceanography, Mt. Soledad Laboratory, La Jolla, CA. 1975, September

Semiquantitative Determination of Uranium, Plutonium, and Americium in Seawater. Analytical Chemistry, 47(11), 1866-1868.

A semi-quantitative method for estimating the concentrations of alpha emitters (uranium, plutonium, and americium) in contaminated seawater has been developed. These radioelements can be precipitated from seawater by the addition of small amounts of sodium hydroxide. Uranium, plutonium, and americium have now been found to plate directly from the dissolved precipitate onto stainless steel planchets, with high yields, in a form suitable for high resolution alpha counting--thereby avoiding the time-consuming isolation and purification procedures usually employed. (Auth) (ND)

<251>
Iyer, P.S., and P.S. Nagarajan, Bhabha Atomic Research Centre, Division of Radiobiological Protection, Bombay, India. 1974, December

Dosimetry of Californium 252 Intracavity Applications Based on the Revised Manchester System. Strahlentherapie, 148(6), 564-570.

The revised Manchester system of loading, in which the dose rates at point A and point B are of importance, is widely used for intracavitary applications. Because of lower oxygen enhancement ratio and absence of gaseous radioactive products, californium 252 is a promising substitute for radium in such applications. The amounts of californium required in each tube to produce biologically effective dose rates at point A, which are nearly equivalent to those from corresponding radium tubes, have been estimated. The isoeffective dose distributions for any particular type of application are found to be similar for radium and californium in the volume of interest. (Auth) (CSF)

<252>
Roth, S.J., and G. Huckaby, Lawrence Livermore Laboratory, Biomedical Division, Livermore, CA; Lawrence Livermore Laboratory, Electronics Engineering Department, Livermore, CA. 1973, November 26

A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER. UCRL-75204; CONF-731112; Part of Proceedings of the IEEE Nuclear Science Symposium held in San Francisco, California, November 14-16, 1973, (13 p.).

<252>

INSTRUMENTATION

<252> CONT.
The evaluation of the sensitivity of a Ge(Li) coaxial detector in comparison with a thin NaI(Tl) detector in in situ terrestrial Am 241 is described. The experiment was performed in areas of natural background and fallout products. Of primary concern is the detection of Am 241 60 keV gamma ray. Calculated from these data are the corresponding quantitations of Pu 239, 240. (Auth)

<253>
Hanson, W.C., Los Alamos Scientific Laboratory, Health Division, Environmental Studies Group, Los Alamos, NM. 1974

Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park. LA-UR-74-1596; Part of Proceedings of the National Environmental Research Park Symposium held in Idaho Falls, Idaho, October 22, 1974, (18 p.).

Designation of land areas of Los Alamos Scientific Laboratory as a national environmental research park was proposed. The goal of such a park would be to provide opportunity for research to help determine how man can live in balance with nature while maintaining his technologies. Benefits to be derived from such a designation are discussed. The proposed park area is described in detail with respect to location, topography, climate, and floral and faunal populations. Current and proposed research projects within the park area are discussed as are the administration of the park and anticipated problem areas. (JTE)

<254>
Boswell, R.N., Australian Atomic Energy Commission, Research Establishment, Lucas Heights, Australia. 1973, April

The Atomic Energy Industry's Approach to Environmental Protection. Atomic Energy in Australia, 16(2), 2-5.

It is noted that the approach to environmental protection by the atomic energy industry is no longer anthropocentric. Much effort today is directed toward studying the radiosensitivity of other species and the total ecosystem. It is stated that establishments which handle significant amounts of radioactive materials treat and concentrate their wastes so that only small amounts of low level activity are disposed of in the environment. Problems associated with locating a nuclear power station and a uranium milling plant are mentioned. Establishment of the direct risks of a toxic material to man or the biosphere is said to be the role of science and technology. Assessment of the costs and benefits in terms of economic, social, and moral values should be carried out by society. The problems involved in maintaining a balance in decision making are discussed and two suggestions are given. First the public must be educated in order to be capable of making objective appraisals. Second, consideration needs to be given to the adequacy of our institutions to permit public participation in decisions concerning the environment, public health and general welfare. (JTE)

<255>

MEDICAL ASPECTS

<255>
Al-Bedri, M.B., and S.J. Harris, University of Surrey, Physics Department, Surrey, England. 1975, June

Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles. Health Physics, 28, 816-818.

The dose equivalent rates at various depths in skin for Am 241 deposited on the skin using tissue equivalent materials were determined. Dose rates were estimated as a function of tissue depth by calculating the energy lost by particles in defined depths of tissues for a uniform deposit of 10(E-5) uCi of Am 241 on 1 cm2 of skin. The apparent reduction in dose rate with increasing skin thickness occured as a result of the decrease of stopping power with decreasing energy. The increasing depth of tissue was then included with little energy loss occurring in it, the net effect being an apparent reduction in dose equivalent rate. For radiation protection, the criteria of greatest importance should be the maximum dose equivalent rate to the basal layer cells. The differential dose equivalent rate to the skin peaked to 210 mrem hr(E-1) in the basal cell layer (4.0 mg cm2). (ND)

<256>
Barr, N.F., U.S. Energy Research and Development Administration, Division of Biomedical and Environmental Research, Washington, DC. 1975, April 1

Quantitative Health Estimates of Transuranic Releases. HASL-291; Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-5 - I-18), 227 p.

Estimates of the potential consequences to human health from transuranium elements released during the generation of electricity by the liquid metal fast breeder reactor fuel cycle are presented. Inhalation of airborne particles is the dominant route of entry into man. The fraction inhaled by man of airborne particles before deposition on the ground is estimated to be 4 x 10(E-6). The fraction which enters man by inhalation of resuspended particles is also estimated to be 4 x 10(E-6). The total fraction inhaled by man is thus estimated at less than 1 x 10(E-5). The ingestion of particles mainly arises from uptake from the soil by plants. The fraction of isotopes released which enter man by ingestion are estimated as follows: Pu 238, 3 x 10(E-4); Pu 239, 8 x 10(E-2); Pu 240, 2 x 10(E-2); Am 241, 2 x 10(E-3); Cm 242, 1 x 10(E-6); and Cm 244, 6 x 10(E-5). Doses to the bones, liver, kidneys, and gonads from inhaled and ingested transuranics are summarized in tabular form. The lowest dose from inhalation is 1 rem per microcurie to the gonads from inhaled Cm 242. The largest is 3330 rem per microcurie to the bones from inhaled Am 241. The fraction of ingested radioactivity absorbed from the GI tract was estimated at 3 x 10(E-5) for Pu and 10(E-3) for Am and Cm. Total population exposures of approximately 5 lung rems, 25 bone rems, 10 liver rems and 0.5 gonadal rems per 1000 MWe-year were estimated. There may be zero to less than 10(E-3) potential cancer and genetic defects of all types produced for each 1000 MWe-year of electricity generated by the LMFBR fuel cycle. It is stated that using the same basis for estimation many more cancer deaths per year would be attributable to natural background radiation. (JTE)

<257>
Campbell, E.E., M.F. Milligan, W.D. Moss, H.F. Schulte, and J.I. McInroy, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973, January

Plutonium in Autopsy Tissue. LA-4875; CONF-710919; Part of Proceedings of the 11th Hanford Symposium on the Biological Implications of the Transuranium Elements held in Richland, Washington, September 27-29, 1971. Published in Health Physics, 22(6), 931.

Since 1959, selected tissues from deceased humans have been examined for the presence of plutonium. The original purpose was to correlate plutonium body burden calculated from urine assay and actual burden determined by analysis of autopsy materials. The tissues have provided data on plutonium deposition in man resulting from general distribution of plutonium in the environment through global fallout and that resulting from plutonium fabrication or research and development operations. Lung, liver, kidney, lymph, and skeletal tissue were the principal materials examined. The analytical data, the significance of the findings, and the considerable uncertainties in the radiochemical analysis and calculations are discussed. Median concentrations in the organs and tissues of a general population (not occupationally exposed) were (each number represents dpm Pu per kg): liver, 1.4; lung, 0.8; lymph nodes, 3.0; bone, 0.6; and kidney, 0.6, Plutonium concentration is generally higher in the tissues of those who have been occupationally exposed to plutonium; the concentration obviously depends upon the nature of the exposure and its severity and duration. (Auth)

Numerous tables and graphs are included in the appendices. The tables show analyses of individual cases and are divided into population categories based on residential area and occupational exposure. Table C II gives a summary of Pu in human tissue estimated from log probability plots of concentration/kg of tissue.

<258>
Cuddihy, R.G., L.D. Chapman, J.R. Wayland, V.L. Dugan, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1974, December

General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs. LF-49; Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 80-84), 384 p.

Anticipated development of nuclear reactor systems for production of electrical power with associated normal releases of transuranic elements (including Pu 238, Pu 239, Pu 240, Pu 241, Am 241, Cm 242 and Cm 244) to the environment makes it necessary to develop comprehensive analyses . Such analyses of their possible impact upon human health. Such analyses must address possible sources for radioactivity releases, environmental transport, accumulation in biological species and related deposition and health risks in man. Mathematical models of these systems adapted to rapid computer solution are being developed to aid in projecting the total and time-dependent human risk factors related to nuclear power development. These studies will also attempt to identify the most sensitive aspects and assumptions of the total health risk

<258> CONT.
assessments and will generally be applicable to effluents from non-nuclear as well as nuclear sources. In both cases, the results can be used to define guidelines for general siting considerations. (AUTH)

Figure 2 shows environmental pathways for transport of transuranics to man. Figure 3 shows inhalation and ingestion model for transuranic elements in man. Table 1 shows estimated risk factors for development of tumors and genetic damage from irradiation.

<259>
Dean, P.N., Los Alamos Scientific Laboratory, Biomedical Research Group, Los Alamos, NM. 1973, April

Estimation of Chest Wall Thickness in Lung Counting for Plutonium. Health Physics, 24(4), 439-441. (U.S. Atomic Energy Commission)

In vivo measurement of plutonium, particularly L-x-rays of uranium requires knowledge of the human rib tissue thickness. As a result, mathematical models for estimating the thickness of the soft tissue overlying the lungs are investigated. The preferred equation given is: T (average chest wall thickness) equals a plus b times W (weight) divided by H (height). (ND)

<260>
Evans, R.D., Massachusetts Institute of Technology, Cambridge, MA. 1966, December

The Effect of Skeletally Deposited Alpha-Ray Emitters in Man. British Journal of Radiology, 39(468), 881-895.

Radium provides the radiation protection standard for skeletally deposited internal emitters in humans. Around the 1920's the careless use of Ra industrially and for therapy was widespread, resulting in three categories of acquisition of internal deposits. The first category includes Ra dial painters, the second includes Ra chemists, and the third includes individuals who received Ra internally for medical reasons. Findings from studies of individuals from these groups are discussed. Both Ra and mesothorium (Ra 228) behave like Ca in the body, with a large fraction being deposited in the bones. The exhaled breath of a person with a skeletal burden of 1 uCi of Ra will have a Rn concentration of about 10 pCi per liter. The average alpha ray dose to the body per microcurie of Ra in the bones tends to increase with time. A typical 5 MeV alpha ray will have a range of about 3.5 cm in air, 35 u in soft tissue, and 25 u in bone. About 100 individuals are known to have ingested a mixture of Ra 226 and mesothorium. Thoron, a decay product of Ra 228, produced in the skeleton is almost completely retained, only about 0.1% is exhaled. The fraction of ingested activity which reaches the blood stream is about 20% for Ra isotopes and 0.02% for the Th isotopes. The principal biological effects produced by radiation exposure are osteoporosis, dense bone necrosis, spontaneous fractures, osteogenic sarcomas, and carcinomas of the paranasal sinuses and mastoids. Dose-response relationships are presented in terms of x-ray score and cumulative rads (CR). Between 2 to 5 uCi Ra pure Ra equivalent (PRE) or 10 to 25 uCi Ra PRE the fraction of cases with sarcomas or carcinomas is roughly 40%. Skeletal effects do not appear to be of clinical significance below 0.5 uCi PRE. (JTE)

<261>
Feinendegen, L.E., Institute of Medicine, Nucler Research Center, Julich, German Federal Republic. 1971

Tritium in Biomedical Research and Clinical Medicine. CONF-710809; Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 647-659), 807 p.

A review of the particular applications of tritium in biomedical research and clinical medicine has emphasized that this tracer has achieved an irreplaceable position in modern biomedical technology. It was only 20 years ago that tritium first came into use. Now it has assumed a unique position with virtues widely appreciated and faults that ask for more definition and final avoidance. (BBM)

<262>
Pleischer, R.L., National Center for Atmospheric Research, Boulder, CO; National Oceanic and Atmospheric Administration, Atmospheric Physics and Chemistry Laboratory, Boulder, CO. 1975, July

On the "Dissolution" of Respirable Plutonium Dioxide Particles. Health Physics, 29, 69-73.

Previous measurements of an apparent solubility of Pu dioxide (Pu 238, Pu 239) particles in simulated lung fluid are inconsistent with there being significant chemical solubility. The results do agree with a model in which small scale, progressive fragmentation of the particles is caused by radiation damage by the recoil nuclei from alpha decay. (Auth)

<263>
Geesaman, D.P., Lawrence Livermore Laboratory, Livermore, CA. 1968, February 9

An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue. UCRL-50387; 17 p.

Pulmonary deposition and clearance are described; and relevant times, lengths and geometries are noted in order to construct a simple model of deep respiratory tissue. Plutonium 238 PuO_2 and Pu 239 PuO_2 are taken as representative aerosols in making quantitative estimates of tissue exposure and response. While no realistic evaluation of the total carcinogenic risk is accomplished, the results are such as to clarify the nature of the problem. In particular, if the loss of mitotic competence by a local cell population is sufficient to guarantee no origin of cancer within that population, then the carcinogenic risk from particulate sources does not scale to the total energy dissipated. To say what dose characteristics are significant to the risk would require an accurate knowledge of clearance, local shielding responses, and the mechanisms of cancer induction. In the absence of this detailed knowledge the suggested course is an experimental determination of the number of source particles per induced cancer. (Auth) (JTE)

<264>
Gus'kova, A.K., and G.D. Baisogolov, Not given.

<264>

MEDICAL ASPECTS

<264> CONT.
1973, February

Radiation Sickness in Man. AEC-tr-7401; 560 p.

A description of the clinic, pathogenesis, and therapy of radiation sickness in man is presented. The book is divided into the following four major sections; (1) theoretical bases of classification of dose levels and forms of radiation responses (3 chapters), (2) acute radiation sickness (5 chapters), (3) chronic radiation sickness (4 chapters), and (4) results and prospects of the investigation of the problem of the diagnosis, clinic and prophylaxis of radiation sickness. This is one of the first investigations giving a characterization of the entire variety of possible forms of human responses to a broad range of radiation doses. A pathogenic classification of radiation lesions and the characteristics of possible etiological factors of the origin of radiation sickness was given. Considerable space ws(S) @sickenss@@sickness devoted to a description of all the basic forms of radiation sickenss in man due to whole-body and local external irradiation or the action of incorporated radioactive substances. The substantial effectiveness of simple methods of therapy of acute radiation sickness in the range of sublethal doses is supported by the observations cited in the monograph. The use of numerous literature data on dose levels and state of health of persons working in contact with ionizing radiations show that the proper organization of work greatly increases the safety of the use of radioactive substances. (JTE)

<265>
Harley, N.H., B.S. Pasternack, and J.H. Harley, New York University Medical Center, Institute of Environmental Medicine, New York, NY; Health and Safety Laboratory, New York, NY. 1975

Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239. Health Physics, 28, 61-67.

Experimental curves of Pu 239 alpha attenuation and stopping power were obtained in polycarbonate plastic which is essentally identical human tissue. With these curves the alpha dose rate was calculated for the human tracheobronchial tree for Pu 239 PuO2 deposited on bronchial airways. Dose rate curves were derived for two types of PuO2 exposure. One computation was for PuO2 deposited as 0.06 um particles, the other for a 2 um PuO2 particle fixed on the bronchial wall. Generalized dose rate curves are presented so that the dose at any depth in bronchial epithelium may be computed if the activity deposited on the bronchial airway is known. The dose rates for ICRP maximum permissible air concentration for continuous exposure are computed as a specific example. The dose rate computed for the 0.06 um particles is 0.014 rads/yr to the basal cells in the entire bronchial epithelium while that for the fixed 2 um particle can be a maximum of 2.3 rads/min to a few tens of cells. (Auth)

Table 1 shows equilibrium concentrations for the Landahl lung model resulting from continuous exposure to 10(E-11) uCi/cm3 of Pu 239. Table 2 shows equilibrium concentrations for the Weibel lung model resulting from continuous exposure to 10(E-11) uCi/cm3 of Pu 239.

<266>
Jeanmaire, L., F. Patti, and M.L. Audren, Centre d'Etude Nucleaires, Departement de la Protection Sanitaire, Fontenay-Aux-Roses, France. 1964

The Interpretation Of Data Relating to Plutonium Contamination. CONF-448; STI/PUB/84; Part of Proceedings of a Symposium on the Assessment of Radioactive Body Burdens in Man held in Heidelberg, Germany, May 11-16, 1964, Vol. 2, (p. 617-628), 1043 p. (French)

Data are presented for plutonium levels in man measured in various samples including blood and bone after heavy contamination through the skin. The progress of elimination is reported on during the year following contamination and the effects of DTPA on urinary excretion are shown graphically. Data resulting from measurements after very slight contamination are also presented and an attempt is made to interpret them. (Auth) (PHM)

<267>
Johnson, L.J., and J.N.P. Lawrence, Los Alamos Scientific Laboratory, Los Alamos, NM. 1974, July

Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory. Health Physics, 27, 55-59.

The incidence of puncture wounds potentially contaminated with plutonium over the period 1960 to 1972 at the Los Alamos Scientific Laboratory is reviewed. Ten cases with activity deposits greater than 1% of the present 40 nCi maximum permissible body burden value have been experienced. Techniques employed for estimating the level of plutonium activity at the wound site and for determining the depth of deposition of the contaminated debris are discussed. Use of a scintillation counter was of fundamental importance in evaluating the potential activity present in each case. Application of a xenon proportional counter to determine the depth of contamination was found to be a useful technique. One case history is reviewed. Data on the anatomical location of 137 injuries potentially involving transuranic materials showed the upper extremities to be the most usual wound site. More than 80% of these cases involved the fingers and hands. (Auth) (ST)

<268>
Khalturin, G.V., E.P. Sevostiyanova, A.K. Zhuravleva, and L.A. Buldakov, Not given. 1974

The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body. Gigiena i Sanitariya, 5, 38-42. (Russian, English Abstract)

In case of intravenous introduction of various compounds of Pu, its distribution in the body depends on its physicochemical state in the solution, i.e. valency, tendency to hydrolysis and to formation of complexes, etc. The more stable is the complex compound and the less is its tendency to hydrolysis, the less Pu accumulates in the liver and spleen and the more was in the skeleton and kidneys. (Auth)

<269>
Lafuma, J., Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France. 1963

Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination.

<269> CONT.
STI/PUB/65; Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 381-386), 450 p. (French, English Abstract)

During an accident a technician's hands were contaminated with hexaplutonium 239 nitrate. The contamination on the left hand alone, measured with an x-detector, was close on 60 uc. The contamination was brought down to 15 uc by a first decontamination carried out under a local anaesthetic; several contamination zones were localized by scanning. A surgical operation, done under an Esmach band with x and alpha-detectors, reduced the contamination from 15 to 5 uc, the hands' functions being integrally preserved. A new zone of activity was localized by a second scan, and a second operation reduced internal contamination in the hand to 2 uc. It has not been possible to localize this activity but it is kept under regular supervision. Parallel with the surgical decontamination, an internal decontamination with DTPA was undertaken. Blood, urine and feces were sampled immediately after the accident and their activity was measured. Afterwards, urine samples were taken daily; blood and fecal samples were taken during each period of treatment. All the measurements indicate that DTPA is extremely effective in the case of internal contamination by Pu 239. It also appears that the percentage of blood plutonium eliminated by the kidney varies with time. The percentage increases, indicating that the plutonium is carried in the blood under different ionic or colloidal forms which are cleared in different degrees by the kidneys. It would accordingly appear that the activity in the urine does not faithfully reflect the internal contamination. (Auth)

<270>
Langham, W., Los Alamos Scientific Laboratory, Los Alamos, NM. 1950

Distribution and Excretion of Plutonium Administered Intravenously to Man. LA-1151; 45 p.

Approximately 0.5 ug of plutonium(+4) in a 0.41% solution of sodium citrate times 2H2O was injected into each of 12 chronically ill patients. Clinical observations in this study combined with observations from earlier studies indicated that administration of 5 to 100 ug of plutonium is without acute subjective or objective clinical effects. Results of tissue analyses showed that there was little difference in the tissue and organ distribution of plutonium in man and in the common laboratory animals. The skeletal system was the major site of deposition. Liver retention and liver biological half-life appeared to be higher and longer in man than in laboratory animals. Blood plutonium concentration dropped rapidly following injection. Urinary and fecal excretion of plutonium was not exponential; expressions for urinary and fecal excretion and total excretion through 138 days are given. The urinary to fecal excretion ratio was not constant. Using the combined expression for excretion it was found that only 8.7% of a single injected dose was excreted in approximately five years. The biological half-life of plutonium in man was estimated to be 118 years. The urinary excretion data were applied to the diagnosis of exposure of personnel to plutonium. (ST)

Table 3 shows the distribution of plutonium in human tissues following intravenous injection of 0.5 ug plutonium citrate.

<271>
Linnemann, R.E., and R.H. Holmes, University of Pennsylvania, Radiation Medicine Center, Philadelphia, PA; Hahnemann Medical College and Hospital, Philadelphia, PA. 1971

Nuclear Accidents and their Management. CONF-691234; Part of Spitzer, S. (Ed.), Proceedings of the 21st Hahnemann Symposium on Emergency Medical Management held in Philadelphia, Pennsylvania, December 8, 1969. Grune and Stratton, Inc., New York, New York, (p. 281-292).

Radiation accidents are unique in their frequency and complexity and few physicians and hospitals have had experience in their management. Radiation accidents are classified according to the source relationship to the patient and the clinical picture. They may involve whole body or local radiation exposure, internal or external radiation contamination, or a combination. The three types of radiation may be alpha, beta, or gamma, and each type requires different treatment. The increasing use of nuclear energy in industry, medicine and research requires the medical profession to take another look at its preparedness to handle radiation accidents. The infrequency of accidents and extensive requirements for definitive evaluation and treatment dictate a regional approach to the problem. A single radiation medicine center with accident treatment capabilities could support all other hospitals in the region. The latter would concentrate on a primary emergency response. This requires minimal radiation knowledge directed towards alleviating fear and preventing gross error. A radiation emergency plan for supporting hospitals is suggested. (BBM)

<272>
Marshall, J.H., P.G. Groer, and R.A. Schlenker, Argonne National Laboratory, Center for Human Radiobiology, Argonne, IL. 1974

Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226. ANL-75-3 (Part 2); Part of Radiological and Environmental Research Division Annual Report, July 1973 through June 1974, (p. 71-72), 231 p.; Part of Proceedings of a Symposium on Biological Effects of thX held in Alta, Utah, July 22-24, 1974, (2 p.).

The ICRP model, Alkaline Earth Metabolism in Adult Man, was tested for all possible values of the size of the bone surface compartment and of its rate constant to determine the reliability of bone surface prediction. The relative distribution factor (RDF) is the ratio of the endosteal doses for equal average doses to vone for both Ra 224 and Pu 239 relative to Ra 226 in man and predicts the relative toxicity of alpha-emitting radionuclides. The RDF value for Ra 224/Ra 226 was 20, and the RDF value for Pu 239/Ra 226 was 28 for surface plutonium sources and 0.96 for volume sources. However, the observed RBE (ratio of average bone doses) of Ra 226/Ra 224 was six. Therefore, Ra 224 appears to be a factor of three less toxic than one would expect according to the simple theory of endosteal dose. (ND)

<273>

MEDICAL ASPECTS

<273>
Martin, W.E., and S.G. Bloom, Battelle Columbus Laboratories, Ecolcgy and Ecosystems Analysis Division, Columbus, OH. 1975

Plutonium Transport and Dose Estimation Model. CONF-751105; IAEA-SM-199/78; STI/PUB/410; Part of Proceedings of a Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p. 385-400), 724 p.

A Standard Man was assumed to live in and obtain most of his food from a Pu-contaminated area at the Nevada Test Site (NTS). A Pu-transport model, based on the results of other studies at NTS, provided a basis for estimating rates of Pu239 inhalation and ingestion as functions of the average concentration of Pu 239 (C sub s equals pCi/g) in the surface soil of the reference area. Assuming the transport system to be in equilibrium, the estimated inhalation and ingestion rates (pCi/day) are 0.002 C sub s and 0.269 C sub s, respectively. A dose estimation model, based on parameters recommended in ICRP publications, is used to estimate organ burdens, accumulated doses, and dose commitments as functions of exposure time. Estimated doses (rems) due to inhalation and ingestion of Pu 239 for 50 years at the rates indicated above are: thoracic lymph nodes, 0.6 C sub s; lung, 0.025 C sub s; bone, 0.015 C sub s; liver, 0.01 C sub s; kidneys, 0.003 C sub s; total body, 0.0007 C sub s; and gastrointestinal tract (lower large intestine), 0.0003 C sub s. Inhalation accounts for 100% of the predicted dose to thoracic lymph nodes and lungs and for about 94% of the predicted dose to bone, liver, kidneys, and total body. According to ICRP recommendations for individual members of the public, the dose rate to the lungs should not exceed 1.5 rems/yr. According to the proposed model, the average concentration of Pu 239 in the soils of contaminated areas at NTS which would result in a predicted dose rate of 1.5 rems/yr to the lung is approximately 3 nCi/g or approximately 170 uCi/m2. (Auth)

Figure 3 shows the pathways that ingested and inhaled Pu follows in reaching the critical organs of Standard Man.

<274>
Maugeri, S., University of Pavia, Pavia, Italy. 1973, March

Risk of Radioactive Contamination. Current and Prospective Problems. Laboro Umano, 25(2), 34-50. (Italian)

The introductory lecture in a course of radiotoxicological techniques for radioprotection is presented. The concepts of biological half-life, radioactive half-life, and critical organ are introduced and defined. The factors affecting internal radioactive contaminatien are the absorption of the contaminant, its distribution in various sytems, and its elimination and these are discussed in detail. The industrial uses of radiation sources are reviewed as a possible source of internal contamination. Contamination of the food chain by radioactive wastes or fallout is discussed. The effects of internal contamination in the production of lesions and mutations are briefly indicated. (JSR)

<275>
McClellan, R.O., H.A. Boyd, S.A. Benjamin, R.G. Cuddihy, F.F. Hahn, R.K. Jones, J.L. Mauderly, J.A. Mewhinney, B.A. Muggenburg, and R.C. Pfleger, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, November

Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case. LF-45; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 287-294), 355 p.

Bronchopulmonary lavage was performed on three occasions on an individual who had accidentally inhaled and deposited in his lung an estimated 450 nCi of Pu 239. The right lung was lavaged on the 8th and 17th day post-exposure and the left lung on the 12th day using large volumes of isotonic saline. Daily treatment with diethylenetriaminepentaacetic acid (DTPA) intravenously was initiated on day 8 post-exposure. Fifty-nine nCi of Pu 239 recovered in the lavage fluid was associated predominantly with lung macrophages and relatively little with recovered surfactant. Eighty-seven nCi of Pu 239 were excreted in the 11 days following the first lavage; 16 nCi in feces and 71 nCi in urine. In total, 146 nCi of Pu 239 and 3.55 nCi of Am 241 were recovered during the first 11 days after treatment was initiated. The Pu 239/Am 241 ratio of material removed via lavage was slightly higher, urine was slightly lower, and feces about the same as the Pu 239/Am 241 ratio of air filter samples obtained at the time of the accident, thus indicating the feasibility of using Am 241 lung counting to estimate the Pu 239 lung burden at early times following the accident. These data indicate the effectiveness of both bronchopulmonary lavage and DTPA in reducing the body burden of Pu 239 following accidental inhalation exposure. (Auth)

<276>
Norwood, W.D., Hanford Atomic Products Operation, Richland, WA. 1963

Removal of Plutonium and Other Transuranic Elements from Man. STI/PUB/65; Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 307-318), 450 p.

Treatment of Pu and other transuranic element contamination in man was discussed. It was recommended, for several stated reasons, that DTPA treatment be given an employee experiencing pulmonary or subcutaneous contamination if it was estimated that the deposit without treatment would be 10% of the NCRP guide level of 0.4 uc or 0.6 ug total body burden of soluble Pu 239. Five employees at the Hanford Atomic Products Operation who had harbored small quantities of Pu 239 for varying numbers of years were treated with DTPA, increasing the urinary elimination by a factor of 50-100 and fecal elimination by 6. DTPA given orally was said to be only 10% as effective in increasing urinary elimination as when adiminstered intravenously. An account was also given of an employee whose finger was pierced by a Pu 239 contaminated urine. The DTPA treatment was not as effective as was expected possibly due to time lost by 3 excisions or insufficient size or number of treatments.

<276> CONT.
One gram of DTPA in 250 cm2 of saline was administered intravenously on four consecutive days, and repeated after 45 days. It was concluded that the assumption that the permissible wound deposition of Pu 239 should be the same as the allowable total body burden may be in error since a high percentage of mice given a subcutaneous injection of 0.064 uc developed sarcomas. (JTE)

<277>
Norwood, W.D., and C.E. Newton, Jr., Hanford Environmental Health Foundation, Richland WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, July; 1975, June

United States Transuranium Registry Study of Thirty Autopsies. CONF-740702; Part of Proceedings of the 19th Annual Symposium of the Health Physics Society held in Houston, Texas, July 7-11, 1974, (7 p.); Health Physics, 28, 669-675.

To aid in the evaluation of biological effects of transuranium radioisotopes in people, some 850 transuranium workers have now agreed to allow autopsies. Many more are expected to cooperate. Results of the first 30 autopsies reported to the Registry are discussed. Where the estimated systemic body burden of plutonium based on urinalysis was greater than 5% of the permissible (0.04 0.02 uCi), this estimate was higher than that obtained by laboratory analysis of whole organs or parts of organs in a large majority of cases. For depositicns less that 5% maximum permissible body burden, there was considerable variation depending upon individual Atomic Energy Commission contractor reporting practices. Nonuniformity within organs was sometimes great, so whole organs (such as lungs, liver, kdneys, spleen, etc.) were usually obtained in the last 30 cases. In relatively high deposition cases (greater than 0.02 uCi), as many as 40 organs were sampled in an effort to determine validity of applying animal data to man. The number of times that various organs had the highest concentration is tabulated. Highest concentrations were found in tracheobronchial lymph nodes, lung and liver in 26 of the autopsies, while highest concentrations were found in a single autopsy in axillary lymph nodes, abdominal lymph nodes, muscle, pancreas, spleen, and thyroid. Deposition in muscle, fat and skin was usually low amounting to about 3% of the total deposition. (Auth)(ND)

Relative concentrations of plutonium in tissues, bones and organs are tabulated. Systemic burden estimates using urinalysis and autopsy results are compared in Table 5.

<278>
Not given, International Commissicn on Radiological Protection, Committee 4. 1969, April

The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes. ICRP Publication 10A; 34 p.

Work was done as an extension cf the ICRP report on "Evaluation of Radiation Doses to Body Tissue from Internal Contamination Due To Occupational Exposure." That report considered the single exposure, but this report is applicable to a wider range of situations. Included are calculations of the radiation dose to the critical organ, the excretion of various times after intake and derived investigation levels. An equation is given which relates the body organ content of a radionuclide to the uptake or deposition as a function of time and the retention as a function of time. The report is concerned mainly with the application of the formula. Various patterns are shown for uptake and the resulting changes in organ content with time. Equations are derived for the amount of radionuclide retained in the compartment or critical organ, the exposure resulting from this content and the excretion coming from the critical organ. Among the examples considered are the deposition of insoluble U, Th or Pu oxides in lungs with the subsequent translocation of the radionuclide to pulmonary lymph nodes, skeleton and excreta, and the deposition of non-transportable bone-seeking radionuclides in a wound with the subsequent translocation to the skeleton and excreta. In considering several uptakes in a limited period, calculations were done for the retentions and excretions from a total intake of 1 uCi distributed over 10 or 100 days for HTO, Sr 90, I 131, Cs 137, Ra 226 and U and the results are displayed in graphical form. Included in the appendices are the deviation of basic equations, the fractions of the total excretion by urine and feces for elements taken up by the extracellular fluid and derived investigation levels for excretion following periods of constant uptake for seven radionuclides (including Pu 239). (FMM)

Table 6 shows derived investigation levels for excretion following periods of constant uptake for HTO, Sr 90, I 131, Cs 137, U 233, U 234, Pu 239 and Ra 226.

<279>
Not given, International Commission on Radiological Protection, Task Group on Lung Dynamics, Committee 2. 1966

Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract. Health Physics, 12, 173-207.

This report was prepared by the Task Group on Lung Dynamics for Committee 2 of the International Radiological Protection Commission. The following items were the major accomplishments and recommendations of the Task Group. A dust deposition model was developed which utilizes and depends upon dust sampling data. A dust clearance model was proposed in which the dust deposited in each respiratory compartment was dealt with quantitatively, kinetically and by pathways. The special problems of radon and its decay products were reviewed, including recent experimental data revealing the rapid clearance characteristics of the radon daughters and a discussion of the suitability of the proposed models, and the "free ion" controversy. Normal respiratory values were collected on both anatomical and physiological bases. (JTE)

<280>
Not given, National Radiological Protection Board, Harwell, England. 1974, October

On the Toxicity of Plutonium. Radiological Protection Bulletin No. 9; 28 p.

The toxicity of plutonium as compared to the toxicity of non-radioactive and other radioactive materials is discussed. Plutonium is termed highly toxic by

<280>

MEDICAL ASPECTS

<280> CONT.
comparison with non-radioactive material, especially for intake by inhalation. Because the effects of the alpha radiation become critical before any biochemical effects appear, the chemical toxicity cannot be determined. The maximum permissible concentration (MPC) for workers is 3 x 10(E-5) ug/m3 for Pu 239, 150 ug/m3, for inorganic lead, 200 ug/m3 for cadmium, and 2 ug/m3 for beryllium. It is noted, however, that by comparison with other radioactive materials Pu is not so toxic. The corresponding MPC for iodine 131 is 7 x 10(E-8) ug/m3 making it 400 times more toxic than Pu. Plutonium is about 16 times more toxic than tritium (as the oxide) in terms of chronic inhalation, but in terms of chronic intake by ingestion, tritium is about 200 times more toxic. (JTE)

<281>
Not given, National Commission on Radiological Protection, Subcommittee on Permissible Internal Dose, Washington, DC. 1953, March 20

Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water. National Bureau of Standards Handbook No. 52; 45 p.

The increased use of radioisotopes by industry, the medical professicn, and research laboratories, made it essential that minimal precautions were taken to protect the users and the public. This was the first official published report of the Subcommittee on Permissible Internal Dose of the National Committee on Radiation Protection. The recommendations contained in this handbook represented the best available opinions on the subject as of that time. The values given were derived on the basis of continuous exposures for a lifetime or for the equilibrium condition in which the rate of elimination had become equal to the rate of deposition in the body in all cases except for Ra 226, Sm 151, and Pu 239. Therefore, their use as interim values for a period of several years was believed to be justified. The values were chosen by the Subcommittee as the most acceptable values after considering a preliminary report which gave values recommended by various radiation protection committees as were listed in this report, and after making comparisons with values calculated by use of the data which was summarized in tabular form. This report considered the radioisotopes that were of interest at that time. Others were to be considered in subsequent reports as information about them was needed and data became available. (JTE)

<282>
Ohlenschlager, L., and H. Schieferdecker, Kernforschungszentrum Karlsruhe, Karlsruhe, German Federal Republic. 1973, December

Report About a Plutonium 239 Contaminated, Lacerated and Incised Wound. KFK-2006; 10 p.; Strahlentherapie, 146(6), 675-684.

This report deals with the diagnosis and therapy of a technician's wrist wound who was accidentally exposed to Pu 239 in the nitrate form. A tourniquet was applied 8 minutes after the accident. Initial alpha activity of the wound was approximately 200 uCi and was subsequently lowered to 7 uCi by a one-time wound excision. Additional decontamination was achieved by excision of the wound edges on the fifth day followed by wound secretion. Intravenous chelation therapy with 6 Na 3(Ca DTPA) injections (2 g each) starting on the 1st day after the incident and continued on the 5th, 7th, 8th, 11th and 83rd day, led to further noticeable lowering of the body burden. No side effects were noted. The problem of early and final body burden estimates which were derived from urine and feces activity analysis is discussed utilizing equations by Langham, Beach and Dolphin. (RAF)

Tabular data are given of daily activity analysis in blood, urine, and feces for 3 1/2 months. Figures 2 and 3 compare daily Pu excretion values with theoretical values calculated according to Longhorn, Beach and Dolphin.

<283>
Purrott, R.J., National Radiological Protection Board, Harwell, England. 1974, October

Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans. NRPB-R-31; Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 116-127), 127 p.

Cytogenetic data for 14 plutonium workers are presented. In 12 cases the plutonium was accumulated in the body at permitted rates during several years. The yield of dicentric chromosome aberrations (5.2 per 1000 cells) was significantly higher than the control value (1.2 per 1000 cells) but this could be explained in terms of the men's additional recorded exposure to external radiation. Results are also described for two clearly defined incidents, both resulting in the incorporation of significant amounts of plutonium. Little chromosome damage was observed in an inhalation case, but elevated levels and a non-random aberration distribution were found in the case where the material entered the body via a wound. This is consistent with exposure of the lymphocytes to localized deposits and alpha-emitter. Some problems concerning in vitro alpha dose-response experiments are discussed. (Auth)

<284>
Saccomanno, G., Saint Mary's Hospital, Grand Junction, CO. 1975

Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975. COO-1826-32; 9 p.

The study was initiated in 1957 by the U.S. Public Health Service and many facets of the project have reached final objectives. The three projects supported by Atomic Energy Commission are of utmost importance and consist of: (a) Collection of material from uranium miners known to have cancer of the lung into a tumor registry. (b) Regression study of sputum cytological findings in uranium miners who showed marked atypical squamous cell metaplasia and have quit smoking cigarettes, mining, or both. (c) Manual of Pulmonary Cytology--There is a dire need for a manual on pulmonary cytology. Approximately 60,000 sputum samples were examined over the last 17 years in cases that showed normal cytology at the inception of a study and subsequently developed carcinoma of the lung, giving an accumulation of material worthy of study and presentation. (Auth)

<285>
Schlenker, R.A., and B.G. Oltman, Argonne National Laboratory, Argonne, IL. 1973

Fission Track Autoradiographs. ANL-8060 (Part 2); Part of Annual Report, July 1972-June 1973, (p. 163-168).

Autoradiographs of Pu 239 and natural uranium in bone were produced using the fission track technique. A refrigerated irradiation facility at the Argonne CP-5 reactor permitting irradiation at temperatures well below the reactor ambient was used for production of fission track autoradiographs. Ten um and 100 um sections of bone laid on Lexan film were irradiated in a flux of ca 2 x 10(E+12) thermal neutrons/cm2-second for 1-24 hours. The films are etched, after separation from the bone, in 6.25 N KOH or NaoH at 60 degrees C for 15 minutes to 1 hour. Etching time is decreased with increased irradiation time to produce a good image. Beagle dog and human bones were so examined. (LR)

<286>
Schofield, G.B., and J.C. Lynn, British Nuclear Fuels Limited, Seascale, Cumberland, England. 1973, March

A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds. Health Physics, 24, 317-327.

DTPA (Diethylenetriaminepentaaceticacid) was administered IV to 6 subjects, involved in accidents which resulted in plutonium exposures. Four instances of plutonium inhalation are described. In three instances the contaminant was either plutonium oxide or plutonium/uranium oxide; in the fourth instance the contaminant was plutonium nitrate in the form of an aerosol spray. Only in this latter case was the DTPA chelation therapy demonstrated to have been effective. Two cases of plutonium contaminated wounds are considered. In the instance when the contaminant was in the form of a metal splinter of plutonium the DTPA chelation therapy was effective. An estimated total of 5190 pCi of plutonium was elimimated in the urine during the first 40 days post incident, and 29% of the amount taken into the system was removed by the application of chelation therapy, assuming that the amount remaining is excreted according to a Langham power function equation. (Auth)

<287>
Seaborg, G.T., Not given. 1973

Medical Uses: Americium 241, Californium 252. Part of Hodge, H.C., et al (Eds.), Uranium, Plutonium, Transplutonic Elements, Chapter 21. Springer-Verlag, New York, New York, (p. 929-940), 995 p.

The use of radioisotopes of the transplutonium series in the field of medicine is severely restricted for a number of reasons. From a medical viewpoint internal administration of elements of this series for either diagnostic or therapeutic purposes is precluded by their extreme toxicity. Hence, medical use of the transplutonium elements is limited to encapsulated sources for radiotherapy or selected medical applications. For Am 241, techniques are described for fluorescent scanning of the thyroid, whole body transmission scanning and some density measurements employing photon beam absorption. For Cf 252, the radiological properties are summarized and its use in cancer therapy is discussed. The neutrons from Cf 252 have relatively poor penetration in tissue, hence the use of this isotope may be restricted to intracavitary and interstitial applications. The considerable flexibility in source design allows treatment of any sites that could be treated with Ra or similar sources. Over the range of dose rates tested and depending on the system used the RBE of Cf 252 neutrons varies from about 2.5 to 10. In initial human studies, a dose rate of about 15 to 20 rads per hour will probably be used. Results of preliminary studies of Cf 252 cancer radiotherapy are reported. (PMM)

<288>
Snyder, W.S., Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1961

The Estimation of a Body Burden of Plutonium for Urinalysis Data. ANL-6637; Part of Proceedings of the 7th Annual Symposium on Bioassay and Analytical Chemistry held in Argonne, Illinois, October 12-13, 1961, (p. 13-21).

The formulae and methods developed by Langham for predicting the body burden of Pu of an individual on the basis of the urinary excretion data are mentioned, as well as the computer code for the IBM 704 developed by Lawrence. The paper develops an alternative method of treating the data and gives a preliminary discussion of the accuracy of the two methods. The mathematical problem consists in expressing the unknown functions q (body burden) and I (intake to blood) in terms of the known or partially known function U (urinary excretion). The mathematical solution fo q and I can be obtained by the use of the Laplace transform. Codes for the IBM 7090 have been prepared using linear interpolation to estimate U for values between successive sample dates. Tables containing estimates of body burden for 26 individuals by Langham by the PUQPUA code and by PUQUAP and PUQUAE are given and they show broad agreement of the estimates. Aspects of the problem which call for further exploration are identified. (PMM)

<289>
Stannard, J.N., University of Rochester, School of Medicine and Dentistry, Rochester, NY. 1973

Toxicology of Radionuclides. Annual Review of Pharmacology, 13, 325-357; UR-3490-182; 33 p.

Radionuclide toxicity is reviewed. The review is directed primarily to the pharmacologist-toxicologist rather than to the specialist in radiation biology. Emphasis is placed on carcinogenesis, dose-response relations and dosimetry, and environmental aspects of the general problem including references to the nuclear power controversy. Recent work is emphasized, but older epidemiological studies of carcinogenesis are also included. Special problems such as tritium and transmutation are discussed. (ST)

<290>
Stradling, G.N., National Radiological Protection Board, Harwell, England. 1974, October

A Rapid Method for the Determination of Plutonium in Urine by Ultrafiltration. NRPB-R31; Part of Stather, J.W., et al, The

<290>

MEDICAL ASPECTS

<290> CONT.
Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 65-73), 127 p.

A rapid and inexpensive method for the determination of plutonium in urine has been developed. The principle depends upon separating macromolecular plutonium species by ultrafiltration and directly assaying the material retained on the membrane by scintillation counting. The limit of detection of the method is equivalent to 0.11 dpm in a 24 hour urine sample and the analysis time excluding counting is about 2 hours. Because the reference level for plutonium, 0.44 dpm per 24 hour excretion, is exceeded only occasionally the method can be used as an effective screening procedure. Since americium, curium, and uranium are similar to plutonium in their ultrafiltration properties, a simple additional stage to characterize the alpha radiation is necessary if the plutonium reference level is exceeded. The method is inappropriate (except for uranium) when DTPA therapy has recently been implemented. (Auth)

<291>
Vanderbeek, J.W., Hanford Atomic Products Operation, Richland, WA. 1960, July 25

Plutonium in Puncture Wounds. HW-66172; 16 p.

Insufficient information was found in the literature to develop a rational plutonium "wound area" critical organ concept. Yet the need for definitive radiation protection guidance in the treatment of this type of deposition persists. Lacking are the human physical, physiological and chemical parameters involved in cutaneous, subcutaneous and intramuscular injections of plutonium, both at the wound site and the ultimate deposition area(s). Specifically, there is need for definition of: The RBE for localized implants of radionuclides in muscle tissue; the rate of transfer from a wound area to a critical organ; the uptake in the critical organ from a low order available source; and a minimum significant volume of tissue. Planned human experimentation is not recommended observation@recommended that human studies be planned such that when there is a maximum injury the practicable data be secured.. Specifically it is recommended that the observationbecause of the high carcinogenic potential of plutonium in soft tissue. However, it is recommended @that the observation concerning the apparent prevalence of a "foreign body" defense reaction be explored. The following values are provisionally offered for guidance in the treatment of plutonium puncture wounds: 1) Upper limit, 0.057 uCi or greater should be physically removed when possible and 2) lower limit, 0.0008 uCi or less should not be of concern if physical removal would cause disfigurement or loss of function. (Auth)

<292>
Wilson, R.H., Hanford Atomic Products Operation, Richland, WA. 1956, June 30

Distribution of Plutonium Observed in Human Blood. HW-44341; 6 p. ("Official Use Only" cancelled December 8, 1975)

The distribution of Pu in the blood system of nine individuals was studied. The predominant modes of intake were by inhalation, absorption and injection. The results obtained indicate defintely that the blood content is much higher than would be predicted by application of the Langham procedure to the urine samples obtained during the first few months after intake and they also indicate the possibility of material being slowly released to the blood from a source at the site of entry. It is recommended that the urine sampling program should be implemented with blood sampling for significant Pu deposition cases to help establish the total body burden. A brief background summary of each subjects deposition history is given in the appendix. (FMM)

<293>
Brightwell, J., National Radiological Protection Board, Harwell, England. 1974, October

The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung. NRPB-R31; Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protectin Board, (p. 74-88), 127 p.

Papers assessing the potential of bronchopulmonary lavage for removing inhaled radioactive particles are reviewed. The technique has been used in man for the treatment of various chronic obstructive lung diseases such as alveolar proteinosis, bronchial asthma and chronic bronchitis. Lavage has been used in experimental animals and in one human case to partially clear the lung of inhaled radioactive particles. Factors influencing the efficiency of lavage in removing insoluble particles include the number and timing of individual lung washes and of lavage sessions, the effect of lung radiation dose and the use of DTPA in the lavage medium. The overall experience with bronchopulmonary lavage in rats, dogs, baboons and man has tended to show that, when conducted under controlled conditions it is a relatively safe procedure and is, at present, probably the most promising potential therapy for accidental inhalation of insoluble radioactive aerosols. (Auth) (JTE)

Tables 2, 4, and 5 show the efficiency of bronchopulmonary lavage in removing inhaled particles from rat, dog and primate lungs respectively.

<294>
Foreman, H., University of Minnesota, College of Medical Sciences, Minneapolis, MN. 1963

Medical Management of Radioactively Contaminated Wounds. STI/PUB/65; Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 387-417) 450 p.

Information and data obtained from the experinces of the author and others concerning radioactive contamination of wounds were presented. Five instances of accidental human contamination were described in detail. A man who received beta doses to his hands estimated at 3000 to 16000 rep on the outer surface of the skin and 30 to 100 rep at 6 mm depth showed four distinct phases in the development of lesions: (1) erythema and edema with blanching of the areas receiving the greatest exposure which peaked at 48 hr; (2) absence of symptoms for 5 days; (3) development of secondary erythema, extravasation of blood into the involved area, vessicles coalesced into bullae at 2 weeks and persisted with some severe pain for

<294> CONT.
32 days; (4) termed the chronic phase, severely damaged areas never recovered but remained as ulcers with granulations in the center which bled easily with trauma. Research was cited which showed that some isotopes (Sr, Pu, I 131, HTO) do pass across the skin into the blood, however, the soluble forms of Pu appeared to be very poorly absorbed. Hazards from alpha activity were said to change markedly by movement of 50 um into the deeper layers of the skin. A worker, four years after having a radioactive sliver removed from his hand, developed a nodule with precancerous characteristics at the site. Skin and underlying tissue were excised, tested and estimated to contain 55 nc of Pu 239. Excision of radioactivity was termed the most practical method for disposing of contamination. The effectiveness of chelating agents was said to be limited by the relative abundance of calcium in the body, however, chelating agents of the polyamino-polycarboxylic type appeared to be effective in cases involving actinide metals, yttrium and the rare earths. Of these Ca EDTA and Ca DTPA had proved most useful. Three such cases were described in which the body burdens were reduced substantially by the use of these agents. (JTE)

<295>
Lafuma, J., Commissariat a l'Energie Atomique, Department de Protection, Section de Pathologie et de Topicologie Experimentale, Fontenay-aux-Roses, France. 1974

Inhaled Radioelements. Radioprotection, 9(1), 15-25. (French)

The results described fall within the framework of long-term research aiming at studying the pathological effects of inhaled radioelements, namely plutonium 239 oxide, americium 241 nitrate and curium 244 nitrate. A LD/50 value was determined for each radioelement and for each physical-chemical form. This LD/50 rises from the curium 244 nitrate to the plutonium 239 oxide. The differences observed are linked to the number of cells affected, which depends on the degree of heterogeneity of radicelement distribution. Many cancers were obtained during the experiments. These cancers had histological types identical to certain human cancers. Irrespective of the dose, the first animals to die showed metaplasia, those living on then had non-malignant tumors, and it was in those living the longest that cancers were found. This systematic succession of cellular damage foreshadows the possibility of interpreting the various different mechanisms entering into cancer induction. (FR-tr)

<296>
Mays, C.W., and R.D. Lloyd, University of Utah, College of Medicine, Radiobiology Division, Salt Lake City, UT. 1972

Bone Sarcoma Incidence vs. Alpha Particle Dose. Part of Stover, B.J. and Jee, W.S.S. (Eds.), Radiobiology of Plutonium. J.W. Press, Salt Lake City, Utah, (p. 409-430), 552 p.

The incidence of bone sarcomas was analyzed in 12 studies involving graded doses of alpha-emitters in humans, dogs, mice and rats. A linear dose-response relationship anchored to control incidence at zero dose, was fit through each set of data over the wide dosage range extending up to, or near, the region of peak incidence. Then in the low dose regions the observed cases of bone sarcoma were compared to those from "wide dose" linear predictions. At low doses the observed cases were significantly fewer (P is less than 0.1) than predicted for Ra 226 plus Ra 228 in humans; for the summed studies of Ra 226, Ra 228, and Th 228 in dogs; and for Pu 239 in mice. However, the low dose results agree better with the indicated linear predictions than with the expected natural incidence for Ra 226 and Ra 224 in mice, and for Pu 239 in rats. The induction of bone sarcomas by alpha-emitters appears to increase linearly with dose in some cases, but to follow threshold or sigmoid relationships in others. This is in sharp contrast to the induction of bone sarcomas by beta-emitters where the observed dose-response over a wide dosage range was non-linear in every known case. (Auth)

Table 6 gives Pu 239 induced bone sarcomas in beagles, April 1970. Table 8 gives Pu 239 induced bone sarcomas in mice, 1962. Table 10 gives Pu 239 induced bone sarcomas in rats, 1970.

<297>
Morgan, K.Z., Georgia Institute of Technology, School of Nuclear Engineering, Atlanta, GA. 1975, August

Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements. American Industrial Hygiene Association Journal, 36(8), 567-575.

The historical development of the value of maximum permissible body burden of Pu 239 is presented and present considerations for the revision of this standard are given. Some evidence is presented that the linear hypothesis may not be sufficiently conservative at low dose rates and especially for the actinide elements. Until certain questions are answered about the particle problem, it will not be possible to set a satisfactory maximum permissible body burden for Pu 239 based on lung as the critical organ, but in the meantime some studies suggest that the present maximum permissible body burden based on bone should be reduced at least by a factor of 200. (Auth)

<298>
Not given, United Nations Scientific Committee, New York, NY. 1972

Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects. United Nations, New York, New York; 447 p.

Genetic effects, effects on immune response, experimental induction of neoplasms by radiation and radiation carcinogenesis are the topics presented in this report. Genetic effects include information on mammals, fish, insects, effects at the cellular and molecular levels and risk estimates. The section on immune responses is grouped into the effects of radiation on susceptibility to infection, antibody formation and cellular immune reactions, radiation and immunological tolerance, induced carcinogenesis and effects of variation of condition of irradiation on immunological responses. The section on experimental induction of neoplasms by radiation deals with the role of animal experiments in predicting radiation carcinogenesis in man, the importance of

<298>

MEDICAL ASPECTS

<298> CONT.
radiation carcinogenesis for life-shortening effects of radiation, statistical analysis of specific disease incidence in survival experiments, special problems of internal emitters, tissues at risk, dose-effect relations, RBE, effects on dose rate, dependence of sensitivity on age and differences in sensitivity between strains and between species. Radiation carcinogenesis aspects in man include leukemia, breast cancer, lung cancer, bone tumors, malignancies in children and malignancies in pre-natally exposed children. (RAF)

<299>
Not given, United Nations Scientific Committee, New York, NY. 1972

Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels. United Nations, New York, New York; 197 p.

This sixth substantive report reviews the levels of radiation received from all sources to which man is exposed and, among the effects of ionizing radiation, it considers the genetic effects, the effects on immune response and the induction of malignancies in animals and man. The acute consequences of massive amounts of radiation that may be received accidentally or during nuclear warfare are not reviewed here. Fully documented technical annexes on radiation levels which are the basis for the Committee's conclusions are given in this volume. Volume 2 contains annexes on radiation effects. Also given are lists of contributing experts and reports received by the Committee. The subject matter of this volume is environmental radiation, doses from medical irradiation, doses from occupational exposure and miscellaneous sources of ionizing radiation. Data on plutonium include levels in the environment and dose estimates. Pu as a component of global fallout is found in surface air. Because of its toxicity when inhaled careful monitoring of surface air is advised. The total amount of Pu 239 produced in nuclear tests can be inferred from the Sr 90 corresponding value, since the Pu 239/Sr 90 activity ratio is about 0.02 both in stratospheric and surface air. If the local fallout is not taken into account, the production of Sr 90 by nuclear tests amounted to 15.5 megacuries in January 1971 and the corresponding value for Pu 239 was 0.3 megacurie. Appreciable amounts of Pu 239 were released locally to the environment when airplanes carrying nuclear bombs crashed in the vicinity of Palomares, Spain in 1966, and Tleule, Greenland in 1968. Additional amounts of Pu 238 were injected into the stratosphere as a result of the burning on re-entry of a satellite. An ICRP model on lung dynamics shows that the slow removal processes from the pulmonary region of Pu by direct translocation to the blood or by ciliary-mucous transport to the gastrointestinal tract take place with a half-time of 360 days. Of this, 10% is introduced into the systemic blood and 90% is presumed to be permanently retained in the lymph nodes. The few measurements of Pu 239 in man confirm the accumulation in respiratory lymph nodes, lung, liver and bone but seem to show that the concentrations in lymph nodes are probably overestimated whereas those in liver are underestimated. (RAF)

<300>
Not given, International Atomic Energy Agency, Vienna, Austria. 1963

Diagnosis and Treatment of Radioactive Poisoning. STI/PUB/65; Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962; 450 p.

The purpose of this book is to review the present state of knowledge on the diagnosis, evaluation and treatment of persons who have accidentally incorporated radioactive materials. It includes papers by three groups of persons: those experienced in various methods of diagnosis and treatment of patients who have been exposed (occupationally or accidentally) to radioactive materials; those engaged in the clinical administration of radionuclides and the study of their behavior in man; and those working on related problems with experimental animals. The papers are separated into six sections; (1) early evaluation, (2) radium (3) strontium, (4) other fission products and nuclides, (5) plutonium and other transuranic elements, and (6) treatment. A section at the end is devoted to summing up and discussion. Six articles have been selected for input. (JTE)

<301>
Popplewell, D.S., National Radiological Protection Board, Harwell, England. 1974, October

Chemistry of Plutonium Incorporated in Humans. NRPB-R31; Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 49-64), 127 p.

It has been demonstrated that transferrin, the iron-transporting protein of mammalian blood, also binds and transports Pu. The addition of ferric chloride solution containing Fe 59 to serum caused the immediate precipitation of ferric hydroxide. A trace amount of sodium citrate was then added to act as an iron masking agent. It was observed that the iron was bound to the protein fraction as before, but the Pu was found almost wholly in the low molecular weight fraction. Investigations with Am and Cm, failed to show binding of these two radioelements to transferrin. A human contaminated with Pu was fed an iron rich diet and the urinary Pu concentrations were measured. Negative results were obtained, however, several intravenous injections of DTPA had been administered earlier and probably had removed much of the Pu. The transfer of Pu to the organelles of the liver cells probably makes the Pu less accessible for chelation with DTPA because the DTPA cannot cross the cell membrane. Chang human liver or Hela cells were placed in suspension in a culture medium containing Pu. Plutonium accumulated by Chang cells was not removed by DTPA, whereas Pu taken up by Hela cells was reduced by DTPA treatment. This difference between types of cells did not occur when citric acid was used as the chelating agent. Filtration and chromatography tests indicate that the low molecular weight binding agent for Pu in urine is citrate. Increasing the plasma concentration of citrate in Pu-bearing rats by continuous infusion of citrate solution appeared to enhance excretion of Pu. (JTE)

<302>
Schlenker, R.A., and B.G. Oltman, Agronne National Laboratory, Center for Human Radiobiology, Argonne, IL. 1974

The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone. ANL-75-3 (Part 2); Part of Radiological and Environmental Research Division Annual Report, July 1973 through June 1974, (p. 82-89), 231 p.

The initial concentrations of Pu 239 on endosteal surfaces of compact and cancellous bone from a person who had received a Pu 239 injection were determined by quantitative autoradiography. The concentrations were higher in cancellous bone than in compact bone, and concentrations in the axial skeleton were greater than in the appendicular skeleton. The values ranged from 0.4 to 4.6 pCi/cm2, and the average over the entire endosteal surface of the skeleton was 3.0 pCi/cm2. The bone surface to bone volume ratio was measured in a cervical vertebra and in a lumbar vertebra and was found to be 114 cm2/cm3 in the former and 101 cm2/cm3 in the latter, close to the value of 110 cm2/cm3 found for a normal adult male by Lloyd and Hodges. The total skeleton bone mass was estimated to be 2100 g and is considerably subnormal, probably because the subject suffered from Cushing's syndrome. The initial uptake of Pu 239 in the marrow-free skeleton was estimated to be 26% of the injected amount. The data were used, in conjunction with a model by Marshall and Lloyd, to predict that the Pu 239/Ra 226 RBE in man will be four times the Pu 239/Ra 226 RBE observed in the Utah beagles. (Auth)

<303>
Myers D.S., W.J. Silver, D.G. Coles, K.C. Lamson, D.R. McIntyre, and B. Mendoza, Lawrence Livermore Laboratory, Livermore, CA. 1975, September; 1976

Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops. CONF-751105; IAEA-SM-199/42; UCRL-77318;Part of Proceedings of the Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p 311-327), 724 p.

After the accidental release of 32 mCi of Pu 239 from Lawrence Livermore Laboratory into the sanitary sewer system, an investigation was carried out to determine the possible adverse health effects associated with the use of sludge from the system as a soil conditioner around public places, homes and gardens. Two possibly significant uptake pathways studied were: (1) resuspension and inhalation of the Pu 239, and (2) uptake of the Pu 239 by plants and subsequent ingestion by people. The sludge was spread over a 10 m x 17 m experimental plot to a depth of 7.5 to 10 cm. Samples taken from the sludge had an average Pu 239 content of 2.8 X 10(E-6) micro Ci/g dry weight. After a 4 week drying period both the experimental and a control plot were rototilled. Nineteen varieties of vegetables selected because they were representative of the types grown in home gardens around Livermore were planted. Conditions were chosen to maximize exposure to Pu 239 through resuspension and plant content. The estimated 50 year doses to their lungs, bones, and liver through inhalation were 6x10(E-4), 1.2 x 10(E-3) rem, and 0.55 x 10(E-4) rem, respectively. Estimated 50 year doses from ingestion of sludge-grown vegetables were 2.2 x 10(E-5) rem to the bones and 1.5 x 10(E-5) rem to the liver. Dissolution rates for Pu 239 in sewer sludge were also calculated. The maximum 50 year lung bone and liver doses were determined to be 4.0 x 10(E-3)% of the annual MPD. (JTE)

<304>
Peterson, K.R., Lawrence Livermore Laboratory, Livermore, CA. 1975, May

Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests. UCID-16790; 17 p.

The second report which will be used to form the basis of an environmental assessment statement from the National Nuclear Test Readiness Program (NNTRP) is presented. Such a statement will be required in the event that atmospheric testing should again become necessary. Prior high altitude tests and a global deposition model are discussed briefly. From 400 kt of fission products injected in winter within the Pacific Test Area at altitudes in excess of 50 km, the largest 30 year average dose to man is about 10 millirem and occurs at 30-50 degrees N latitude. The main contributor is external gamma radiation from gross fission products. Individual doses from Sr 90 via the forage-cow-milk pathway and Cs 137 via the pasture-meat pathway are about 1/5 the gross fission product doses. The global 30 year population dose is 3 x 10 (E+7) person-rem, which compares with a 30 year natural background population dose of 1 x 10(E+10) person-rem. Over 98% of the global person-rem from the proposed high altitude tests is received in the Northern Hemisphere, while about 75% of the total population dose occurs within the 30-50 degrees N latitude belt. Summer detonation would decrease the global dose by about a factor of three. (JTE)

Table 3 presents 30 year individual population doses for the proposed high altitude tests, arranged by 20 degree latitude bands and pathways.

<305>
Knox, J.B., and C.R. Molenkamp, Lawrence Livermore Laboratory, Livermore, CA. 1974, October

Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols. UCRL-76109; 52 p.

The status of development of some submodels that have been applied in actual assessments to estimate the dose-to-man from the wet deposition of nuclear aerosols is summarized, and the uncertainties of the dose-to-man assessments are discussed. The rainout effects associated with the detonation of free airburst nuclear devices appear to be capable of creating significant radiation hazards in areas far removed, a few hours travel time for 1 kt, from the closein area. There is a spectrum of opinion regarding the importance of rainout effects. The particle size distribution of the nuclear aerosol generated from a free airburst of low yield and its specific activity distribution as a function of particle size constitutes perhaps a most important difference of opinion. If the aerosol created is such that the particles are much less than a tenth of a micron in size, and if the specific activity distribution were such that the bulk of the radioactivity were on the smaller particles (as some would assume) the rainout hazard is significantly reduced. The specification of

<305>

MEDICAL ASPECTS

<305> CONT.
the relevant scavenging mechanism is a subject of debate; in the assessments made, in-cloud scavenging was selected as the most probable mechanism for low yield nuclear devices or aerosols created by a comparable energy release. If, however, there is very little energy in the release and the aerosols are created close to the ground washout might well be the primary removal mechanism. In general, there is an order of magnitude difference in the removal rates depending on whether rainout or washout is selected. (FNM)

<306>
Matthess, G., Universitat Kiel, Geologisch-Palaontologisches Institut and Museum, Kiel, German Federal Republic. 1974

Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters. Geologie en Mijnbouw, 53(4), 149-155.

The natural and man-made concentrations of heavy metals are discussed concerning their abundance, geochemical mobility and their physiological effects on man. The many gaps of geochemical information concerning abundance and behavior of heavy elements in the ground should be filled especially for those elements which are important to human health. Mention is made of the damage to the liver and kidneys by chromium, copper damages to the liver, nickel damages tc the nervous system and the Minimata disease, that is is, damage to the nervous system caused by mercury. The maximum permissible concentrations (MPC) are given for several radionuclides including Pu 239, Pu 238, U 235 and U 238. The MPC of U 238, (4.10 pCi/l), which is equivalent to about 120 ppm U, is not exceeded in natural water, but the danger from its chemical toxicity which causes liver damage is greater than the danger from radiation. (Auth) (FNM)

Table 5 shows maximum permissible concentrations of radioactive heavy metals in drinking water. Included are Pu 238, Pu 239, Pu 240, Pu 242, U 235 and U 238.

<307>
Tamplin, A.R., and T.B. Cochran, Natural Resources Defense Council, Washington, DC. 1974, February 14

Radiation Standards for Hot Particles. A Report on the Inadequacy of Existing Radiation Protection Standards Related to Internal Exposure of Man to Insoluble Particles of Plutonium and other Alpha-Emitting Hot Particles; 52 p.

The report is written in support of a petition by the National Resources Defense Council to the U.S. Environmental Protection Agency and the U.S. Atomic Energy Commission requesting (1) a reduction of the radiation protection standards for internal exposure to alpha-emitting hot particles and (2) the establishment of standards governing the maximum permissible air concentrations and maximum permissible surface contamination levels in unrestricted areas. The material is divided into the following sections: Plutonium Use and Public Health, Existing Standards for Plutonium Exposure, Calculating the Dose Due to Insoluble Alpha-Emitters, Biological Data Related to the Cancer Risk from Insoluble Plutonium Exposure, Critical Particle Activity, Exposure Standards for Hot Particles, and a Summary of Recommendations. The major recommendations for alpha-emitting hot particles are: (1) for occupational exposure, maximum lung particle burden (MPLPB)=2 hot particles, maximum permissible concentration for Pu 239=3.5 x 10(E-16) uCi/ml; Ci/ml; (2) for non-occupational exposure, MPLPB=0.2 hot particles, MPC for Pu 239=2 x 10(E-18) uCi/ml; (3) for accidental releases exposure MPLPB (2 hours exposure)=10 hot particles; and for unrestricted areas maximum permissible surface concentration = 1 hot particle/m(E+2). An appendix containing descriptions of radiation standards setting organizations and their roles is included. (JTE)

<308>
Lister, B.A., Jr., United Kingdom Atomic Energy Authority, Health Physics and Medical Division, Harwell, England. 1963

The Problems and Methods of Sample Assay. STI/PUB/65; Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 23-44), 450 p.

In assessing the radiological effects on staff handling radioactive materials, less confidence was expressed in the ability to determine the amount of radioactive material retained in the body after inhalation, ingestion or skin penetration than in measuring the external radiation dose. Most routine bioassay programes in laboratories handling radioactive materials are based on the regular collection and analysis of samples of urine. This paper posed the question of the purpose for the program and discussed the need for a bioassay program, the difficulties in interpreting the results, the setting of investigation levels, and problems of planning, including frequency of sampling and size of sample. Consideration was given to the need for fecal sampling both after accidental intake and as a routine measure. A brief survey was given of current analytical methods for specific radionuclides. It was indicated that there was a great need to amass further information on excretion patterns both by experiments on animals and on human subjects and by investigating thoroughly the occasional cases of accidental internal contamination which arise. (Auth) (JTE) (CTS)

<309>
Sill, C.W., J.I. Anderson, and D.R. Percival, U.S. Atomic Energy Commission, Health and Safety Division, Idaho Falls, ID. 1964

Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants. CONF-448; STI/PUB/84; Part of Proceedings of a Symposium on the Assessment of Radioactive Body Burdens in Man held in Heidelberg, Germany, May 11-16, 1964, Vol. 1, (p. 217-229), 1043 p.

Since the beginning of the atomic energy era, the detection and determination of internal contamination by radionuclides has depended primarily on the routine examination of urine. During the past three years, the in vivo whole-body counting program being carried out at the National Reactor Testing Station has demonstrated clearly that urinalysis is grossly inadequate as a general monitoring technique for internal contaminants. Thirty-one different radionuclides have been encountered in human subjects by whole-body counting, of which only iodine 131-133, cesium 134-137, mercury 197-203 and molybdenum-technetium 99 were

<309> CONT.
excreted significantly in the urine. The other nuclides were eliminated so exclusively in the feces that, except for an occasional trace, the nuclide could not be detected even in a 1500-ml urine sample. The conclusion seems clear that for inhalation of particulates, the metabolic fate will be more dependent on the physical properties of the element itself. The effective half-lives and modes of excretion are presented for many of the nuclides encountered. In vivo whole-body counting avoids many of the problems of excretion analysis for gamma emitters. However, whole-body counters are generally expensive both in terms of the original cost of the equipment and the continuing costs of working time lost while the subjects being counted are away from their jobs. A new instrument is described in which the heavy shielding normally associated with whole-body counters is eliminated to achieve portability and reasonable costs that most laboratories can afford. The prototype weighs about 640 pounds and can be mounted in a small van to permit moving the counter to different reactor sites to increase the coverage for the same cost. Yet, approximately 0.01 uc of cesium 137 can be detected in a 10-min count, a level that is more than adequate for practical personnel protection. (Auth)

<310>
Barr, N.F., U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC. 1974

Assessment of Potential Health Consequences of Transuranium Elements. CONF-740529; STI/PUB/375; IAEA-SM-184/16; Part of Proceedings of a Symposium on Population Dose Evaluation and Standards for Man and his Environment held in Protoroz, Yugoslavia, May 20-24, 1974, (p. 451-462), 646 p.

Quantitative estimates (per unit of electrical power generated) of potential consequences to human health from inhaled or ingested transuranium elements released during the generation of electricity by the liquid metal fast breeder reactor (LMFBR) fuel cycle have been determined. Soon after release direct inhalation of downward descending airborne particles is the dominant route of entry of transuranic elements into man. The fraction of material entering man in this way is estimated to be 4 x 10(E-6). A comparable fraction enters man through inhalation of material resuspended into the atmosphere after deposition. Estimates for the fraction of released material that enters man through ingestion processes from the time of release to complete decay of the activity are made for the most significant radioisotopes of plutonium, americium and curium. Americium 241 is the largest contributor to dose by this pathway. Health effects estimates based on current metabolic data, ICRP dose models and the report of the committee on Biological Effects of Ionizing Radiation of the U.S. National Academy of Sciences, when combined with these pathway analyses, indicate that there are likely to be more than about 10(E-3) potential health effects for each 1000 megawatt electric year of power generated. (Auth)

<311>
Not given, Not given. 1974, November 23

Hot Spots or Hot Lungs. Lancet, 2(7891), 1238-1239.

A.R. Tamplin's and T.B. Cochran's report on "Radioactive Standards for Hot Particles", is evaluated. Contradictory studies are cited and their results compared with Tamplin's interpretations. The basic controversy is whether radiation damage (e.g., cancer) depends on the size of the dose absorbed per unit volume of tissue (i.e., cell or subcellular organelle) on the integrated dose multiplied by the number of cells exposed or, in fact, on the average dose to the whole organ which includes populations of irradiated and non-irradiated cells. The ICRP provides adequate estimates of radiation hazards in most cases of external radiation exposure$ however, the internal exposure resulting from incorporation of radioactive materials often presents a heterogeneous dose distribution, within an organ as well as an individual cell, e.g., inhalation of insoluble plutonium particles. Data reported by Tamplin and Cochran were derived from radiation induction of carcinomas in rat skin and in relating this data to man they suggest a maximum permissible lung burden (MPLB) for radiation workers of 2 particles. The risk estimate per 10(E+6) people per rem per year implied a risk of cancer at the maximum permissible dose rate to the lung of 15 rem/yr or about 3 x 10(E-5) per year. Other studies are reported on the health of men handling plutonium in the early days at Los Alamos and Windscale. No evidence of hazard to man has been revealed. More statistical work, based on the concept of an at-risk register and intensive medical follow-up of individuals carrying a known radioactive body burden, is needed. (CSF)

See also "Radiation Standards for Hot Particles," a report on the existing inadequacy of existing radiation protection standards related to internal exposure of man to insoluble particles of plutonium and other alpha-emitting hot particles, 1974.

<312>
Rundo, J., P.M. Starzyk, Sedlet J., R.P. Larsen, R.D. Oldham, and J.J. Robinson, Argonne National Laboratory, Center for Human Radiobiology, Argonne, IL; Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL. 1974

Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection. ANL-75-3 (Part 2); Part of Radiological and Environmental Research Division Annual Report, July 1973 thrugh June 1974, (p. 136-141), 231 p.

Three persons who had received injections of plutonium in 1945-1947 were hospitalized on a metabolic ward in 1973. Complete collections of urine and feces were made for periods of 8 to 14 days, and these excreta were shipped to Argonne National Laboratory for plutonium analysis. Two of the individuals received intravenous injections of about 0.3 uCi of plutonium(+4) citrate; the third individual received an intramuscular injection of 0.095 uCi of plutonium (+6) nitrate. The intravenous injections were of (Pu 239), while the intramuscular injection was of Pu 238. The results showed substantial amounts of Pu 239 in the daily excreta of the two subjects who had been injected intravenously with plutonium citrate Pu 239 10(E+4) days previously. The urine of the third subject injected intramuscularly with Pu 238 contained just measurable amounts of this nuclide. (Auth) (FMM)

Table 3 shows Pu in the fecal samples of 2 patients who received Pu 239. Table 2 shows Pu

<312>

MEDICAL ASPECTS

<312> CONT.
in human 24 hr urine samples.

<313>
Angel, K.C., and H.P. Anderson, Mound Laboratory, Miamisburg, OH. 1969

Different Type Glove Box Filters Used for Plutonium 238 Work. CONF-690103; Part of Willis, C.A., and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1969, Vol. 2. Gordon and Breach, Science Publishers, New York, New York, (p. 981-993), 1848 p.

A review is presented of the different type glove box filters that have been used with Pu 238 glove boxes at Mound Laboratory. Three filter installation types are discussed: (1) box-type filter mounted inside a small housing on top of glove box, (2) cylindrical filter with 2-in. diameter threaded pipe at one end designed to screw into exhaust line inside glove box, and (3) dual cylindrical filters with molded rubber gaskets designed to fit inside a stainless steel or fiberglass tube below glove box. Each type filter installation is discussed in terms of filtration adequacy, sources of leaks, ease of filter change, contamination control problems during filter change, and interference wihth glove box operations. (Auth)

<314>
Bliss, W.A., and F.M. Jakubowski, National Environmental Research Center, Las Vegas, NV. 1975, June

Plutonium Distribution in the Environs of the Nevada Test Site--Status Report. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for January, 1975, (p. 237-250), 504 p.

In September, 1970, the National Environmental Research Center, Las Vegas began a study to define the distribution of plutonium in the environment surrounding the Nevada Test Site (NTS). As a part of this study, off-NTS air and soil are being investigated for plutonium content. Air samples analyses have been limited to filters collected at selected Air Surveillance Network Stations over a period from 1966 to 1973. Soil samples have been collected in close proximity to the NTS. Extensive soil sampling has been conducted downwind from the NTS in accordance with old atmospheric fallout patterns. Since the plutonium-in-soil study began, several special related projects have been started. A basin study is under way to determine the movement of plutonium with surface water drainage. A fruit and vegetable study has just been completed. The study was designed to determine the uptake of radionuclides in locally grown and consumed crops. Another special related project has been designed to define the transport of radionuclides off the NTS via Fortymile Canyon. A resuspension study is being designed to measure the ambient levels of plutonium northeast of the NTS. The collection and analysis of both air and soil samples should remain the same as in the past. Whenever special related projects such as those noted above are designed, appropriate plutonium studies should be included. (Auth)

Figures 1 and 2 show the amounts of Pu 239 in nCi/m2 found in soil samples from the vicinity of NTS and from eastern Nevada and central Utah. Figures 3-6 show the amounts of Pu 239 in fCi/m3 found in air sampling filters from Austin, Texas, Spokane, Washington, Albuquerque, New Mexico, Medford, Oregon, Aberdeen, South Dakota, and St. Joseph, Missouri.

<315>
Brady, D.N., and B.W. Church, Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV; U.S. Atomic Energy Commission, Washington, DC. 1975, June

Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 217-230), 504 p.

The Nevada Applied Ecology Group Distribution and Inventory Programs sampling effort during 1974 was significantly upgraded by implementation of improved sampling techniques. Initiation of Phase 3 sampling, based upon results of the overview phase, was achieved. Phase 3 sample locations were selected using two methods, grid and random. Once the sampling locations had been identified, metal stakes were driven into the ground and tagged. After a surface sample had been obtained, a backhoe was used to dig a sampling trench about 24 inches wide, 4 feet deep, and 6 feet long. Five samples were taken at each location; at the surface, and at 30, 60, 90, and 120 cm. A 10 cm long, 10 cm wide, 5 cm deep sampling tool was forced into the wall of the trench by using an electrically driven pneumatic ram. This system increased sample collection efficiency by at least 30%. The bulk of the soil samples were being evaluated using an "inferred plutonium" technique based upon 100 min Ge(Li) scans of soil samples for Am 241. Known ratios of plutonium (wet-chemistry to americium (Ge(Li) scans) were applied to these sample data to calculate the plutonium content. (JTE)

<316>
Buset, K., and K.W. Price, Los Alamos Scientific Laboratory, Los Alamos, NM; Lawrence Livermore Laboratory, Mercury, NV. Not given

Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS). LA-UR-74-1953; 13 p.

In the summer of 1972, a program was begun to determine lightning activity characteristics at the Nevada Test Site. Preliminary work performed in 1971 was used to initiate this program and design a practical lightning warning and data procurement system. A major objective of the program was to obtain information on flash densities in areas vulnerable to lightning damage. Instrumentation used in this study was designed to respond in accordance with the results of Dr. E. T. Pierce's work published in 1955 relating mean electric field change magnitude vs distance from a lightning discharge. From the data collected, we were able to calculate flash densities and lightning strike probabilities. The results indicate that lightning flash densities may be found in localized areas and may be used as a guide in location of vulnerable installations. A definite relationship between lightning activity and topographical and meteorological characteristics of the

<316>

MONITORING, MEASUREMENT AND ANALYSIS

<316> CONT.
Nevada Test Site were also obtained. It was found that applying generalized lightning activity information for a large geographical area is not adequate in determining lightning strike probabilities and flash densities in portions of that area. In addition, we feel that the data obtained and subsequent results may be a valuable supplement tc associated studies of lightning activity. (Auth)

<317>
Church, B.W., E.S. Hedling, and D.N. Brady, Nevada Operations Office, Las Vegas, NV; Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV. 1975, June

A Different Look at Area 13 FIDLER Survey Data. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 231-235), 504 p.

FIDLER (Field Instrument for Detection of Low-Energy Radiation) data corresponding to soil samples analyzed for Pu 239 was evaluated for all isopleths of Area 13 of the Nevada Test Site. The FIDLER used consisted of an NaI (Tl) activated, scintillation crystal having a geometry (cylindrical, 1/16-in. to 1/8-in. thick x 4-in. diameter) which optimized it for detection of low-energy photons up to approximately 140 Kev. The crystal was connected to a photomultiplier (PM) tube by means of a light pipe arrangement. The output of the PM tube was connected to an Eberline PRM-5 (modified) count rate meter with three-channel Pulse Height Analysis (PHA) capability. It was found that when considering data for the total area, a function can be derived predicting surface Pu 239 concentrations approximately within a factor of 2. (Auth) (JTE)

Figure 1 is a comparison of FIDLER measurements with plutonium results in Area 13 soil.

<318>
Dabrowski, T.E., Douglas United Nuclear, Inc., Richland, WA. 1973, March 1

Reactor and Fuel Production Facilities, 1972 Environmental Release Report. DUN-8133; 12 p.

During calendar year 1972, an estimated total of 4,000,000 pounds of waste materials, including approximately 1 gram of radionuclides were discharged to the environs in liquid effluent streams emanating from Douglas United Nuclear, Inc. operated facilities. During the same period, approximately 2,000,000 pounds of reported waste materials, including a small fraction of a gram of reported radionuclides, were discharged to the atmosphere. Among the radioactive materials discharged to the Columbia River were Np 239 at an average concentration of 78 pCi/l and a total release value of 93 Ci. (RAF)

Individual listings of chemicals and radionuclides discharged to river, air and ground are given in tabular form.

<319>
Dean, P.N., and J.H. Jett, Los Alamos Scientific Laboratory, Los Alamos, NM. 1972

Analytical Support. LA-5337-PR; Part of Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972, (p. 76-78), 144 p.

Three systems of data analysis are discussed. These are: (1) chest and whole-body counting data analysis, (2) flow microfluorometric (FMF) data analysis, and (3) HUMCO II data analysis. In system number 1 a new method of background suppression based on pulse-shape discrimination with an ORTEC 458 pulse shape analyzer is in use, also the multichannel pulse-height analyzer has been replaced with a PDP-8/1 computer programmed to accomplish both data collection and analysis. Count rates are calculated as are lung burdens and standard deviations for Am 241, Pu 238 and Pu 239. Several ways of improving system number 2 are discussed which may improve its applicability to a wide variety of biological experiments. System number three is being improved by developing a new small computer to replace the large computers in the LASL central computer facility. The HUMCO II counter is used (1) to measure the amount of K and Cs 137 in humans, (2) to determine the biological half life of radioisotope in both animals and man, and (3) for counting problems where high efficiency is required and limited energy resolution can be tolerated. (JTE)

<320>
Denham, D.H., and J.K. Soldat, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project. Health Physics, 28, 139-144.

Studies of some parameters affecting radiation doses received from consumption of water derived from the Columbia River downstream of the Hanford production reactors were performed. Included were measurement of radionuclides in (1) water entering and leaving the water treatment plants at Richland and Pasco, Washington; (2) sanitary (municipal) water at a number of points in Richland; and (3) coffee brewed from sanitary water. The removal efficiencies for the alum-floc water treatment plants studied ranged from 80% for rare-earth nuclides to 10 % for Cr 51. The relative concentration of radionuclides, principally Na 24, As 76, Sb 122, and Np 239, found within the Richland distribution system was used to estimate the average dose to residents consuming the water. Average GI tract doses calculated for persons residing at each of six locations within the city were 1/3-1/2 of those calculated for consumption of water leaving the treatment plant. The average dose received, calculated by weighing these six individual doses by the population distribution, yielded 45 % of that calculated for consumption of water leaving the treatment plant. The estimated radiation doses to the average Richland resident in 1969 were calculated for the radionuclides of Hanford origin observed in the water and food consumed by area residents. Water is the primary source of radiation dose to the adult gastrointestinal tract and infant thyroid. The concentrations of radionuclides in the water and coffee brewed from it were not significantly different for those radionuclides contributing the most to the GI tract dose, and hence those doses were not significantly reduced. (Auth) (JTE)

See also BNWL-SA-4545 (Rev.), CONF-730603, Part

<320> CONT.
of Proceedings of the 18th Health Physics Society Annual Meeting held in Miami, Florida, June 17-21, 1973, (13 p.)

<321>
Dillman, L.T., and T.D. Jones, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1975, July

Internal Dosimetry of Spontaneously Fissioning Nuclides. Health Physics, 29, 111-123.

A general method has been developed which allows one to estimate the radiation dose to various organs of a homogeneous reference man phantom for the case of internally deposited spontaneously fissioning nuclides. Spontaneously fissioning nuclides are bone seekers but the GI tract, lungs, liver and genetic organs are also considered in this study. The doses due to neutrons, prompt and delayed gamma rays, beta particles, and recoil fragments are each considered separately. The known calculated neutron dose distribution about a point-isotropic Cf 252 source is used to obtain the average dose, by Monte Carlo techniques, to any organ for the source uniformly distributed in a specified organ. The prompt and delayed gamma spectra associated with the fission of U 236 are used in conjunction with known specific absorbed fractions in order to obtain dose estimates. The fission of U 236 is also used as a prototype for beta dosimetry calculations. For neutron, gamma and beta radiation, methods are discussed which allow one to obtain corresponding results for any spontaneously fissioning nuclide. (Auth)

<322>
Duport, P., G. Madelaine, and A. Renoux, Commissariat a l'Energie Atomique, Service Technique d'Etudes de Protection et de Pollution Atmospherique, Paris, France; Laboratoire de Physique des Aerosols et de Radioactivite Atmospherique, Faculte des Sciences, Brest, France. 1975, October

Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine. Chemosphere, 4(5), 283-288. (French)

The radioactivity of the atmospher of a uranium mine is due almost exclusively to the active deposition of radon (RaA, RaB. RaC) which is found eithe r in the free form or fixed to inert aerosols. The maximum permissible concentration (MPC) set by the ICRP for the protection of workers is given by the equation where MPC of radon is equal to 3 x 10(E-6) divided by 1 + 1000 of uCi/cm3, if being the free fraction. In order to determine if, here defined as the free fraction of RaA, five different methods based on the Brownian movement of particles were employed. These methods include the use of the Mercer impact, apparatus, diffusion batteries and capture by metabolic rods. The five methods gave comparable results with an average value of the order of 0.30, with however a wide spread. Several reasons are suggested for this. One suggestion is that the work was done in a laboratory mine with constant ventilation. In the case of the Mercer impact, the activity collected on the plages was very low which gave rise to statistical errors. The measurements were spread out in time, therefore dependent on unavodable variations of the initial conditions. It is necessary to choose an apparatus which is best adapted for measurements of f in a working mine. In this case it will be low because of strong turbulences and effective ventilation. The apparatus chosen should therefore give a direct measurement of the free RaA with as high counts as possible. The metal rods apparatus seems best suited to meet these criteria. Average values of the free fractions of a RaB (f sub B) and RaC (f sub C) were determined with f sub B=0.16 and F sub C=0.15, showing that the concentration of suspended ultrafire particles of RaB and RaC is not negligible in a non-working mine. A theoretical justification of the results is in progress. (tr-PMN)

<323>
Engstrom, D.E., Reynolds Electrical and Engineering Company, Inc., Mercury, NV. 1975, June

Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress for 1974, (p. 473-490), 504 p.

The recent completion of the Reynolds Electrical and Engineering Company (REECo) Automated Laboratory and associated software systems has provided a significant increase in capability while reducing manpower requirements. The system is designed to perform gamma spectrum analyses on the large numbers of samples required by the current Nevada Applied Ecology Group (NAEG) and the Plutonium Distribution Inventory Program (PDIP) soil sampling programs while maintaining sufficient sensitivities as defined by earlier investigations of the same type. General descriptions were given of various aspects of the Automated Laboratory including: automated laboratory hardware, gamma spectrum reduction software, the daily report system, and calibration for soil gamma analyses. In the six months preceeding the report, the system had produced results for over 7,000 analyses of which 3,000 were gamma spectrum analyses of soils. (JTE)

<324>
Fowler, E.B., and E.H. Essington, Los Alamos Scientific Laboratory, Los Alamos, NM. 1975, June

Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 1-25), 504 p.

Soils Element Activities conducted on behalf of the Nevada Applied Ecology Group were summarized. Major activities of the Soils Element during the past year included; (1) collection, preparation, and radiochemical analyses of soil, vegetation, and animal tissue samples from the intensive study area sites (Area 13, Area 5 GMX, Area 11, and the Tonopah Test Range), (2) review and formulation of soil sampling, sample preparation, and analytical techniques, (3) statistical evaluation of soils analytical data and the calculation of plutonium inventories for several sites, and (4) determination of plutonium association with soil particle size distribution at various locations in the intensive study areas. Emphasis was placed on statistics of sampling

<324>

MONITORING, MEASUREMENT AND ANALYSIS

<324> CONT.
and analysis, mound sampling, and referee laboratory activities. The laboratory activities were divided into the following ten topics with some discussion of each: (1) Analytical Effort, (2) Animal Tissue Preparation, (3) Plutonium Dissolution Procedure Modification, (4) Screening Soil Samples for Uranium, (5) Vegetation Dring, (6) Residue Testing, (7) Effect of Solution Acidity, Electrodeposition Time, and Sample Pretreatment on Plutonium and Uranium Recovery, (8) Meat Analysis--Laboratory Calibration, (9) Interlaboratory Quality Control and (10) Uranium-Americium Study. (JTE)

<325>
Frindik, O., Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, German Federal Republic. 1973, October

Total Alpha Activity Determination in Foodstuffs. Deutsche Lebensmittel-Rundschau, 69(10), 364-368.

The total alpha activity of foodstuffs was determined from the activity of the ashes. In individual foodstuffs and in complete daily rations an alpha activity of 5 to 6 pCi/kg was found. Ashed soil samples from the Rhine valley near Karlsruhe in the average gave higher activities by a factor of 21 than ashes of food from the same region. No increase of alpha activity was found in biological samples near nuclear installations. (Auth)

Tabular data are given on total alpha activity of beef liver, beef, potatoes, asparagus, wheat and apples, and of mixed vegetation, pine needles, grass, beef blood and tobacco.

<326>
Gilbert, R.O., L.L. Eberhardt, E.B. Fowler, E.M. Romney, E.H. Essington, and J.E. Kinnear, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, June

Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 339-448), 504 p.

Results of the statistical design and analysis work conducted during Calendar Year 1974 for the Nevada Applied Ecology Group (NAEG) at plutonium study sites on the Nevada Test Site (NTS) and the Tonopah Test Range (TTR) were reported. Estimates of Pu 239-240 inventory in surface soil (0-5 cm depth) were given for each of the NAEG intensive study sites, together with activity maps based on FIDLER surveys showing the field areas to which these estimates apply. The estimated Pu 239-240 inventories (in curies) for Area 13 and GMX Site in Area 5 were 44 plus or minus 8.8 (plus or minus standard error) and 2.5 plus or minus 0.30, respectively. Those for the four Roller Coaster sites at TTR (Double Track, Clean Slates 1, 2, and 3) were 5.0 plus or minus 1.4, 5.2 plus or minus 1.6, 29 plus or minus 6.2, and 30 plus or minus 4.9, respectively. The total Pu 239-240 inventory in Area 11 was estimated to be 39 plus or minus 4.4 which was divided between B site (6.2 plus or minus 1.0), C site (8.9 plus or minus 1.9), D site (18.5 plus or minus 3.5), a CD overlap region (0.81 plus or minus 0.34), and the low-level region surrounding these sites (4.5 plus or minus 1.4). Profile samples indicate that most plutonium in soil was present in the top 5 cm, with the average percentage ranging from 0.68 plus or minus 0.14 for Clean Slate 2 to 0.97 plus or minus 0.01 for Clean Slate 3. This information and that obtained from a pilot study of profile samples in blow-sand mounds and desert pavement was discussed relative to the inventory of plutonium to greater depths. Average Pu 239-240 concentratios in vegetation and soil were estimated for all strata (subregions) in all study sites. These data were also used to compute average vegetation to soil ratios for each stratum, which ranged from 0.07 to 0.44 in Area 13, from 0.05 to 0.16 for GMX, from 0.004 to 0.09 at the four Roller Coaster sites, and from 0.01 to about 0.4 in Area 11. Average Plutonium/Am ratios were computed for all sites, and range in general from about 5 to 8 in Area 11, 9 to 10 in Area 13 and GMX, and 22 to 26 at TTR. These data were plotted and fit by linear regression models. Pu/Am ratios with depth were computed for profile samples. There was some evidence for a decrease in ration with depth in Area 13, but the data were inconclusive for the other areas. Correlation coefficients between Pu 239-240 and Am 241 (Ge(Li)) concentrations on the same sample were computed; these generally were greater than 0.95. Correlation coefficients were also computed between Pu 239-240 concentrations in surface soil and net FIDLER cpm readings taken 1 ft directly over the soil sample spot immediately before the sample was taken. These ranged from near zero for some strata with low average Pu concentrations, to as high as 0.94 for Stratum 3 at the TTR Clean Slate 2 site. Data was given on a cross-calibration interlaboratory comparison using two soil samples collected off the Nevada Test Site. No statistically significant differences between average Pu 239-240 concentrations were found among five participating laboratories. Differences were found between two laboratories analyzing for Pu 238. Additional information was presented on the variation between aliquots of soil from the same soil sample. Throughout the report, an attempt was made to discuss the results from a statistical point of view by discussing the statistical estimation procedures that were used, along with some of their strengths and weaknesses. (Auth) (JTE)

Figures 15-27 consist of computer drawn Pu 239-240 concentration contours and three-dimensional "surfaces" illustrating soil and vegetation concentrations.

<327>
Greene, D., and D. Major, Christie Hospital and Holt Radium Institute, Physics Department, Manchester, United Kingdom. 1974

The Dosimetry of the Radiation from Californium 252. Physics in Medicine and Biology, 19(4), 448-459.

In using the two chamber method to separate components of neutron dose and gamma ray dose in the mixed beam from californium 252, difficulties arise in determining the chamber sensitivities to neutrons from their calibration with a standard Cobalt 60 gamma-ray field. This is because in the neutron field neither chamber can be regarded as a Bragg-Gray cavity. Conversion factors are calculated for two chambers of the same geometry, one made with tissue-equivalent walls and gas filling and the other made with

<327> CONT.
carbon walls and used either with air or with carbon dioxide gas filling. The expected accuracies of dose measurement have been found to be plus or minus 6% for total dose, plus or minus 9% for the neutron component and plus or minus 7% for the gamma-ray component. (Auth)

<328>
Gudiksen, P.H., and O.D.T. Lynch, Jr., Lawrence Livermore Laboratory, Livermore, CA. 1975, July; 1974, October 24

Radioactivity Levels in Enewetak Soil. Health Physics, 29, 17-25; UCRL-75371 (Rev. 1); 26 p.

A radiological survey was performed to define the distributions of radioactivity within the soil on the islands in the Enewetak Atoll, a former U.S. nuclear weapons test site in the Pacific. Soil samples were collected on each of the 40 islands within the atoll. Special emphasis, in terms of increased sample collections, was given to islands expected to have been the most affected by the testing program as well as those considered to be the most likely sites for future habitation. Approximately 3000 soil samples were analyzed by Ge(Li) gammaaa spectrometry and by wet chemistry. The predominant radionuclides observed in the samples were Sr 90, Cs 137, Pu 239, and Co 60. Amounts of K40, Fe 55, Rh 101, Rh 102m, Sb 125, Ba 133, Cs 134, Eu 152, Eu 155, Bi 207, Ra 226, U 235, or Pu 238 and Am 241 were detected in some or all samples. In general, the activities appeared to approximate log-normal distributions. Geometric mean values were determined for each area exhibiting significantly different radiological characteristics. The southern islands showed the lowest levels of activity and they were distributed in a fairly uniform way over the surface of the islands. On the northern islands, where weapons testing was most intensive, the highest activities were observed toward the island interiors or in proximity to ground zero sites, and could usually be related directly to the surrounding vegetation density. The distribution of activity with soil depth shows a wide range of variations. On the southern islands the activities are low to the depth sampled. Within areas subjected to fallout, but excluding ground zeros and construction areas, the activities generally show a rapid decrease immediately below the surface and then level off. Beaches exhibit lower activities than the interiors and the depth distributions are essentially homogenous. Profiles obtained in the ground zero and construction areas show highly variable depth distributions with layers of buried contamination indicated at some locations. The island of Yvonne is the most contaminated land area within the atoll. Particles containing as much as several milligrams of plutonium are randomly scattered on or near the surface over most of the northern part of the island. In addition, the northern tip of the island includes the highest external gamma levels (500-750 uR/hr) due to soil radioactivity found on the atoll. (Auth)(ND)

See also NVO-140 (Vols. 1-3) for a more detailed report of the data on the total radiological environment of the Enewetak Atoll. Mean values and ranges of Sr 90, Cs 137, Pu 239 and Co 60 in soils are tabulated.

<329>
Hart, J.C. (Ed.), R.H. Ritchie, and E.S. (Ed.) Varnadore, Oak Ridge National Laboratory, Oak Ridge, TN. 1974, October

Population Exposures. CONF-741018; Proceedings of the 8th Health Physics Society Midyear Topical Symposium on Population Exposures held in Knoxville, Tennessee, October 21-24, 1974, 434 p.

The technical questions considered at the conference involved the potential adverse effects that the nuclear power industry may have on the environment, pathways that various radionuclides follow in the biosphere when released in air or water, the relationship of such information to other radiobiological hazards, and environmental problems associated with the alternative fossil-fuel production of electricity. Fifty-five papers were presented at the conference and three of these have been abstracted separately for inclusion in the data base. The first session dealt with background radiation exposures, session two with medical radiation exposures and session three with nuclear power exposures. Subsequent sessions covered dosimetry and population exposures from other than nuclear power sources. There was also a public forum on population exposure from electrical power generation, both nuclear and non-nuclear. (FHM)

<330>
Hegelson, G.L., and D.C. Pollard, Helgeson Nuclear Services, Inc., Pleasanton, CA. 1969

Some Observations Obtained from a Nation-Wide In Vivo Counting Service. CONF-690103; Part of Willis, C.A. and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1969, Vol. 2. Gordon and Breach, Science Publishers, New York, New York, (p. 1235-1255), 1848 p.

Since most radionuclides encountered in the nuclear industry are insoluble, in vivo counting provides one of the best methods for determining internal burdens of many radionuclides. The paper discusses findings from approximately 7000 counts during the first three years of a nation-wide mobile in vivo counting service. Cobalt 60, the most frequently observed contaminant, will probably contribute the most lung exposure. Its effective half-life is generally about one to two years. Zinc 65 is present in people working at reactors where admiralty metal is used. Using an 8" x 0.5" NaI (Tl) detector in a Shadow Shield Whole Body Counter routine measurements of as low as 20% of the maximum permissible lung burden (MPLB) of U 235 in a 40 minute count were made. If the true lung burden is 0.245 mg of U 235, one MPLB at 93% enrichment, the probability is 90% that in any one measurement the observed activity will be 0.245 plus or minus 0.088 mg. The in vivo records have proven very useful in discovering trends in plant contamination status, boosting sagging employee morale, and in proving the regulatory agencies that th health physicist is using the latest techniques for estimating internal dose. The legal significance of an in vivo counting record appears far superior to urinanalysis records because of the relative simplicity of interpretation. (Auth)

<331>
Hornbacher, D.D., and C.J. Barker, Rockwell International, Atomics International Division,

<331>

MONITORING, MEASUREMENT AND ANALYSIS

<331> CONT.
Rocky Flats Plant, Golden, CO. 1975

Radioactive Effluent Monitoring at the Rocky Flats Plant. CONF-750967 (Vol. 2); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 607-621), 1015 p.

An overview of the air and water radioactive effluent monitoring program at the Rocky Flats Plant is presented. All streams leaving the plant site are sampled. Water is monitored continuously, and samples are collected daily from the sewage treatment plant influent and effluent, and from some of the holding ponds. Continuous sampling is also conducted downstream. Measurement for total long-lived, alpha-emitting radionuclides is conducted daily and measurement of total long-lived, beta-emitting radionuclides is conducted weekly. The daily samples are composited into weekly samples for analysis of Pu, U, Am, and Sr 90. Two independent monitoring networks are used for detecting and measuring the quantities of airborne particulate material. The first continuously monitors the exhaust air from production and research facilities. Samples are collected 3 times each week from about 36 exhaust systems. These are analyzed for total long-lived, alpha-emitting radionuclides then composited weekly and analyzed specifically for Pu and in some cases for U. Sixteen exhaust systems are monitored for tritium. The second network consists of 39 ambient air sampling stations located on and near the plant site, and in surrounding population centers. Samples are collected weekly, composited, and analyzed monthly for Pu and for long-lived, beta-emitting radionuclides. (JTE)

<332>
Kamada, H., M. Yukawa, and M. Saiki, National Institute of Radiological Sciences, Chiba, Japan. 1974

Studies on the Improvement of a Composite Dust Sampler and Its Utilization in Environmental Research. CONF-731110; STI/PUB/354; IAEA-SM-181/14; Part of Proceedings of a Symposium on Physical Behavior of Radioactive Contaminants in the Atmosphere held in Vienna, Austria, November 12-16, 1973, (p. 181-187.

Various methods of sampling airborne dust were examined for improvement on the conventional collector. Radiological studies on the behavior of radionuclides in the environment were also carried out by use of this collector. For a low-level radioactivity survey on airborne dust, a filter-type sampler was unsuitable and a Cottrell-type sampler was inadequate to collect a large amount of dust. A composite dust sampler was therefore assembled, designed to collect and deposit up to 99% of particles, size 10 um, at a flow rate of 10(E-3) per minute. It was indicated that the yield was more than twice as high as obtained by the conventional Cottrell method. Since 1965, the monthly variation of radionuclide concentration in air has been effectively observed using the improved sampler. Short-lived radionuclides due to a nuclear explosion test at the South Pacific Ocean were clearly detected in this survey, and the diffusion velocity was calculated as 3-4 m/s, using the data obtained in 1968. To estimate the time and degree of contamination by fission products to airborne dust, the daily change of the radioactivity ratio Nb 95/Zr 95, which is the degree of growth of Nb 95 and decay of Zr 95 in the dust samples, was carefully determined with a Ge(Li) detector from October 1971 to April 1972. Then fractionation of effects from multiple nuclear tests and estimation of the time of the occurrence were successfully achieved by simultaneous equation analysis. A satisfactory result was obtained. (Auth)

<333>
Kauffman, P.E., and P.J. Magno, Northeastern Radiological Health Laboratory, Public Health Service, Winchester, MA. 1967, April

Plutonium 239 in Total Diet and Milk. Radiological Health Data and Reports, 8(4), 191-194.

The National Center for Radiological Health initiated a program in July 1965 to determine the level of plutonium 239 in the total diet and milk. The diet samples were obtained from the Institutional Total Diet Sampling Network of the Public Health Service and the milk samples were obtained from the PHS Pasteurized Milk Network. Using a gastrointestinal absorption factor of 3 x 10(E-5) as suggested by the International Commission on Radiological Protection the average amount of plutonium 239 reaching the blood stream from the diet is estimated to be 2 x 10(E-4) femtocuries per day. (Auth)

<334>
Knox, J.B., Lawrence Livermore Laboratory, Livermore, CA. 1970, March 2

Hot Spot Mechanisms. UCRL-50230 (Rev. 1); Part of Knox, J.B., et al, Radioactivity Released from Underground Nuclear Detonations: Source, Transport, Diffusion, and Deposition, Chapter 9, (p. 99-104), 113 p.

Mechanisms producing hot spots in fallout at close range and/or in the deposition pattern at longer ranges are discussed. It appears that rainout and washout of particles are the most important hot-spot producing mechanisms. Thus, periods of rainfall should be avoided in nuclear caratering explosions. (BBM)

<335>
Knox, J.B., Lawrence Livermore Laboratory, Livermore, CA. 1970, March 2

Scales of Atmospheric Motion and their Impact on the Fallout Problem. UCRL-50230 (Rev. 1); Part of Knox, J.B., et al, Radioactivity Released from Underground Nuclear Detonations: Source, Transport, Diffusion, and Deposition, Chapter 3, (p. 18-23), 113 p.

Disturbances in the wind field span many orders of magnitude. Various scales of atmospheric motion have been developed, and by measuring the wind components from these scales, surface wind is a highly variable quantity. Mesoscale forecasting in a short range prediction and circulation elements are not subject to prediction. Thus, it can be inferred that if the prediction of fallout is to be treated determindistically, then shot-day conditions must contain relatively little energy in mesoscale and convective systems. If a fallout model based on gravitational sedimentation is to be valid, then frontal zone, with their local maxima of vertical motion, and mesoscale systems must be avoided or included in an approximate way in the calculation. To maximize the predictability of trajectories and deposition of fallout debris, shot day criteria have

<335> CONT.
evolved. Winds in the transpcrt layer should be directed into a preferred fallout sector and their stability should be confirmed at the time of the shot. The debris cloud should not encounter rain or snow for the first several hours, and the diffusion environment for the cloud should be deemed good. If these conditions are achieved, sedimentation fallout models are reasonably valid. (BBM)

<336>
Kownacka, L., Central Radiological Protection Laboratory, Warsaw, Poland. 1971

Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles. Przeglad Geofizyczny, 16, 197-208. (Polish)

The paper deals with theoretical predictions of relative concentration of heavy particles falling on the earth surface from a cloud which originates from a nuclear explosion. The calculations were based upon a simple linear model of a radioactive cloud, whose size and maximum height in the atmosphere is athe function of explosion yield. Particle size-distribution in the cloud is determined by the log-normal function, and their fall rates were calculated by various methods depending on their relative size. The particle size distribution on the ground as the function of the distance on the ground as the function of the distance from the source was calculated assuming the wind velocity to be a linear function of height. The six equations were obtained determining the relative concentrations of the particles on the earth surface. A IGIER computer was used for numerical calculations, for small explosions producing clouds in the troposphere found for distances covered by the local fallout. Curves on the size distribution and mass of the particles for several distances and explosion yields are presented. Significant differences in shape of the particle size distribution and mass distribution for differences in explosion yields were found. (Auth) (INIS)

<337>
Krey, P.W., and M. Kleinman, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1970, April 1

Project Airstream. HASL-224; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, December 1, 1969 through March 1, 1970, (p. II-9 - II-19), 144 p.

Project Airstream is HASL's study of radioactivity in the lower stratosphere using aircraft as a sampling platform. Data in the report cover missions flown in April, July, and October 1969. Air filter samples were collected and analyzed. Based upon gamma measurements, fractions of the filters were combined and sent to contractor laboratories for detailed analyses including Fe 55, Sr 89, Sr 90, Zr 95, Ce 141, Pb 210, Po 210, Pu 238 and Pu 239 and 240. Results of the quality control program for October 1969 showed the precision error of analyses is less than plus or minus 10% except for Pu 238 and Pu 239 results for samples 2476 which differ widely from its duplicate 2458. A third duplicate will be submitted to verify results. (BBM)

<338>
Lefeore, H., and A. Godement, Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France. 1974, May 6; 1974, July 26

Liquid Scintillation Counting of Alpha Emitters. Radiochemical and Radioanalytical Letters, 17(3), 197-205; BNWL-tr-127; 7 p. (French, English Abstract)

The use of liquid scintillators for monitoring solutions contaminated with Pu 239 to Pu 242, Am 241 and Np 237 was tested. In a liquid scintillator, energy transfer occurs in a homogenous medium. The alpha particle looses its energy by transferring it to the molecules of the solvent which then excites the primary scintillation. Scintillators were tested under conditions of different mixtures and different conditions. There was little difference between acitivities measured in HCL and H_2SO_4 media, but in an HNO_3 medium alpha counting loss was caused by loss of low energy betas of Pu 241 (0-21 kw). Measurements of the various isotopes and the efficiency of liquid scintillation for monitoring alpha contaminated solutions were discussed. (JTE)

<339>
Lindeken, C.L., J.H. White, A.J. Toy, and C.W. Sundbeck, Lawrence Livermore Laboratory, Livermore, CA. 1975, November 21

Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory. UCRL-77106; Part of Proceedings of the Health Physics Society 9th Midyear Topical Symposium on Operational Health Physics held in Denver, Colorado, February 9-12, 1976, (6 p.).

Thermoluminescence dosimetry (TLD) is the principal means of measuring ambient gamma radiation at the Lawrence Livermore Laboratory. These dosimeters are used at 12 perimeter locations and 41 locations in the offsite vicinity of the Laboratory, and are exchanged quarterly. Control dosimeters are stored in a 75-mm-thick lead shield located out-of-doors to duplicate temperature cycling of field dosimeters. Effect of dosimeter response to radiation in the shield is determined each quarter. Calibration irradiations are made midway through the exposure cycle to compensate for signal fading. Terrestrial exposure rates calculated from the activities of naturally occurring uranium, thorium, and potassium in Livermore Valley soils vary from 3 to 7 uR/hr. Local inferred exposure rates from cosmic radiation are approximately 4 Ur/hr. TLD measurements are in good agreement with these data. Offsite and site perimeter data are compared, and differences related to Laboratory operations are discussed. (Auth)

<340>
Lins, W., and W. Weinlander, ALKEM, Hanau, German Federal Republic. 1972

Design and Fabrication of Plutonium Sources for Cardiac Pacemakers. CONF-720519; Part of Proceedings of the 2nd International Symposium on Power from Radioisotopes held in Madrid, Spain, May 29-June 1, 1972, (p. 8 93-905), 986 p.

In a cooperation of ALKEM, Hanau, and GfK, Karlsruhe, a Pu 238 device for the Siemans-type thermoelectric converter has been developed. The criteria leading to the choice of fuel form and the cladding materials are discussed in connection wtith the safety aspects involved. The different fabrication steps of the capsule are described, beginning with the purification of Pu 238, the primary treatment, the

<340>

MONITORING, MEASUREMENT AND ANALYSIS

<340> CONT.
fabrication of the fuel and of the capsule, and the quality control. First results of the safety tests against fuel release and radiation, and capsule design stability are given. In all cases, leak-tightness of the capsule was preserved. New centrifuge tests are being applied to determine the strength of welding on the device. (BBM)

<341>
Major, W.J., K.D. Lee, and R.A. Wessman, LFE, Environmental Analysis Laboratories, Richmond, CA. 1975, June

Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 449-463), 504 p.

Analysis of environmental levels of Pu 239 and Am 241 in Nevada Applied Ecology Group (NAEG) large-sized bovine samples requires development of special procedure modifications to overcome the complexities of sample preparation and analyses. Also, special techniques are often employed to prepare and analyze different types of bovine samples, such as muscle, blood, liver, and bone. Sample sizes range up to 4 kg of muscle and 1.5 kg of bone. Muscle and large tissue samples are cubed prior to ashing, and bone is sawed into small sections. Large samples are split between several 2-liter Pyrex beakers and decomposed on a hot plate to a charcoal appearance. Ashing is completed at 450 degrees C in an ashing furnace. Ashing is done conservatively to outgas the sample without starting grease fires. The ash is dissolved in dilute HCl. Any insoluble residues are filtered, ashed, and dissolved with HF-HNO3, H3BO3, and combined with the dissolved ash. Plutonium 236 and Am 243 tracers and Y carrier are added and equilibrated with sample acitivity. In large samples, the Pu and Am are first carried on a mixed CAF2 - YF3 precipitate. Plutonium and Am are separated on an anion column, and Pu is purified and determined by previously reported methods. Americium is purified by liquid-liquid extraction with HDEHP, then carried on a precipitate of YF3. Residual Ca and Mg are removed in an acid oxalate step. Americium is finally purified on an ETOH-6N HNO3 anion exchange column and electrodeposited on platinum for alpha spectrometer counting. Plutonium and Am 241 detection limits vary with sample ash content, but typically are 10(E-4) dpm/g ash. Average tracer recovery for Pu 236 and Am 243 is 80 and 60%, respectively. Since Am 241 has a higher energy than Am 243 (5.49 vs 5.28 MeV), the tracer must be matched with the Am 241 for accurate measurement. (Auth)

Figures 1 and 2 summarize sample preparation and separation of plutonium and americium. Figures 3-5 summarize extraction, isolation, and purification of americium. Table 1 shows the elution percentages of americium 241 from Dowex 1 x 4 anion resin column by organic aqueous washes.

<342>
McClearen, H.A., Savannah River Plant, Aiken, SC. 1974, July

Plutonium in Soil at the Savannah River Plant. WASH-1332; CONF-740406; DPSPU-74-30-14; Part of Proceedings of the 2nd AEC Environmental Protection Symposium held in Albuquerque, New Mexico, April 16-19, 1974, Vol. 1, (p. 495-510), 1151 p.

The amount of plutonium in undisturbed soils reflects cumulative deposition from all sources. The program to measure Pu in soils was intensified at the Savannah River Plant (SRP) in 1972. Plant perimeter and off site soil samples showed a background deposition level of approximately 2 uCi/km2. This was well within the range of deposition noted in southeastern United States and indicates that off site deposits due to SRP operations are small compared to background. Samples taken with in a 2-kilometer radius of each of the two chemical separations areas show higher levels, indicating some plant contribution. (Auth)

Table 1 shows the plutonium deposition profile for 1973.

<343>
Mijnheer, B.J., Commission of the European Communities, Joint Nuclear Research Centre, Geel Establishment, Central Bureau for Nuclear Measurements, Luxemburg, Belgium. 1973, October

The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes. EUR-5041-e; 46 p.

A description is given of a personnel neutron dosimeter based on fission track registration in a 10 um thick Makrofol foil in combination with two thorium discs, for use on the hands of operators during the handling of Cf 252 sources inside glove boxes or during implantation work for therapy purposes. The device contains also a TLD-100 chip for measuring the gamma-dose equivalent on the hand. The angular dependence of the response of the dosimeter with thorium and other fissile materials was measured at different energies. The neutron sensitivity of the dosimeter was determined with a calibrated Cf 252 source and amounts to 14.9 plus or minus 0.7 mrem. (Auth)

<344>
Moden, D.D., J.W. Mullins, and R.E. Jaquish, National Environmental Research Center, Las Vegas, NV. 1971

Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples. CONF-710809; Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 512-516), 807 p.

Techniques have been developed for sample preparation and tritium analysis of surface water, atmospheric moisture, milk, urine, vegetation, soil, blood, animal tissue, and natural gas. Degassers used and procedures carried out to remove water from the Linde 13 x molecular seive which are used to collect atmospheric moisture are described. Water for analysis is removed from soil, vegetation, animal tissue, and blood by vacuum distillation. Water is removed from milk and urine by distillation using standard micro glassware. Natural gas samples are combusted by passing the gas over copper oxide at 750 degrees C. The water given off is collected and distilled. Beckman LS-100 ambient temperature counting systems with low background photo-multiplier tubes are used for counting. (JTE)

<345>
Moore, R.E., and S.V. Kaye, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN. 1974, October

The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses. CONF-741018; Part of Hart, J.C., et al (Eds.), Proceedings of the 8th Health Physics Society Midyear Topical Symposium on Population Exposures held in Knoxville, Tennessee, October 21-24, 1974, (p. 283-288), 434 p.

Uncertainties in values used for deposition velocities of particulate radionuclides released to the atmosphere by nuclear facilities have led to uncertainties in estimated population doses. A computer study of 33 radionuclides, assumed to be released as particles from an LMFBR fuel reprocessing plant, was designed to evaluate the sensitivity of estimated doses to selected values for deposition velocities. Deposition velocities were varied from 0.1 to 10 cm/sec, which is approxiamtely the range found in the literature for the few measurements that have been reported. Atmospheric deispersion from a 100-meter stack was estimated for the average annual meteorological conditions of 18 reactor sites in the United States. A uniform population distribution within a 50-mile radius of the plant was assumed. Increasing the deposition velocity increases the dose through ingestion of food produced in the area and the dose through exposure to contaminated land surfaces, but decreases the inhalation and immersion doses. The deposition velocity for each radionuclide was determined so as to give the average of the minimum and maximum doses (for whole body and for reference organs) computed over the range of deposition velocities used in this study. Nearly all of the values fall within the range 0.7 to 1.35 cm/sec, with most close to 1 cm/sec. The use of these values assures that doses would not be underestimated by more than 50%. The uncertainties for whole body dose range from plus or minus 4 to plus or minus 99 percent; the majority is greater than plus or minus 80 percent. Uncertainty limits for a total facility release can be assigned by weighting dose uncertainties for the specific radionuclides by their release rates to the environment. (Auth)

Table 2 shows deposition velocities and population dose uncertainties for several radionuclides, including Pu 239, Pu 238, U 235, U 238, U 234, Am 241, and Cm 244.

<346>
Nichols, C.E., Idaho Nuclear Corporation, Health and Safety Branch, Idaho Falls, ID

Plutonium Sensitive Alpha Air Monitor. CONF-690103; Part of Willis, C.A. and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1969, Vol. 2. Gordon and Breach, Science Publishers, New York, New York, (p. 1117-1125), 1848 p.

A plutonium sensitive alpha-air monitor, utilizing two ZnS scintillation detectors, has been developed at the Idaho Nuclear Corporation Health and Safety Laboratory that will detect Pu 239 in the presence of the most adverse natural activity atmospheres found within the National Reactor Testing Station. The instrument, without the use of discriminators, has demonstrated that it can eliminate greater than 90% of the 2,250 dpm alpha natural background activity collected in order to detect 48 RCGs of soluble Pu 239 within 1-1/2 hours. With the use of discriminators, the instrument should be able to detect even lower concentrations of Pu 239. (Auth)

<347>
Not given, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC. 1973, March

Plutonium in Airborne Particles, July-September 1972. Radiation Data and Reports, 14(3), 208.

The results of the plutonium analysis of samples collected by the U.S. Environmental Protection agency from eleven selected Radiation Alert Network Stations were presented briefly. These reports were initiated in November, 1965. (JTE)

<348>
Not given, Mound Laboratory, Miamisburg, OH. 1974, March

Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971. Radiation Data and Reports, 15(3), 134-147.

The average concentrations of Po 210, Pu 238 and tritium detected in the environment surrounding Mound Laboratory from January through December, 1971 were presented. Air samples were collected from an area of 1250 square miles around the laboratory. Air samples collected by the Montgomery County Combined General Health District were also analyzed, and three on site sampling stations were utilized. The highest average concentrations of Pu 238 and tritium in air during 1971 were 1% and 4% of their respective AEC standards. The average concentrations of Po 210 were approximately 0.2% of the AEC standard. Water samples were collected twice per week along the bank of the Great Miami River and from two ponds northeast of the laboratory. The highest average concentration of Pu 238 was 0.2% of the AEC standard. The highest average concentrations of Po 210 and tritium were 1.8 and 2.8% of their respective AEC standards. Drinking water from surrounding communities was sampled quarterly and analyzed. Concentrations of Po 210, Pu 238 and tritium were less than 0.05%, 0.01%, and 2% of their AEC standards respectively. Locally grown food and vegetation samples including milk, eggs, garden vegetables, grass and aquatic life were collected and analyzed. The highest Po 210 and Pu 238 concentrations were found in the aquatic life, 7.7 and 0.12% of the respective AEC standards. Only milk was analyzed for tritium, and showed a concentration of 0.24% of the AEC standard. Soil samples were taken by surface scrapings approximately 1/8 inch deep and analyzed for Pu 238. The highest concentration was approximately 2.0% of the most restrictive levels for urban areas. Soil core samples and silt samples were also analyzed and given, however, no standards were available at that time. (JTE)

Monitoring of the MOund Laboratory environs for 1971 is displayed in twenty-four tables.

<349>
Not given, Health and Safety Laboratory, New York, NY. 1973, April 1

Fallout Program Quarterly Summary Report,

<349>

MONITORING, MEASUREMENT AND ANALYSIS

<349> CONT.
Appendix. HASL-273; 451 p.

Extensive data collected by four fallout monitoring programs are compiled and presented in tabular form. The programs are: Strontium 90 and Sr 89 in Monthly Deposition at World Land Sites, Radiostrontium Deposition at Atlantic Ocean Weather Stations, Radionuclides and Lead in Surface Air, and Radiostrontium in Milk and Tap Water. Tables of conversion factors and radionuclides are included. (JTE)

<350>
Not given, U.S. Atomic Energy Commission, Directorate of Regulatory Standards, Washington, DC. 1974, May

Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil. Regulatory Guide No. 4.5; 9 p.

This guide describes procedures acceptable to the Regulatory staff for sampling and analysis of plutonium in soil with the sensitivity and accuracy needed to adequately monitor plutonium in soil in the environs of fuel reprocessing and fuel fabrication facilities. (Auth)

<351>
Not given, Mound Laboratory, Miamisburg, OH. 1974

Mound Plutonium Study. Presentation given to the Joint Committee on Atomic Energy in Washington, D.C., October 2, 1974; 64 p.

The objectives of the study are: evaluating the inventory of plutonium 238 in the environment at Mound Laboratory, determining the source of plutonium 238, and alleviating any potential health hazard to the general public. The information which is in the form of pictures, tables, lists, drawings, etc. with no text, is separated into five topics: Locations of Contamination, Results of Sampling, Health and Safety Analysis; Source of Contamination, and Onsite/Offsite Actions. The highest concentrations were found in north Canal (4.56 nCi/g) and south canal (3.37 nCi/g). It was determined that water and air concentrations were below the concentration guide and that there is no health hazard. Some of the actions planned is temporary dams, hillside soil removed, hillside ground cover, retention basins/drainage upgrade, and an overflow basin. (JTE)

<352>
Not given, Comitato Nazionale per l'Energia Nucleare, Rome, Italy. 1971, October

Data on Environmental Radioactivity Collected in Italy, January-December, 1970. EROT-SAN-11-71; 233 p.

The data compiled in this report is divided into 3 sections based on the origin: (1) national networks, (2) local networks, (3) isolated and various stations, and a fourth section contains a list of papers dealing with data on environmental radioactivity. Preceeding each grouping of data, information is given on sampling, sample treatment and the type of counters used. All data is presented in tabular or graphical form. The radionuclides with which the studies are concerned are strontium 90, strontium 89, zirconium 95, cesium 137, and plutonium 239. Data are presented on the radionuclide content of fallout and the radioactivity in air, surface waters, drinking water, milk, bread, bovine meat, fish, mollusks, industrial food products, and various vegetables. Plutonium was determined only in the section on fallout and only at the Ispra station. The Pu 239 content fluctuated from 0.63 x 10(E-3) mCi/km2 in January to 3.5 x 10(E-3) in September and 0.33 x 10(E-3) by December. (JTE)

<353>
Not given, Mound Laboratory, Miamisburg, OH. 1974, December

Mound Laboratory@@Laboratory, January-December, 1972. Radiation Data and Reports, 15(12), 834-841.

The average concentrations of Po 210, Pu 238, and tritium detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, are presented for calendar year 1972. The average concentrations of these radioisotopes were well within the stringent standards adopted by the Atomic Energy Commission. Atmospheric monitoring for radioactive species was upgraded by the completion of an offsite network of 10 continuous, high-volume air sampling stations during February 1972. The average concentrations of Po 210, Pu 238, and tritium measured in air during this period were less than 0.02 percent, 0.3 percent, and 0.1 percent of their respective AEC standards. Water monitoring for radioactive species found the average concentrations of Po 210, Pu 238, and tritium measured at the water sampling locations during this period to be less than 0.3 percent, 0.1 percent, and 0.5 percent of their respective AEC standards. These results represent a significant reduction in concentrations of Po 210 and tritium over those measured during 1971. Additionally, data concerning radioactive species in surface water, community drinking water, foodstuffs, soil and silt are presented. No significant uptake of radioactive species from air or water by plant or animal life has been observed. No reentrainment of radioactive species from soil or silt is indicated at this time. Soil core samples analyses will continue to establish a Pu 238 soil inventory as part of the total program to assess the impact of the laboratory's operations on the environment.

Table 26 shows concentration of Pu 238 and tritium in milk, fruit and vegetables, grass, field crops and fish for January-December, 1972. Table 27 shows Pu 238 results in soil core samples, Mound Laboratory, January-December, 1972. Table 28 shows summary of Great Miami River silt samples for Pu 238, Mound Laboratory, January-December, 1972.

<354>
Not given, Mound Laboratory, Miamisburg, OH. 1973, March

Mound Laboratory, July-December, 1970. Radiation Data and Reports, 14(3), 216-219.

Air and water monitoring around Mound Laboratory for the period of July through December, 1970 is described and data is presented. The average concentrations of Po 210, Pu 238, and tritium in the environment were all below the Atomic Energy Commission radiation protection standards. (JTE)

<355>
Rangarajan, C., and U.C. Mishra, Atomic Energy Establishment, Health Physics Division, Bombay, India. 1966

Methods of Fallout Measurements Used in India. CONF-660341; Part of Proceedings of the All India Symposium on Radioactivity and Meteorology of Radionuclides held in Bombay, India, March 14-18, 1966, (p. 287-300).

Measurements of environmental radioactivity in India have been made since early 1956. These measurements are useful in estimating the contamination of the environment with the radioactivity released in nuclear tests, in studying atmospheric motions and mixing processes involved, and in obtaining information on types of weapons. Measurements have been made on the radioactivity of ground level air, rainwater and deposited dust, milk and other food stuffs consumed by the population, human bone and surface soil. Ground level air, rainwater and deposited dust have been measured for total beta activity and also for certain long-lived isotopes. Milk is analyzed for Sr 90, Cs 137 and natural activity due to K 40. Bone analyses are confined to Sr 90 measurements. Soil measurements are carried out to estimate the natural activity from uranium, thorium, K 40 and also the fission product activity deposited as a result of nuclear tests. A brief summary of these measurements is given. (LR)

<356>
Reimer, A., J.K. Reichert, and A.G. Scott, Atomic Energy of Canada, Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, Canada. 1974

Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters. CONF-731110; IAEA-SM-181/26; STI/PUB/354; Part of Proceedings of a Symposium on the Physical Behavior of Radioactive Contaminants in the Atmosphere held in Vienna, Austria, November 12-16, 1973, (p. 189-210).

A study of suspended particulates and associated natural radionuclides in the lower atmosphere was undertaken at the Whiteshell Nuclear Research Establishment not only because of the expectation that it would illuminate the sometimes perplexing behavior of airborne fission products, but also because the data are intrinsically important in monitoring atmospheric diffusion and air pollution. The results show that summer radon and thoron daughter concentrations depend mainly on temperature and wind, whereas no clear-cut association is found in winter. Monthly mean particulate concentrations varied from about 25 ug/m3 in summer to about 8 ug/m3 in winter except during soil erosion. Harmonic analysis revealed a particulate concentration cycle of 3 to 4 days, which agrees well with an atmospheric pressure periodicity for this latitude of 3.5 to 3.9 days. This similarity exemplifies the physical dependence of pollution cycles on synoptic-scale meteorological features. (Auth)

<357>
Rhoads, W.A., and L.A. Franks, EG&G, Santa Barbara Division, Goleta, CA. 1975, June

Radiation Doses and Possible Radiation Effects of Low-Level, Chronic Radiation in Vegetation. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 89-95), 504 p.

An area around Site D, Area 11, was chosen for measurement of radiation doses with the objective of investigating low-level, low-energy gamma radiation (with some beta radiation) effects at the cytological or morphological level in native shrubs. In this preliminary investigation the exposure doses to shrubs at the approximate height of stem apical meristem were estimated for a ten year period. Dosimeter packets were suspended about 25 cm above the earth's surface by nylon filament lines attached to tetrahedron dosimeter supports. Dosimeters were left in the field for 69 days, returned to the laboratory and exposures evaluated. When the dosimeters were removed from the field, number of standard field monitoring radiation measurements were also made. The dosimeters indicated exposures of approximately 30 to 140 R for the period of ten years. The field instrument doses extrapolated to doses only 20.7% plus or minus 6.4% of the dosimeter doses. Several factors which could have contributed to the differences were discussed. It was concluded that a survey instrument reading made at about 25 cm should indicate about 1/5 the dosimeter measured exposures. No cytology has yet been undertaken because of the drought since the winter of 1973. (Auth) (JTE)

<358>
Robinson, E.L., J.K. Bair, and J.L. Duggan, University of Alabama, Birmingham, AL; Oak Ridge National Laboratory, Oak Ridge, TN; North Texas State University, Denton, TX. 1975, March

Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source. Health Physics, 28, 205-207.

Systems for x-ray fluorescent scanning of thyroid glands use the gamma-radiation from multicurie Am 241 sources to stimulate characteristic x-rays of the iodine in the gland. Nuclear reactions induced in the source matrix by alpha-particles from the decay of Am 241 produce a flux of fast neutrons. The neutron flux of a 5 Ci Am 241 source in the source-collimator assembly of a fluorescent scanner was measured to be 3.22 10(E+4) neutrons/sec with an error of the root mean square of plus or minus 2.2 percent. (Auth)

<359>
Rusch, G.K., W.P. McDowell, and W.G. Knapp, Argonne National Laboratory, Argonne, IL; Argonne National Laboratory, Idaho Falls, ID. 1976, February

The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System. Transactions on Nuclear Science, 23(1), 690-692; CONF-751116; Part of Proceedings of the Nuclear Science Symposium held in San Francisco, California, November 17-21, 1975, (4 p.).

The design and operation of an airborne plutonium monitoring system which is installed in the Zero Power Reactor No. 9 (ZPR-9) facility at Argonne National Laboratory are discussed. This monitoring system utilizes particle size and density discrimination, alpha particle energy discrimination, and a background-subtraction technique operating in cascade to separate airborne-plutonium activity from other, naturally occurring, airborne activity.

<359>

MONITORING, MEASUREMENT AND ANALYSIS

<359> CONT.
Relatively high sensitivity and reliability are achieved. The ZPR-9 airborne Pu monitors are capable of detecting Pu doses by mechanical disruption of Pu or its oxide of the order of 1 radiation concentration guide (RCG) hour in the presence of normal backgrounds. The monitors are insensitive to U 234 and are not affected significantly by gamma-ray or beta particle radiations. (Auth) (JTE)

<360>
Russell, J.L., and F.L. Galpin, U.S. Environmental Protection Agency, Washington, DC. 1973

A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants. CONF-721107; Part of Proceedings of a Symposium on the Management of Radioactive Wastes from Fuel Reprocessing held in Paris, France, November 27-December 1, 1972, (p. 99-130), 1266 p.

A review of offsite doses from fuel reprocessing as measured by EPA and as calculated from several sources of information indicates that radioactive iodine and krypton 85 discharges are currently the critical radionuclides in terms of public health. Developmental efforts should be directed to the control of these radionuclides. Discharges of radioactive ruthenium during the solidification process may also be significant; however, operating experience is required to establish decontamination factors. (Auth)

<361>
Sehmel, G.A., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats. BNWL-1950 (Part 3); Part of Simpson, C.L., et al, Annual Report for 1974, (p. 221-223), 287 p.

A resuspension experiment was conducted at Rocky Flats during July 1973, to determine airborne plutonium concentrations as a function of wind speed, particle diameter, and sampling site. The maximum airborne concentration of Pu 239 measured was 3.7 x 10(E-15) Ci/m3 which is significantly less than the maximum permissible concentration of 6 x 10(E-13) Ci/m3 for nonoccupational exposure in a 168-hr week. The main sampling site was a 30 m tower east of the plant approximately mid-way between the eastern security fence and cattle fence. Airborne plutonium concentrations were measured at elevations from 0.3 to 30 m above ground. However, airborne concentrations did not decrease as expected from 10 to 30 m, but concentration increased with elevation. Plutonium in air samples collected at each height was also analyzed by mass spectroscopy for isotopic Pu content. There are differences in the isotopic plutonium compositions at 30 m compared to lower elevations of 0.3, 1, and 3 m. Isotopic compositions in these lower elevations might be similar to that on the surrounding contaminated ground if resuspension is the source of airborne plutonium. In this case, isotopic compositions of resuspended plutonium ranged from 5.73 to 5.97 a/o for Pu 240 and from 0.31 to 0.35 a/o for Pu 241. These ranges include the 5.93 a/o Pu 240 and 0.33 a/o Pu 241 obtained for the back-up filter at a 30 m elevation. In contrast, the isotopic compositions for 2 and 3.3 um particles at 30 m were outside these ranges. The data on isotopic ratios of plutonium support the hypothesis that a source of airborne plutonium was present in addition to that of locally resuspended soil. (PHM)

<362>
Sharma, R.C., S. Somasundaram, T. Surendran, D.K. Kapur, and S.P. Garg, Bhabha Atomic Research Centre, Health Physics Division, Bombay, India. 1974

Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems. BARC-748; CONF-730907 (Part 2); Part of Snyder, W.S. (Ed.), Proceedings of the 3rd International Congress of the IRPA held in Washington, D.C., September 9-14, 1973, (p. 979-984).

The development of detector systems for assessment of inhaled Pu-Am dust deposited in human lungs by external detection of the low-energy photons emitted, is a continuing program at Trombay. The paper describes the work done with thin NaI(Tl) scintillation detector systems. The background data inside Trombay steel room in different low-energy bands for crystals of thicknesses 1, 2 and 5 mm are presented. To study the capabilities of three detector systems, each consisting of a set of crystals of the same thickness, a realistic chest phantom of an Indian adult was designed and employed. The chest phantom was constructed from the rib cage taken out of the cadaver of an Indian adult. It was enclosed in a hard polythene cover to simulate the chest profile. Measurements were made on the absorption and scattering of low-energy photons (17, 22 and 60 keV) by four constructional materials in order to verify their degree of equivalence to human tissue and granular sugar was chosen as tissue-equivalent material in phantom construction. The counting efficiencies and limits of detection of the three detection systems for point sources of plutonum distributed in the central plane of each lung of the phantom were studied. A few normal subjects were counted with one of the detector systems and the increase in background in the low-energy region was investigated. The natural and acquired radioactivity of each subject was monitored with a (20.32 cm diameter x 10.16 cm thick) NaI(Tl) crystal in a 50 cm arc chair geometry. Finally, the effect of body build of a subject on the counting efficiency of Pu is commented upon and the future program is briefly indicated. (Auth)

<363>
Silver, W.J., C.L. Lindeken, J.W. Meadows, E.H. Willes, and D.R. McIntyre, Lawrence Livermore Laboratory, Livermore, CA. 1974

Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report. UCRL-50027-74; 48 p.

In 1974, the average annual gross beta activity on particulate air filters was about five times higher than in 1973. This increase was due almost entirely to the nuclear debris added to the stratosphere by the large-yield Chinese atmospheric event of June 27, 1973. There were corresponding increases in specific fission-product radionuclides. Airborne U 238 concentrations at Site 300 were higher than those at Laboratory perimeters due to the use of "depleted" uranium (a byproduct of U 235 enrichment) at the Site. These uranium

<363> CONT.
concentrations were well below the standards set by the AEC. Soil samples collected in the offsite vicinity of the Laboratory and at Site 300 were analyzed for plutonium. There were negligible changes from the levels reported in 1973. Water samples collected within the Livermore Valley and Site 300 exhibited normal background gross beta and tritium activities. Vegetation samples collected in areas generally downwind from the Laboratory contained tritium activities 10 to 100 times higher than those collected in areas where the Laboratory's contribution should be minimal. There were also two locations at Site 300 at which tritium levels in vegetation were above background. In all cases if this vegetation were a regular part of one's diet, the annual whole-body radiation dose from tritium would be less than 1 mrem. The ecological study at Site 300 showed that while tritium Be and U were present in some plants and animals, in general the levels were not significantly different in those found in organisms obtained from environmental areas of similar ecology. The average annual gamma dose rate at Laboratory perimeters was 74 mrem. In the offsite vicinity, the average annual background dose rate was 68 mrem. Both Laboratory perimeter and Site 300 annual average airborne beryllium concentrations were less than 1% of the appropriate standard. Releases of heavy metals to the Livermore sanitary sewer system conformed to the discharge regulations of the City of Livermore. No Laboratory effluent resulted in estimated radiation doses to the public exceeding 5 mrem. Assessment of the radiation doses to an individual from the environmental activities listed in this report demonstrates that the dose contribution from Laboratory operations in 1974 was small compared with the approximately 100 mrem per year dose received from natural sources. (Auth)

Table 5 shows Pu, Sr, and U in air at LLL perimeter during 1974 (uCi/ml.)

<364>
Simpson, O.D., Aerojet Nuclear Company, Idaho Falls, ID. 1975

Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory. CONF-790967 (Vol. 2); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 584-606), 1015 p.

The Effluent and Radiation Measurements Laboratory at the Idaho National Engineering Laboratory (INEL) has recently upgraded capabilities in the field of monitoring and analysis of radioactive airborne and liquid effluents using the techniques of gamma-ray spectrometry. The techniques and equipment used include remotely-operated, computer-based Ge(Li) spectrometers which obtain data on a real-time basis. Permanent record files were maintained of both the effluent release values and the gamma-ray data from which the release values were calculated. Should values for release levels ever be challenged, the gamma-ray spectral information for any measurment can be recalled and analyzed as needed. Daily effluent release reports were provided to operating personnel which contributed to prompt correction of any operational problems. Monthly, quarterly, and annual reports were compiled which provide inventories of the radionuclides released. A description of the effluent monitoring, reporting and records system developed at INEL for this application will be presented. (Auth)

<365>
Smithwick, G.A., J.J. Nelsen, S.R. Wright, E.J. Cahoon, and C.R. Toussaint, Savannah River Operations Office, Safety and Environment Division, Environmental Activities Branch, Aiken, SC. 1975

Integration of Environmental Programs at a Diversified Nuclear Production Site. CONF-750967 (Vol. 1); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 204-219), 1015 p.

The environmental protection programs at the Savannah River Plant (SRP) site have expanded to encompass a wide range of objectives including minimizing the release of contaminants thus ameliorating the impact of the operations on the environment, and providing information that can help resolve regional and national problems. Thermal discharges into streams, movement of transuranic elements in the environment, and coal ash studies are examples of these programs. Through the use of an integrated approach to management, the Savannah River Operations Office has developed an efficient method for accomplishing its mission as a production facility while making significant contributions to environmental protection. Integrated programs underway include a study of Pu released from SRP chemical separations areas to determine the effects of agronomy on resuspension and the soil Pu profile, plant deposition versus uptake, and the influence of animals on Pu movement. This program and others dealing with nonradioactive subjects are discussed. (JTE)

<366>
Tamura, T., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN. 1975, June

Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site. NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group, Progress Report for 1974, (p. 27-41), 504 p.

Total plutonium was determined in nine surface soil samples (0-5 cm) from Area 13 in the Nevada Test Site (NTS). Particle size segregation was performed, and each particle size fraction of seven samples was analyzed for plutonium. The coarse silt fraction (53-20 uM) contained the highest percentage of plutonium in the soil (about 65%). Evidence of erosional translocation of plutonium was observed in one of the samples, and corroborative evidence was noted in describing the soil type. Tests with 8 M nitric acid showed that about 13% of the plutonium was leached from the NTS sample, about 70% from sediments at Oak Ridge and about 83% from sediments at Mound Laboratory. In 0.1 M citric acid, about 1% of the plutonium was extracted from an NTS sample, 25% from Oak Ridge samples and 44% from Mound. Implications of these results on the transport of plutonium in NTS are discussed. (Auth)

<367>

MONITORING, MEASUREMENT AND ANALYSIS

<367>
Tewes, H.A., Lawrence Livermore Laboratory, Livermore, CA. 1970, March 2

Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions. UCRL-50230 (Rev. 1); Part of Knox, J.B., et al, Radioactivity Released from Underground Nuclear Detonations: Source, Transport, Diffusion, and Deposition, Chapter 2, (p. 8-17), 113 p.

The radionuclides produced by the detonation of a nuclear excavation explosive come from fission, fusion and neutron activation of the materials in the explosive and the surrounding rock or soil. Adequate means for estimating the activities produced by fission exist and are discussed. However, the principal products of the fusion reaction (tritium) are probably not known better than 25%. The latest models for calculating activation products give estimates for the significant nuclides, including sodium 24, manganese 54, and tungsten 185, are generally within a factor of 2 of observed date. Results indicate that for calculations of external exposure due to fallout, more than 95% of the induced activity can be represented in the sub-surface source, and later in the cloud source, by as few as five nuclides. (Auth)

<368>
Thomas, C.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska. BNWL-1950 (Part 3); Part of Simpson, C.L., et al, Annual Report for 1974, (p. 20-21), 287 p.

Concentrations of Pu 238, Pu 239, Pu 240, and Am 241 have been measured in air samples taken at Richland, Washington, and Point Barrow, Alaska, since 1962, and the concentration of several other transuranium radionuclides estimated. During 1974, the concentrations of nuclear-weapons-produced radionuclides were 3 to 10 times higher than those of 1973, as a result of the June, 1973, Chinese nuclear test. Radioactivity levels on grass samples collected at approximately 40-mile intervals between Los Angeles, California, and the Canadian border were surveyed. The results indicated concentrations below detection levels which gave I 131 radiation exposure values for the grass-milk-man pathway for the U.S. west coast of <0.042 mrem, based on a 2-g child thyroid. These I 131 thyroid exposures were two to four orders of magnitude lower for U.S. west coast residents than those from the March 1972 low yield Chinese nuclear test. (Auth) (FMM)

Table 1 shows atmospheric concentrations of fallout debris from the Chinese nuclear test of June 17, 1974 in surface air at Richland, Washington. Figure 1 shows radionuclide concentration in surface air at Richland, Washington from 1961-1974.

<369>
Toy, A.J., and C.L. Lindeken, Lawrence Livermore Laboratory, Livermore, CA. 1975

The Implications of Sampling from a Log-Normal Population. CONF-750967 (Vol. 1); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 144-167), 1015 p.

The environmental radioactivity surrounding the Lawrence Livermore Laboratory (LLL) is typically log-normally distributed. The geometric standard deviation of radioactivity in all types of samples--air, water, soil, sewage, and vegetation--is about two. Hypothesis testing was done using the mean geometric standard deviation of these samples. Parametric studies demonstrated the effect of the number of background samples, the magnitude of tolerable errors, the variability of the sample population, and the precision of the analysis on the detectability of differences from natural and global fallout radioactivity. It was decided to accept an error probability of 50% that the analysis would show a sample to be different from background when, in fact, it was not, and an error probability of 5% that the analysis would show a sample to be background, when in fact, it was not. For these assumptions, an analysis must differ from background by a factor of 1.6 to indicate a statistical difference, and a sample must contain radioactivity a factor of 8.6 different from background to be 95% detectable with 50% confidence. The difference in the mean of two such populations which is 95% detectable with 50% confidence is 2.8 if six samples are taken from each population. (Auth)

<370>
Wahlgren, M.A., and D.M. Nelson, Argonne National Laboratory, Argonne, IL. 1973

Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water. ANL-8060 (Part 3); Part of Radiological and Environmental Research Division Annual Report, January through December,1973, (p. 85-89), 187 p.

Extensive lake-wide sampling carried out in June, 1972, established the inventory of Pu 239, Cs 137, Sr 90, and H 3 in the water column of Lake Michigan. For Sr 90, the mean lake value from the experimental measurements was 0.81 pCi/l. Based on the average of Green Bay and Argonne Sr 90 fallout estimates from precipitation monitoring, the predicted 1973 concentration in Lake Michigan is 0.71 pCi/l, assuming the contribution to the lake from land runoff to be 2%/yr, and loss of outflow and by incorporation to the sediments to equal 2%. The difference between the measured and calculated values may be due to dry deposition. The cumulative fallout input of Cs 137 to Lake Michigan can be deduced fairly rigorously, since the ratio of 137Cs to 90Sr is fixed in the fission processes. A Cs 137 -to-Sr 90 ratio of 1.5 and a Cs 137-to-Pu 239 ratio of 60 have been assumed to apply to Lake Michigan. For Pu 239, the mean activity in Lake Michigan in 1973 is 7 x 10(E-4) pCi/l. If it is assumed that a constant fraction of the activity present is removed each year, removal half-times of 1.0 plus or minus 3 yrs for Pu 239 and of 1.3 plus or minus 0.3 yr for Cs 137 are obtained. There is an apparent contradiction in removal half-times depending on the method used and this is thought to be a natural consequence of the initial fallout input occurring in a range of particle sizes. (FMM)

Table 1 shows mean activity, pCi/l, in Lake Michigan water in 1973 for Pu 239, Cs 137, Sr 90 and H 3.

<371>
Waite, D.A., Oklahoma State University, Stillwater, OK. 1972

<371> CONT.
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range. Ph.D. Thesis, Oklahoma State University; 104 p. (Dissertation Abstracts, 33(12), 5780-B)

An aerosol production apparatus built around an ultrasonic nebulizer was constructed and tested. Specifically designed to operate at high efficiency and low air volume, the apparatus was ideally suited for work with aerosol particles tagged with less readily available isotopes. Sub-micron particles generated by this method were hollow and had widely varying densities depending upon their size. A limited number of experiments were carried out using human volunteers inhaling an aerosol of known activity, solubility, and particle size. Data from the volunteers were collected over a definite period of time by enough independent means to indicate both levels and trends concerning aerosol retention, excretion, translocation, and distribution. Excretion, retention, and distribution results following the human inhalation of these particles were consistent with ICRP Lung Dynamics Task Group models. The results of such inhalations gave a consistent pattern of lung deposition showing a high lung retention with a long, retained half period for atypical breathing patterns aimed at maximizing pulmonary deposition. The human to human-phantom cross calibrations which were provided by these human inhalation experiments showed that using realistic chest phantoms to supply basic calibration data and body-build parameters to modify such data was a valid method but one of first-order correction only. Without any phantom calibration correction, errors up to a factor of 10 may occur. (Auth) (ND)

<372>
Welty, C.G., Jr., and M.W. Tiernan, U.S. Atomic Energy Commission, Division of Operational Safety, Washington, DC. 1974, October

Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites. CONF-741018; Part of Hart, J.C., et al (Eds.), Proceedings of the 8th Midyear Topical Symposium of the Health Physics Society on Population Exposures held in Knoxville, Tennessee, October, 21-24, 1974, (p. 421-428), 434 p.

There are 27 major AEC sites in the United States which handle or process radioactive materials in quantities to warrant the maintenance of a routine environmental monitoring and reporting program. In 1972 as part of this routine program, these sites made an annual assessment of the radiation dose to the public which could have resulted from operations conducted at the site. Actual measurements of radioactivity in the pathways of exposure close to man are used whenever possible, although for certain nuclides, like noble gases, estimates of dose are normally made using effluent and meteorological data, and appropriate dispersion equations. Estimates include (1) site boundary dose rates, (2) population dose, and (3) the whole-body 80 kilometer man-rem population dose. In 1973 estimated whole-body dose rates near the boundary of AEC sites ranged from less than 1 to about 30 mrem per year, or from less than 1 to about 6 percent of the radiation protection standard for an individual. The doses are dependent on the types of operations conducted at the particular site and often on the size of the site itself. The 80 kilometer man-rem estimates for all AEC sites ranged from less than 1 to about 195 man-rem per year, the maximum due primarily to tritium. (Auth)

Table 5 shows estimated maximum dose from Pu to individuals in the population near AEC sites. Table 6 shows estimated maximum dose from U and Th to individuals in the population near AEC sites, critical organs are also shown. Table 1 shows estimated maximum dose from tritium to individuals in the population near AEC sites, including the Nevada Test Site.

<373>
Witherspoon, J.P., and D.C. Parzyck, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN. 1974, October

Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations. CONF-741018; Part of Hart, J.C., et al (Eds.), Proceedings of the 8th Midyear Topical Symposium of the Health Physics Society on Population Exposures held in Knoxville, Tennessee, October 21-24, 1974, (p. 199-205), 434 p.

The increased use of nuclear power reactors for generation of electricity will require a growth in the number of nuclear fuel cycle facilities to support the power reactors. Facilities in the nuclear fuel cycle release radionuclides to the environment which may contribute to population radiation dose long after the nuclear facility has ceased operation. The long-term environmental impact of model support facilities was studied. The contribution of the long-lived radionuclides released by the nuclear fuel cycle plants to long-term population exposures was calculated from the time of cessation of plant operations until significant decay of the radionuclides. The model plants were typical of current design and location, and the surrounding populations were representative of present-day populations. The model facilities included a uranium mill (2000 metric tons of ore per day), fuel fabrication plants (5 metric tons of uranium dioxide fuel per day, 1 metric ton of uranium-plutonium oxide fuel per day), and a fuel reprocessing plant (5 metric tons of fuel per day). The source terms defined for the four types of nuclear facilities have been referenced previously. The longest-lived radionuclides released by each type of plant were enumerated and the area of radionuclide deposition defined. The significant pathways of exposure were examined with an evaluation of the population exposure resultant from resuspension of deposited activity, ingestion of deposited radionuclides, and radiation from contaminated ground surface. Dose estimates were made for populations (man-rems) living in the vicinity of the nuclear plants, and the average dose was calculated for the critical organ for each long-lived radionuclide. (Auth)

Table 3 shows estimated long-term radiation doses to populations within 50 miles of model fuel cycle. Table 4 shows percent contribution of radionuclides (including Ra 226, U 234, U 235, Pu 238, Am 241, Pu 241, I 129) to long-term total-body and organ (bone, liver, kidney, thyroid and lung) doses of populations around model fuel cycle facilities.

<374>
Wood, R.A., H. Nishita, M. Hamilton, and S. Wakakuwa, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. Not given

<374>

MONITORING, MEASUREMENT AND ANALYSIS

<374> CONT.
The Determination of Plutonium 238 and Curium 242 in Aqueous Soil Extracts. UCLA-12-1047; 9 p.

A method is described for the quantitative determination of Pu 238 and Cm 242 contained in aqueous soil extracts. The organic matter was destroyed using standard wet ashing techniques. The 87.8-h Pu 238 and 163-d Cm 242 were isolated by co-extraction with iron and purified using cation exchange techniques. The final eluate is evaporated to dryness on stainless steel planchets and counted using an alpha spectrometer system in conjunction with a silicon surface barrier detector. Greater than 98 percent recovery of Pu 238 and Cm 242 was obtained from ammonium acetate and sodium hydroxide-nitric acid extracts of traced soil. The primary advantages of this method are: 1) secondary tracers are not needed for the determination of chemical yields, and 2) expensive and time consuming electrodeposition techniques are not required for final sample mounting. (Auth)

<375>
Fearon, T., H.D. Maillie, and W.A. Kremer, University of Rochester, School of Medicine and Dentistry, Department of Radiation Biology and Biophysics, Rochester, NY. 1975, April

Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons. Health Physics, 28, 443-449; UR-3490-552; 7 p.

Neutron energy spectra and fractional absorbed dose distributions in Linear Energy Transfer of a 14-MeV monoenergetic neutron beam have been obtained in a tissue equivalent liquid phantom. Threshold activation foils were used in the energy spectral determinations and a Rossi type proportional counter for the LET absorbed dose distributions. The effects of an inhomogeneity in the phantom were also examined. Results showed that the energy spectrum shifted to lower energies as a function of depth in the phantom and the absorbed dose distribution in LET showed modification with a decrease in the dose average LET. The inhomogeneous phantom caused a shift to lower energies in the energy spectrum and an increase of the dose average LET. (Auth)

<376>
Lachker, J., Y. Patin, and J. Sigaud, Commissariat a l'Energie Atomique, Centre d'Etudes de Bruyeres le Chatel, Service Physique Nucleaire, Montrouge, France. 1974

Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy. CEA-CONF-2970; CONF-7409106; Part of Proceedings of the International Symposium on Neutron Induced Reactions held in Smolenice, Czechoslovakia, September 1-7, 1974, (8 p.).

The energy dependence of some characteristics of fission have been studied for the fissioning nucleus Pu 240. The variations of kinetic energies and fragment masses from Pu 239 (d,pf) have been measured as a function of the excitation energy of Pu 240. These results have been analyzed together with those from studies of spontaneous fission and isomeric fission, as reported by other authors. The results tend to demonstrate the existence of two modes of fission, the first mode superfluid and the other viscous; these modes depend on the nature of the fissioning state. (Auth)

<377>
Phelps, P.L., and L.R. Anspaugh, Lawrence Livermore Laboratory, Livermore, CA. 1975, June

Resuspension Element Status Report. UCRL-76536; NVO-153; Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 197-205), 504 p.

Progress to date on research devoted to developing predictive resuspension models was summarized. A previous resuspension element report (Anspaugh, et al, 1974) covered the implementation of experiments at the GMX site in Area 5 of the Nevada Test Site. Other recent publications (Anspaugh, et al, 1974b, 1974c, 1974d; Porch and Shinn, 1974; Shinn, et al, 1974 and Sinclair, 1974) give results of the various resuspension studies. The historical resuspension factor approach was extended by development of a time-dependent resuspension factor model which more accurately described resuspensions from aged sources. The most significant progress, however, was the synthesis of soil erosion studies, dust flux measurements, and resuspended plutonium concentration measurements into an integrated approach which also used Healy's model of atmospheric transport and diffusion. The results of this new approach may lead to a general resuspension model that is site-independent. Current efforts are directed at characterizing resuspension under a wider variety of meteorological conditions and at refining the relationship between vertical dust flux and soil erodibility index. Future proposed studies are also briefly covered. (Auth) (JTE)

<378>
Raabe, O.G., G.J. Newton, R.C. Smith, C.J. Wilkinson, and S.V. Teague, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1974, December

Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility. LF-49; Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 24-28), 384 p.

Samples of the aerosols present in a glove box during a plutonium oxide and uranium oxide powder mixing operation were taken with a small seven-stage cascade impactor to determine the aerodynamic size distribution and concentration and with a Lovelace Aerosol Particle Separator (LAPS) to study the characteristics of the particles with respect to aerodynamics equivalent size. Using alpha spectroscopy, it was found that about 11% of the alpha activity of the aerosol was associated with Am 241. The size distributions measured with the cascade impactor had activity median aerodynamic diameters (AMAD) equal to 1.9 plus or minus 0.3 (standard deviation) um and geometric standard deviations (delta g) equal to 1.59 plus or minus 0.07 with alpha activity concentrations best expressed as log-normally distributed with median of 45 nCi/l and geometric standard deviation of 1.8. (Auth)

<379>
Maninger, R.C., Lawrence Livermore Laboratory, Livermore, CA. 1974, October 23

An Overview of Fundamentals for Radiation Measurements. UCRL-76141; CONF-741208; Part of Proceedings of the 4th Measurement Science Symposium held in San Luis Obispo, California, December 6-7, 1974, (15 p.).

A brief descriptive overview of the basic concepts and factors involved in the origin, detection and measurement of radiation from the nuclear power industry in the environment is presented. Atomic structure is discussed and the process of nuclear fission is described. A short section is devoted to defining commonly used radiation terminology. Alpha particles, beta particles, neutrinos, gamma rays, and neutrons are discussed individually. The use of gas counters, semiconductor counters, and scintillation counters for detecting and measuring radioactivity is briefly discussed. (JTE)

<380>

PRODUCTION

<380>
Sheth, A., S.D. Gabelnick, M.S. Foster, M.G. Chasanov, and C.E. Johnson, Argonne National Laboratory, Chemical Enginering Division, Argonne, IL. 1974, September

Bibliography of Properties Data on Actinide Carbides and Nitrides. ANL/CEN/AF-100; 326 p.

The National Advanced Fuels program requires chemical, mechanical, and thermophysical properties of potential fast reactor fuel candidates. Properties data are given for carbides, nitrides, carbonitrides, oxycarbides, and oxynitrides of uranium and plutonium and mixed uranium and plutonium compounds. In all, 39 different properties are given for 25 different compounds and supported by 743 literature abstracts. (Auth)

<381>
Thomas, C.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, February

Radionucides from Nuclear Power Reactors. BNWL-1950 (Part 3); Part of Simpson, C.L., et al, Annual Report for 1974, (p. 22-24), 287 p.

The relative concentrations of transuranium radionuclides expected to be present in radioactive wastes from reactors were calculated. This will aid in predicting the environmental hazards posed by accidental release of radicactive wastes. To provide perspective as to the relative amounts of the radionuclides in nuclear power industry wastes their concentrations have been compared to either Cs 137 or Pu 239. The very long decay of fission product mixture will result in the relatively rapid loss of the more common short-lived fission products and will leave a fission product spectrum containing Zr 93, Nb 93m, Sm 151, Tc 99, Se 79, Sn 126, Cs 135 and I 129. The activation products will vary widely dependent on changes in construction material. However, it is believed that the activation radionuclides of greatest significance will be Fe 55, Mn 54, H 3, Ni 63, Co 60 and C 14. The most striking difference in radionuclide ratios in wastes from nuclear energy generation will be in the heavy element radionuclides. It is evident that with the high fuel exposure for the nuclear industry, the Am and Cm radionuclides and Pu 238 will be of far greater significance in nuclear wastes, both in abundance and in radiological hazard, than is Pu 239. (Auth) (FNM)

Tables 1 and 2 show the activity of fission products in accumulated waste for the entire nuclear industry (normalized to 1 for Cs 137 and Pu 239). Table 3 shows heavy element activities in nuclear fuels (Np, Pu, Am and Cm).

<382>
Franklin, R.E., and R.L. Watters, U.S. Energy Research and Development Administration, Washington, DC. 1975

A Research Program on Transuranic Elements in Soil-Plant Systems. CONF-750847; Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 123).

Transuranic elements arise in the nuclear fuel cycle as a result of the neutron activation of uranium or its activation products. The elments to be produced in largest quantities are Pu, Cm, and Am. Although small accidental releases may occur at power reactors where the production of these elements occurs, the major source of environmental contamination will be the fuel reprocessing and fabrication plants. The major questions in the soil-plant area range from some which are easily answered to those which require innovative approaches, e.g., what are the concentration factors (plant/soil) for various soils and plants under agronomic conditions, what is the effect of biological and chemical weathering on these concentration factors, how long does it take before these elements pass out of the root zone, and what is the effect of physical and chemical form of the source material. There will be strong interactions among these factors. A new ERDA research program has been initiated which will improve the accuracy with which we can answer these questions. (Auth)

<383>
Mishima, J., U.S. Atomic Energy Commission, Washington, DC. 1974

Fractional Airborne Release of Plutonium Under Shipping Accident Conditions. CONF-740901 (Part 2); Part of Proceedings of the 4th International Symposium on Packaging and Transportation of Radioactive Materials held in Miami Beach, Florida, September 22-27, 1974, (p. 1148-1161), 1195 p.

The quantity of hazardous material which will be injected into the atmosphere under specific conditions is required to pre-evaluate the potential radiological consequences from a postulated accident. Lack of data on the characteristics and behavior of plutonium aerosols generated under accident conditions make evaluation difficult even if all accident conditions could be quantified. The reported data on the fractional airborne release of plutonium and some plutonium compounds available was compiled and it applied to some situations found in transportation accidents. Under most conditions studied the fractional airborne from powder (Activity Median Aerodynamic Diameter approximately 1 um) was greater than from nitrate solutions. Some of the numerous factors influencing airborne release of Pu are physical and chemical characteristics of the source materials and the conditions under which the source material exists, alteration of source material and conditions as a result of accident, alteration of airborne material prior to release, and resuspension of deposited material. (Auth) (RAF)

<384>
Anspaugh, L.R., and P.L. Phelps, Lawerence Livermore Laboratory, Livermore, CA. 1975, May 6

Resuspension Element Status Report. UCRL-76823; 10 p.

The resuspension-inhalation pathway is generally regarded as the critical pathway for a few radionuclides of very low biological availability, such as plutonium. The primary goal of the resuspension element program is to develop a general model for the prediction of the average concentration of resuspended contaminants. This report briefly summarizes the past accomplishments, current studies, and future plans of the resuspension project being conducted at the USERDA's Nevada Test Site. Past accomplishments have been the measurement of the concentration of resuspended Pu 239 over short time periods of consistent meteorology with concomitant detailed micrometeorological measurements; the develcpment cf two interim predictive models and the derivation of protective guidelines for soil contamination with Pu 239; the derivation of parameterizations of resuspended soil concentrations and fluxes as functions of friction velocity and soil erodibility; the test of these parameterizations' applicability to the resuspension of Pu 239; and the development of an integrated approach to a general resuspension model. Current studies include the test of the resuspended soil concentration and flux parmeterizations at a variety of Test Site locations; the development of an airborne platform for the study of mass fluxes produced by episodic events such as dust devils; the development of a computer-controlled sampling system for the testing cf model validity; additional data analysis of collected data; and the development of improved detectors and methods for the in situ quantitation of Pu 239 and Am 241 in soils. Future plans are for a major experimental program in July, 1975, at the GMX location in Area 5 under a wider variety of meteorological conditions; participation in proposed trials of clean-up procedures; and further efforts to develop a general resuspension model. (Auth)

<385>
Brown, F., P.T. Good, and J.B. Parker, United Kingdom Atomic Energy Authority, Aldermaston, Berkshire, England. 1970, June

Sampling of Stores for Safeguards Purposes. COS-4A; 23 p.

The confirmation of managements statements regarding the amount of nuclear material stored has been accepted as being one of the most important functions of a Safeguards Inspector. This report deals with the determination of the size of the sample required for various inspection densities and with the inspection of stores containing nuclear material in different forms or in units of different sizes. An equation of the probability of detection of the diversion (P sub D) was derived with application to specific cases. A computer program was created to obtain numerical values of P sub D. The results of the program were used to draw up tables relating the sample size required to give 90, 95 and 99% confidence of detection of the diversion of various numbers to the store sizes. (RAF)

<386>
Dolphin, G.W., National Radiological Protection Board, Biology Department, Harwell, England. 1973

Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements. Part of Hodge, H.C., et al (Eds.), Uranium, Plutonium, Transplutonic Elements, Chapter 19. Springer-Verlag, New York, New York, (p. 897-908), 995 p.

Permissible standards for exposure to transplutonium elements have developed slowly. A new report should be available in 1973 or 1974. This report will take into account more recent metabolic data from animal experiments and use new models of transfer of radionuclides from the gut and lungs to the blood and body tissues. Present maximum permissible body burdens are based on radiation dose to the whole body organs within the body. Permissible amounts in body organs of reference and MPBB for americium, berkelium, californium, einsteinium, and fermium are tabulated. For radiological protection purposes, the critical organ is taken as that where radiation damage causes the greatest biological effect on the whole body. To ensure that biological damage from exposure to ionizing radiation is kept to a minimum, upper limits of environmental contamination are recommended at which a person may be exposed continuously without accumulating unaccectable amounts of damage. These upper limits, or maximum permissible concentrations, are derived for air and water. The values for MPBB and MPC are derived from equations developed from fundamental concepts of radiological protection. It is changes in these which may affect the presently accepted values. (BBM)

<387>
Fieuw, G., and H. Bultynck, Centre d'Etude Nucleaire, Studiecentrum voor Kernenergie, Mol, Belgium. 1972

Reference Levels in Health Physics. Part of Fieuw, G. (Ed.), Proceedings of the Tripartite Symposium on Safety Measurements on Nuclear Research held in Brussels, Belgium, April 19, 1971, (A.3.1-A.3.7).

A report is presented on radiological protection methods used to insure that the exposure to ionizing radiation of workers and the public due to operation of a nuclear research center is held to a minimum. The information is divided into three sections dealing with the release of radioactive liquid waste into rivers and reference levels in working areas. Stack releases are monitored, there is continuous monitoring of suspected parti cles in the air, and milk and grass samples are regularly checked for I 131, Cs 137 and Sr 90. Permissible limits are discussed and methods for determining reference levels for source terms of stacks are presented. Liquid wastes are monitored after treatment before being released. The maximum total monthly activity release is 4,500 mCi. During 1970, 67% of the total permissible amount was released. In all normal accessible work areas a level of 2.5 mR.h(E-1) is not to be exceeded. In places where the residence time exceeds 30% of the time, a level of 0.75 mR.h(E-1) is aimed for. Work schedules are arranged in order not to exceed a weekly dose of 100 mrem. Maximum permissible contamination of skin contact surfaces are fixed by the following levels, 5 dps x decimeter squared for alpha emitters and 50 dps x decimer squared for beta and gamma emitters. (JTE)

<388>

RADIATION SAFETY AND CONTROL

<388>
Glauberman, H., W.R. Bootmaun, and A.J. Breslin, Health and Safety Laboratory, New York, NY. 1967

Studies of the Significance of Surface Contamination. CONF-555; Part of Fish, B.R. (Ed.), Proceedings of a Symposium on Surface Contamination held in Gatlinburg, Tennessee, June, 1964, Pergamon Press, New York, New York, (p. 169-178), 423 p.

Air-surface contamination effects were studied in a systematic manner at a discontinued precious metals recovery plant where the radioactive contamination was plutonium, and at an operating uranium processing plant. When contaminated surfaces were subjected to repeated standardized conditions of disturbances, reproducible concentrations of air contamination were observed. This only held true for our given act of conditions. Findings indicated that air-surface contamination relationships derived at one facility will not be valid at another facility except by coincidence. (RAF)

<389>
Holaday, D.A., Not given. 1973

Uranium Mining Hazards. Part of Hodge, H.C., et al (Eds.), Uranium, Plutonium, Transplutonic Elements, Chapter 7. Springer-Verlag, New York, New York, (p. 295-306), 995 p.

The report discusses the problems inherent in producing uranium ores, methods of evaluation of hazards, and control procedures. Non-radiation hazards are mentioned due to the fact that uranium miners are exposed to all the other hazards inherent to metal mining but the primary purpose of the article is a discussion of radiation hazards. Miners are exposed to external radiation of gamma and beta radiation from ore bodies and from radioactive dust. The mean radiation rates from this source range from 0.20 to 0.70 mrem/hr and cause relatively insignificant exposures. The primary radiation hazard is exposure to the daughters of radon which are continually emitted into open spaces in mines. Experiments involving animal exposures to radon and radon daughters are discussed as well as studies of human exposures to radon and radon daughters. Methods used to measure radon and radon daughter concentration within mines are discussed. Control of radon and radon daughters in mine atmospheres is accomplished by ventilation and by air cleaning. Volume ventilation must be kept at a minimum, recirculation eliminated and stagnation of air avoided. Conservation of ventilation air is possible when it can be cleaned and used for further dilution ventilation. Factors determining feasibility of air cleaning are atmospheric radon concentration and time required for use of cleaned air. (BJC)

<390>
Kukacka, L.E., and R.J. Isler, Brookhaven National Laboratory, Department of Applied Science, Upton, Long Island, NY. 1973, February

Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area. BNL-17433; 23 p. (U.S. Atomic Energy Commission)

Cost estimates were made for remedial action in residences in the Grand Junction, Colorado area in which uranium mill tailings were used as a fill material under and around foundations. Gamma radiation profiles were analyzed and remedial action plans formulated for 226 residences. Removal of all uranium tailings under or within 5-ft of the dwelling was stipulated for all residences in which the external gamma radiation (EGR) level was greater than or equal to 0.05 mR/hr above background, Level 1 of the Surgeon General's guidelines. For residences with an EGR greater than or equal to 0.001 and less than 0.05 mR/hr above background it was presumed that the radon daughter concentration (RDC) was greater than 0.01 Working Level (WL). In this case, the use of sealants and grouting materials in conjunction with appropriate tailing removal was assumed as an alternative to complete removal of tailings. Economic data were compiled for 226 homes. Eighty homes had an EGR less than 0.001 mR/hr above background and therefore required no remedial action. For the other levels the cost estimates ranged from $2360 to $6560. The average for the 226 residences was $2110. Based on the established radiation level criteria and the assumed remedial action plan, a total program cost of $10,000,000 was estimated for the 4800 residences in Grand Junction that have tailings under or near the structure. This is approximately 33% lower than a previous estimate of $15,000,000 which was based entirely on the removal of tailings from soil under or near areas in which the gamma radiation level was above background. Compared to the latter, the use of sealants and grouts results in an overall cost reduction of $1,900,000 (approximately 13%). The remainder of the saving ($3,100,000) is due to the deletion of any remedial action for residences with an EGR less than 0.001 mR/hr above background and for limiting tailings removal to within 5-ft of residences. (Auth)

<391>
Moore, P.R., Savannah River Plant, Aiken, SC. 1974, July

Decontamination of a Highly Radioactive Chemical Processing Facility. WASH-1332; CONF-740406; Part of Proceedings of the 2nd AEC Environmental Protection Symposium held in Albuquerque, New Mexico, April 16-19, 1974, Vol. 2, (p. 715-725), 1151 p.

Five modules of the highly radioactively contaminated "hot canyon" in one of the chemical processing plants for irradiated fuel at Savannah River Plant were successfully decontaminated for installation of a new process. Decontamination was completed in about one year at a cost of about $150,000. The various techniques employed, equipment used, and the overall job plan are described. (Auth)

<392>
Nooteboom-Beckman, Z.M., and B. Verkerk, Stichting Reactor Centrum Netherlands, The Hague, Netherlands. 1974, June

Sense and Nonsense Over Plutonium Toxicity. Atoomenergie en Haar Toepassingen, 16(2), 139-141. (Dutch)

Recent reports on the toxicity (and carcinogenicity) of plutonium are summarized and assessed. While some of the more "alarmist" pronouncements are discounted as unfounded, it is emphasized that more data are needed before complete confidence can be placed in existing safeguards. This data must be acquired and evaluated as a matter of urgency, in view of the expected increase in plutonium production and usage in fast

<392> CONT.
breeder programs over the next decades. (NL)

<393>
Not given, U.S. Atomic Energy Commission, Directorate of Regulatory Standards, Washington, DC. 1973, August

General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants. REG/G-3.12 (8-73); 6 p.

At plutonium processing and fuel fabrication plants, a principal risk to health and safety is the release and dispersal of radioactive materials. The prevention of such release and dispersal is an important function of the ventilation systems. The regulatory guide presents methods acceptable to the regulatory staff for complying with requirements for the design of ventilation systems for plutonium processing and fuel fabrication plants. Sections are devoted to: general safety, occupied area ventilation systems, process ventilation systems, fans, construction and layout, testing and monitoring, glove boxes and other process enclosures, filtration systems, and quality assurance programs. (TFD) (JTE)

<394>
Barrick, H. L., Sandia Laboratories, Albuquerque, NM. 1972

Weapon Effects Tests--Planned Emergencies. CONF-690103; Part of Willis, C.A. and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the 3rd Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1966, Vol. 3. Gordon and Breach, Science Publishers, Inc., New York, New York, (p. 1573-1580).

Radiation emergencies usually involve the following parameters: A large source of radiation released to the environment; recovery of valuable property of information; unknown contamination, external radiation, and air concentration levels;, necessary reentry of personnel into the area;, and high levels of induced radioactivity in materials to be recovered. These characteristic elements also define a weapon effects test. Three types of test are discussed: the Small Boy event, Operation Roller Coaster and tests in tunnels. In the first type, conducted slightly aboveground, the entire area, including bunkers, was covered with fused silica containing fission products. Removal of the fused silica lowered radiation levels to about one R/hour. Operation Roller Coaster yielded molten plutonium metal that combined with device materials, earth, concrete and metal. Debris out to a range of 2500 feet from ground zero area was collected and buried inside the ground zero area, together with contaminated soil, which had been scraped to a depth of several inches. In tunnel tests, the hazards of radiation, explosive and toxic gases, unexploded explosives and tunnel damage are monitored until conditions are safe for reentry of personnel. (LR)

<395>
Sehmel, G.A., and F.D. Lloyd, Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Department, Particulate and Gaseous Waste Section, Richland, WA. 1974, August; 1976

Particle Resuspension Rates. BNWL-SA-5124; CONF-740921; Part of Engelmann, R.J. and Sehmel, G.A. (Coords.), Proceedings of the Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants Symposium held in Richland, Washington, September 4-6, 1974, (p. 846-858), 988 p.

Particle resuspension rates were measured during four months of field testing in a lightly vegetated area. Resuspension of an inert submicrometer tracer placed on the ground in a circle of 22.9 m radius was measured. At the circle center, airborne concentrations were measured to heights of 6.1 m. The resuspended plume extended above 6.1 m. Resuspension rates were from 10(E-10) to 10(E-8) fraction resuspended/sec. Resuspension rates increased non-linearly as a function of wind speed. For wind speeds greater than 3.6 m/sec, resuspension rates increased with wind speed to the 6.5 power. (Auth)

<396>
Sehmel, G.A., and F.D. Lloyd, Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Department, Particulate and Gaseous Waste Section, Richland, WA. 1974, August; 1976

Resuspension of Plutonium at Rocky Flats. BNWL-SA-5085; CONF-740921; Part of Engelmann, R.J. and Sehmel, G.A. (Coords.), Proceedings of the Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants held in Richland, Washington, September 4-6, 1974, (p. 757-779), 988 p.

In a July, 1973 field experiment at Rocky Flats, vertical airborne plutonium concentrations were determined as a function of respirable particle size. The principal sampling site was a 100-foot meteorological tower which was instrumented at several heights with self-orienting, high volume cascade impactor-cowl systems. Wind speed instrumentation activated selected impactors as a function of wind speed. Airborne plutonium concentrations and concentrations on airborne soil were measured as a function of both height and wind speed. Below 10 m, concentrations decreased with height. Above this height to 30 m, an increase suggested that an elevated upwind source could be contributing. The maximum airborne concentration measured was 3.7 x 10(E-15) Ci/m3. The maximum concentration per gram of gross airborne soil was 50 pCi/g. Somewhat higher concentration was found on the approximately 2 um airborne soil fraction. All concentrations were significantly less than the maximum permissible concentrations. (Auth)

<397>
Taube, M., Not given. 1964

Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles. Part of Plutonium, Chapter 3. Pergamon Press, New York, New York, (p. 85-102), 262 p.

Alpha particles emitted by Pu 239 have a small range in air, only 3.61 cm. There is practically no danger for the human body of bombardment by alpha particles from external sources. One alpha particle with energy approximately 5 MeV is capable of directly or indirectly creating over 100,000 ion pairs. This enormous number of ions created in a very small space, i.e. over a length of 45 u, is a characteristic feature of the

<397> CONT.
physiological effect of alpha radioactive isotopes of Pu. The critical organ for Pu varies depending on the solubility of the toxic material and the way of intake. Bone is the critical organ for inhaled, ingested or injected Pu in soluble form, and under conditions of slow intake. The lungs is the critical organ for inhaled Pu in the insoluble state. The maximum permissible body burden for Pu is taken as 0.04 uCi (0.64 ug) which corresponds to approximately 1500 alpha disintegrations/sec. The maximum permissible Pu concentration in air is 3.2 x10(E-2) uCi/cm3 and for drinking water it is 0.5 x 10(E-4) mCi/cm3. The presence of Pu in the body may be established by examination of the bones or by urinalysis. Note should be taken of the hazard of Pu being introduced into the body through a small open wound or through scar tissue. Zirconium compounds administered shortly after contamination with Pu have been found to reduce substantially the Pu burden in the body. The intravenous injection of a Ca-Na salt of EDTA has been very effective for Pu removal. General rules for the efficient running of a Pu laboratory are described such as the use of rubber gloves, protective overalls and clothing, glove boxes, filtering of the air from hoods and glove boxes and medical supervision of personnel. (FMM)

<398>
Unruh, C.M., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1970, January

Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice. BNWL-SA-3075; 99 p.

The manual provides specific information that can be useful in establishing and administering safe programs for working with transuranium radionuclides. Also, it provides those relatively inexperienced in working with transuranium radicnuclides with the background of experience that has been developed by other users. The manual presents and discusses good practices that should be observed by management, technical staff, and technicians. Among the topics covered are the physical and chemical properties of the transuranium elements; facility site selection, facilty design with such considerations as ventilation, glove boxes and material handling; personnel considerations, including training, protective clothing, personnel dose measurement, and shielding control of interior deposition and personnel decontamination, and procedures for emergencies. It is pointed out that the manual is a manual of good radiation protection practices and not a handbook of physical property data or design criteria. (FMM)

<399>
Cross, F.T., C.H. Bloomster, P.L. Hendrickson, and I.C. Nelson, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, March

Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners. PB-237-744; NIOSH-72-2; 289 p.

The methods and criteria employed in the development of radiation exposure standards over the past thirty years are studied. Literature pertaining to miners is reviewed and evaluated with respect to the criteria which could have been used in setting standards in the past which would have provided maximum miner protection. Included in the review are: radiation dose calculations and consensus methods; epidemiology studies of uranium miners and other miners exposed to radon and radon daughters (flourspar, iron, hard rock, coal, gold, manganese, pot ash, and zinc miners); bioassay studies of inhaled radon and radon daughters (Pb 210, Po 210); and epidemiology studies of other pulmonary radiation exposures to man (thorotrast patients, spondylitis patients, and atomic bomb survivors). The pertinence of experimental animal studies, sputum cytology studies, chromosome aberration studirs, and Mantel-Bryan Model extrapolation studies are evaluated. The relationship of cost to mine operators and incidence of respiratory cancer deaths for different occupational health standards are evaluated. The various costs to government and society associated with standard setting methodologies are calculated and evaluated. The selection of appropriate standard setting methodologies and exposure standards are theoretically evaluated and compared with respect to cost effectiveness. Factors influencing enforcement of exposure standards including: legal enforceability, technical capability, and mine owner compliance are considered. Appendices giving subjective mine conditions and radon daughter dose calculations, ranges of plausible exposure standards for standard setting methodologies, 1942-1971 ventillation costs (theoretical and actual) and the health impact of the standard setting methodologies and exposure standards are included. (ND)

<400>
Geue, P.J. (Comp.), Australian Atomic Energy Commission, Research Establishment, Lucas Heights, Australia. 1972, August

Nuclear Materials Management and Safeguards. AAEC-LIB/BIB-362; 95 p.

This chronological bibliography with a total of 508 listed references is presented in three parts: 1) conferences, books and bibliographies (16 references), 2) safeguards systems and safeguard objectives (182 references), and 3) safeguards techniques and instrumentation (310 references). The literature search of NSA and INIS covers the period 1969 to August 1972. (RAF)

<401>
Henry, H.F., Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN. 1961, May 2

Is All Nuclear Radiation Harmful?. K-1470; 25 p.

An analysis is made of available experimental results on the longevity effects of chronic low-level radiation upon animals. It is shown that a statistical average life-lengthening effect occurs at chronic life-time radiation exposure levels below about 2-5 rad/week; for higher exposures, a life-shortening effect is observed although the data do show variations among animals. Similarly, available data on chronic internal exposures resulting from injection of radioisotopes show that for such materials of interest as plutonium and uranium statistical life-lengthening effects also occur for comparatively low injections where higher injections produce life shortening. The principal sources of human data are statistical studies on the longevity of

<401> CONT.
radiologists, and these also indicate an apparent greater life expectancy for this group as compared to physicians in general. It is noted that available data do not permit unequivocal determination of the over-all genetic effects of low levels of radiation, primarily because the data do not clearly indicate environmental selection principles. Some of the philosophical bases involved in evaluating the over-all somatic and genetic effects of low levels of radiation are briefly discussed. (Auth)

<402>
Long, A.B., Argonne National Laboratory, Applied Physics Division, Argonne, IL. 1971, June

Plutonium Inhalation: The Burden of Negligible Consequence. Nuclear News, 14(6), 69-73.

The maximum permissible concentration in air of insoluble plutonium accepted by the Federal government, the International Commission on Radiological Protection and the National Commission on Radiological Protection in 1959 is 4 x 10 (E-11) uCi/cc of air. The author contends that in the light of data accumulated over the past 10 years a serious question exists whether the risks associated with the present PuO2 inhalation limits are justified by the benefits derived from activities involving the production of use of plutonium. The difficulty in detecting the minute amounts of plutonium in the air and in the body intensifies the problem of enforcing the exposure limits. Based on an entire lung mass of 1000 g and a maximum permissible dose of 0.3 rem/week there is calculated a maximum permissible lung burden of 0.016 uCi. This figure in turn can be used to calculate the maximum permissible concentration in air for PuO2 at the end of 50 years of occupational exposure (8 hours/day, 5 days/week, 50 weeks/year) when the pulmonary lung burden is equal to the maximum permissible lung burden. Owing to lack of human exposure data, it was necessary to rely on inhalation experiments conducted on animals. This data formed the basis for the values of many of the parameters used to establish the present exposure limits. More recent animal tests show a maximum permissible concentration in air for PuO2 ranging from 5.3 x 10(E-12) uCi/cc to 1.1 x 10(E-15) uCi/cc depending on the choice of lung and lymph gland mass chosen as well as the model. (LR)

Table 3 shows the maximum permissible concentration in air of Pu 239 PuO2 to give a dose of 0.3 rem/week in critical organ after 50 years exposure.

<403>
Nickson, J.J., J.E. Rose, K.S. Cole, and J.G. Hamilton, University of Chicago, Chicago, IL. 1944, December 7

Monthly Health Report on Problems Relating to Product for Period Ending October 31, 1944. CN-2312; 13 p. (Declassified January 18, 1956)

Surveys for alpha contamination in rooms, air and on personnel were made. Air velocity of not less than 100 feet per minute through hood openings was recommended for safe operation with plutonium. Five methods for detecting plutonium in urine are described. Reports are made on inhalation of plutonium aerosols by rats, absorption of plutonium from gastrointestinal tract of rat, adsorption of plutonium on glass, and distribution of absorbed plutonium in mice. Radioautographs are presented for mouse humerus, tibia, liver and spleen. Radioautographic, tracer, PuO2 aerosol and decontamination studies on rats are also reported. Concentrations of plutonium in air above tolerance levels, owing to evaporation conditions and to transfer methods, are reported. Precautionary measures are proposed. (LR)

<404>
Not given, National Council on Radiation Protection and Measurements, Scientific Committee 14 on Radiological Factors Affecting Decision Making in a Nuclear Attack, Washington, DC. 1974, November 15

Radiological Factors Affecting Decision-Making in a Nuclear Attack. NCRP Report No. 42; 66 p.

This more practical revision of NCRP Report No. 29 was prepared to assist in preparedness activities for large disasters in which exposure of many people to nuclear radiation is of primary concern. Radiobiological problems are discussed associated with nuclear attack using data from accidental human radiation exposures and contemporary experimental radiobiological information to evaluate how fractionation and protraction of radiation exposure might influence the effectiveness of total-body radiation exposure. A system for predicting the outcome of human exposure is developed. A section of this report is devoted to the process of decision-making in relation of exposure to effect, utilizing a "penalty" table of dose-time considerations. (RAF)

<405>
Not given, U.S. Atomic Energy Commission, Division of Technical Information, Washington, DC. 1971

Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities. CONF-710401; Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities held in Golden, Colorado, April 13-16, 1971; 457 p.

The purpose of this meeting was to review and discuss innovations for the safety of plutonium operations. All those attending were concerned with and involved in the safe handling of plutonium. The symposium was divided into four general areas: (1) glovebox design and operation, (2) ventilation systems, (3) fire detection and suppression systems, and (4) environmental considerations. This volume is a record of the 42 papers that were presented. It should provide an indication of the state-of-the-art of plutonium safety in various facilities and a starting point for studies to further improve the safety of plutonium facilities. Thirty-eight papers have been selected for input into the data base. (JTE)

<406>

WASTE DISPOSAL AND MANAGEMENT

<406>
Bahr, W., W. Hild, and K. Scheffler, Kernforschungszentrum Karlsruhe, Gesellschaft fur Kernforschung, Karlsruhe, German Federal Republic. 1974, October

Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe. CONF-741026; KFK-2089; Part of Proceedings of a Symposium on the Management of Plutonium-Contaminated Solid Wastes held in Marcoule, France, October 14-16, 1974, (14 p.).

Solid-plutonium-containing wastes from a fuel production plant, a reprocessing plant and several research laboratories are treated at the decontamination department of the Karlsruhe Nuclear Research Center for disposal in the Asse salt mine. The main quantities of alpha-contaminated solid wastes are generated within glove boxes. Combustible wastes are collected in plastic bags or cylindrical cardboard containers which are removed from the boxes after being sealed into plastic bags. Noncombustible wastes are collected separately in cylindrical cardboard containers. Both types of wastes are separately collected in 200 liter inforced drums and transported to the decontamination department of Karlsruhe, where they undergo quantitative Pu determination and treatment. Combustible wastes are incinerated and the flue gases pass through a series of ceramic filter candles. A Pu concentration limit of less than or equal to 10 mg Pu/200 l drum has been instituted above which combustible wastes may not be incinerated, but are conditioned by special treatment into disposable forms without volume reduction as are the non-combustible wastes which fall into the same contamination range. These wastes as well as dismantled, contaminated equipment which has undergone decontamination and packaging procedures are disposed of in the Asse salt mine. Maximum Pu 239 content is 8 g per 200 liter drum, other transuranium radionuclides, Pu included, are limited to 0.5 Ci per 200 l. Future aspects of waste treatment and disposal are discussed. (JTE)

<407>
Bartlett, J.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, November

Advanced Methods for Management and Disposal of Radioactive Wastes. BNWL-1952; Part of Platt, A.M. (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 1-17), 51 p.

A conceptual plan was developed for management of high-level waste for purposes of recovery and use of economic values. Work on radionuclides migration from nonsalt formations was completed. The report, soon to be issued, concludes that there are achievable conditions of final geologic storage for which incentives to partition transuranics and other nuclides from the wastes are negligible. Analysis of data from the survey of public attitudes toward nuclear waste management is near completion. Differences in respondent's attitudes were found to be real and not an artifact of the measurement technique. The study of alternatives for management of iodine and technetium was completed. (ND)

<408>
Borduin, L.C., W.E. Draper, C.L. Warner, R.A. Koenig, and T.K. Keehan, Los Alamos Scientific Laboratory, Los Alamos, NM. 1975

The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility. CONF-750967 (Vol. 2); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 889-905), 1015 p.

The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility established to test candidate production-level solid waste reduction processes at 100-200 lbs/hr throughput. The first process selected for development and evaluation was controlled air incineration in a dual-chamber device. Under-fire air was used in the lower (ignition) chamber to initiate incineration under starved air conditions. Supplementary air was introduced in the upper chamber to complete combustion of the volatile products and entrained solids produced in the lower chamber. Natural gas fired burners provided the heat for both ignition and combustion. This device has been tested with a variety of synthetic (i.e., non-radioactive) wastes typical of those expected from a plutonium processing area. Future modifications and plans are also being described. (Auth)

<409>
Claiborne, H.C., and F. Gera, Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN. 1974, October

Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico. ORNL-TM-4639; 84 p.

The report examines potential containment failure mechanisms and estimates their probabilities and consequences, when possible, for a hypothetical waste repository located in bedded salt-breach in southeastern New Mexico. The primary conclusion of the study is that a serious breach of containment for such a repository, either by human action or natural events, is only a very remote possibility and falls into the category of least likely occurrences which affect society. A sealed repository 600 m underground would be virtually sabotage proof; even the surface burst of a 50-megaton nuclear weapon could not breach the containment. The mechanism of containment failure with the most serious potential consequences seems to be the impact of a meterorite that produces a crater extending to the disposal horizon. The probability of such a catastrophic meteorite impact was estimated at 1.6 x 10(E-13) per year. Based on the tectonic activity of the Delaware Basin over the past 200 million years, the probability of faulting through the repository has been estimated at 4 X 10(E-11) per year; however, the probability that faulting would cause failure of waste containment is only a small but unknown fraction of this value. Exposure of the waste horizon to the action of . The contamination of surface aquifers due to this mechanism of release could be relatively serious, despite the very long time necessary to produce such a displacement. (Auth) (FNM)

<410>
Conche, R., R. Phillipin, L. Hayet, and G. Rouffet, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France. 1973

<410> CONT.
Details of the Disposal of Radioactive Wastes Contaminated with Plutonius 239. CEA-CONF-2417; CONF-730667; Part of Proceedings of the 15th Symposium of the Committee on Hot Laboratories of Euratom held it Goesthacht, Germany, June 14-15, 1973, (p. 721-743). (French)

The processing and storage of radioactive wastes contaminated with Pu 239 necessitate special care. The gamma activity and the very long lifetime of Pu 239 (24,000 yr) impose air-tight casings. At Fontenay-aux-Roses these wastes are processed in shielded cells. The volume reduction of compressible wastes, confinement in air-tight casings, and the transport of the wastes to decay stations or for storage in air-tight devices is described in some detail. (tr-Auth)

<411>
Daly, G.H., and A.S. Kluk, U.S. Energy Research and Development Administration, Division of Waste Management and Transportation, Washington, DC. 1975, April 1

Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste. HASL-291; Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-110 - I-126), 227 p.; CONF-741047; Part of Proceedings of the American Nuclear Society Symposium held in Washington, D.C., October 27-November 1, 1974, (16 p.).

Up to 20 percent of solid radioactive wastes which have been generated at ERDA sites may be contaminated with transuranium nuclides. Prior to the requirement for 20-year retrievable storage in March, 1970, solid waste contaminated with transuranium nuclides was buried with other radioactive waste at carefully selected locations. A total of about 900 kg of transuranium nuclides are contained in just over 1 million cubic meters of radioactive waste at these locations. Approximately 760 kg of transuranium nuclides are contained in the buried waste, while the remainder is contained in the stored waste. Another 80 kg of transuranium nuclides are contained at the five commercial burial sites. All evidence to date indicates that transuranium nuclides have not migrated significantly from their burial location. (Auth)

<412>
Dillon, R.L., and R.S. Kemper, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, November

Decontamination and Densification of Chop-Leach Cladding Residues. BNWL-1952; Part of Platt, A.M., (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 19-29), 51 p.

Fuel element cladding residues from the chop-leach head end process constitute a low-density, high-surface area metallic waste with a substantial actinide element contamination. The feasibility of and development of methods for removal of long half-life transuranics from the cladding residues and consolidation of the zirconium and stainless steel residues was determined. The study involved: (1) Selection and laboratory testing of methods for transuranic removal by aqueous, reagents, molten salt reagents, and fluxing during melting; (2) consolidation of the fuel element hulls by melting and casting Zircaloy, stainless steel, Inconel or alloys of the three; (3) testing and evaluating the consolidated fuel hulls for long-term waste management; (4) absorption and fixation of tritium into the waste ingots; and (5) consolidation of transuranics removed. The analysis of high-exposure PWR fuel cladding confirmed previous estimates that much of the transuranic activity could be leached from the fuel clad, a second substantial portion was confined to the corrosion product oxide, and only about 1/100 of 1% was in the cladding metal. (ND)

<413>
Draper, W.E., C.L. Warner, and C.J. Umbarger, Los Alamos Scientific Laboratory, Los Alamos, NM. 1974, October

Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF". LA-5762-PR; Part of Transuranic Solid Waste Management Research Programs, Quarterly Report, April-June, 1974, (p. 6), 18 p.

The Facility Design Criteria Report had been published, and the preliminary Safety Analysis Review was progressing rapidly. The Process Design Criteria Report was to be published in July, 1974. The multienergy gamma assay system (MEGAS) or box counter has been installed at the Plutonium Handling Facility (CMB-11). The system was calibrated for Pu 238 as well as U 235. The detection limit for Pu 238 is about 3 times lower than Pu 239 because the L x-ray yield from Pu 238 is approximately 3 times greater than from Pu 239 per disintegration. (JTE)

<414>
Herceg, J.E., S.L. Lambert, M.E. McLain, and C.J. Umbarger, Los Alamos Scientific Laboratory, Health Division, Waste Management Section, Environmental Studies Group, Los Alamos, NM. 1974, May

Transuranic-Contaminated Solid Waste Treatment Development Facility, A413. LA-5614-PR; Part of Transuranic Solid Waste Management Research Programs Quarterly Report, October-December, 1973, (p. 15-17), 55 p.

A task force was organized to assemble data on types of incinerators used or being considered for the processing of transuranic contaminated wastes and to review the choice of incinerator types for the transuranic contaminated solid waste Treatment Development Facility (TDF). The standard controlled air incinerator was reconfirmed as the candidate process for the TDF. Other activities for the report period are summarized including work towards evaluation of design capacity, air cleaning design and a preliminary experimental plan prepared as a guide for process instrument design. Facility design criteria for the TDF were reviewed and updated including unit operations for process engineering. The development of instrumentations for plutonium assay has progressed both for a modified FIDLER system monitoring sorted, low density wastes and the MEGAS system for the assay of plutonium L x-ray emission of uranium and the higher energy gamma rays from plutonium and other transuranic elements. (BBM)

<415>
Koenst, J.W., and D.E. Blane, Mound Laboratory, Miamisburg, OH. 1975

<415>

WASTE DISPOSAL AND MANAGEMENT

<415> CONT.
Chemical Coagulation of Radioactive Wastes at High pH. CONF-750967 (Vol. 2); ERDA-92; Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 810-824), 1015 p.

The waste treatment facility at Mound Laboratory was recently modified for the treatment of plutonium-bearing wastes. Prior to July 1, 1975, the facility had been run at pH 8.8; however, since the plant was modified it has been run at pH 11.3 with different chemical dosages. The improvement in effluent quality using the higher pH process (pH 11.3) has been dramatic. Prior to the changeover, the system effluent activity levels ranged from 2-3 dis/min/ml (9-14 x 10(E-4) uCi/l) specific Pu 238; after the changeover effluent activity levels ranged from 0.3-0.5 dis/min/ml (1.4-2.3 x 10(E-4) uCi/l) specific Pu 238. Total activity discharged (on a monthly basis) has been cut by more than a factor of 2, because of the changeover to the high pH process. Effluent levels are about as low as can be obtained in this type of waste treatment process. (Auth)

Table 1 lists the typical chemical dosages for Pu removal.

<416>
Mudge, L.K., and P.C. Walkup, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, November

Pyrolysis-Incineration of Combustible Alpha Wastes. BWNL-1952; Part of Platt, A.M., (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 31-34), 51 p.

A pyrolysis-incineration process for safe and economical reduction of the volume of alpha wastes from 10 to 50-fold as a precursor to ultimate disposal has been developed. Modification of the demonstration unit was completed to overcome problems that occurred during operation of the unit. Changes included relocation of the off-gas line outlet, installation of an air flow controller, installation of steam addition lines, reinforcement of the distributor support, and redesign of the distributor plate. Analysis of ash collected during the run indicated a tap density of 0.76 g/cm(E+3) and a carbon content of 13 wt%. This represented a 99.5% burnup of the simulated waste, which had an ash content of 3.6 wt%. The volume reduction factor for the simulated waste of bulk density 0.13 g/cc was calculated to be 140. (ND)

<417>
Not given, Los Alamos Scientific Laboratory, Environmental Studies Group, Waste Management Studies, Los Alamos, NM. 1974, July

Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974. LA-5666-PR; 24 p.

The progress for three transuranic solid waste management research programs funded by the AEC Division of Waste Management and Transportation during the period of January-March 1974 is reviewed. The interim storage criteria have been redesignated as guidelines and will be issued as a Los Alamos Scientific Laboratory document after incorporation of final revisions. Studies of corrosion of mild steel in humid air have shown that Zinc Chromate Underseal, Chemical and Water-Resistant Rustoleum Industrial Coating, and Rust Gard do not prevent corrosion. Analysis of the gaseous products of radiolysis of cellulosics contaminated with 1.2 mg Pu 238/g waste matrix have shown hydrogen and carbon dioxide to be the major products. Waste production is being evaluated on an individual process basis, and flowsheets are being prepared to show material input and waste output for each plutonium handling process. The Transuranic-Contaminated Solid Waste Treatment Development Facility has been redesigned to permit increased research ability and flexibility. The program to evaluate past burial practices has been redirected to emphasize local burial areas. Fluid dynamics computer codes are being evaluated for use in soil transport, atmospheric dispersion, and resuspension models. Agricultural and population data are being obtained for the areas surrounding Los Alamos. (Auth)

<418>
Platt, A.M., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, November

Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975. BNWL-1952; 51 p.

Progress within ERDA nuclear waste management and transportation programs at Battelle-Pacific Northwest Laboratories is described. Advanced methods for the management and disposal of radioactive wastes for purposes of recovery and use are detailed. Included in this section are reports on: fission by-product management (partitioning and fuel reprocessing, candidate by-products, radioisotopic tracers, mineral resources, and toxic materials); radionuclide migration from nonsalt formations; a public attitude migration from nonsalt formations; a public attitude survey toward nuclear waste management; and alternatives for management of iodine and technetium. The decontamination and densification methods of chop-leach cladding residues with actinide element contamination were investigated and evaluated. Development studies of a pyrolysis incineration process for safe and economical reduction of the volume of alpha wastes prior to disposal are reported. Methods for separating and fixing tritiated water for permanent storage were examined and tested. Alternatives for the disposal of retired contaminated facilities at Hanford are reported. The risks associated with the shipping of radioactive materials (Pu O2 and PuNO3) by truck and rail were analyzed and evaluated. (ND)

<419>
Routson, R.C., Battelle Memorial Institute, Pacific Northwest Laboratories, Water and Land Resources Department, Richland, WA. 1973, March

A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967. BNWL-1464; 59 p.

The literature regarding effects of the liquid waste disposal operations at Hanford on the soil environment was summarized. Radionuclides which normally need to be considered in waste disposal include Sr 90, Cs 137, Pu, Co 60, Ru 106, rare earths and H 3. The summary is divided into studies pertaining to: 1) the vadose zone below a depth of twenty feet (lower vadose zone); 2)

<419> CONT.
the saturated zone; 3) the vadose zone above twenty feet (upper vadose zone). The division is based upon the relative desirability of these three zones for nuclear waste disposal (storage). Liquid nuclear wastes have been safely discharged to the lower vadose zone for over 20 years. Migration of these wastes from the lower vadose zone by the mechanisms of diffusion, leaching, and particulate transport is discussed. It is concluded that: 1) little movement of sorbed radionuclides by the above mechanisms within ten half-lives of even the long-lived radionuclides occurs; 2) the sorbed radionuclides can only be removed from this zone by a cataclysmic occurrence in which the sediment in the zone and the entrained wastes are both physically removed. The saturated zone is the second most desirable zone for radioactive waste disposal. Since water disposed to the saturated zone takes several years to travel from the disposal areas to the Columbia River a finite time period for radioactive decay exists. Radioactive wastes accidentally released to the vadose zone above twenty feet (upper vadose zone) are carefully monitored and controlled, since this is the zone where possible organism contact is most probable. The monitoring program is designed to detect buildup or reconcentration of long-lived radionuclides such as Sr 90 in the surface soil or in plants. Biological cycling studies, including uptake of Cs and Pu by plants, are discussed. It is concluded that due to the suitable climate, deep permeable sediments with adequate sorption capacities, and great depth to ground water, the Hanford project offers a nearly ideal environment for ground disposal of radioactive wastes. (Auth) (FMN)

<420>
Scousselier, Y., Commissariat a l'Energie Atomique, Paris, France. 1973, March

Safety Principles In the Storage Of Fission Products. CONF-721107; Part of Proceedings of a Symposium on the Management of Radioactive Wastes from Fuel Reprocessing held in Paris, France, November 27-December 1, 1972, (p. 181-198), 1266 p. (French)

The solutions to be adopted in the storage of fission products arise on the one hand from their activity and on the other from principles aimed assuring that the storage will not involve any risk or inconvenience to future generations. The examination of the radiological harmfulness of the different constituents of fission products makes it possible to show that a decontamination factor of 10(E+3) to 10(E+4) is necessary to reduce the noxiousness of alpha emitters to a value compatible with a storage near the surface of the soil and that that ought to be guaranteed for a period of 800 y. The other possibility is storage in a salt formation/or in a deep geologic formation. Among the latter type, storage in a granite formation presents particular interest because it would often permit storage under the site of reprocessing plants and would avoid the transportation of the fission products. An important element in putting a safe policy of storage into effect is the financial aspect. It is indispensable to provide for a means of solidification and final storage of the fission products. (tr-auth)

<421>
Scousselier, Y., Commissariat a l'Energie Atomique, Chatillon-sous-Bagneux, France. 1972

Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes. CONF-720453; Part of Proceedings of the Information Symposium on Disposal of Radioactive Waste held in Paris, France, April 12-14, 1972, (p. 193-203), 290 p. (French, English Abstract)

At present, radioactive wastes do not raise serious conditioning or storage problems mainly because the quantities produced are small. However, the extremely rapid increase in the number of nuclear power stations in operatio during the coming years will result in a considerable growth in volume of the wastes to be stored and mainly, in the amount of contained radioactivity. It will then be necessary to determine the suitability of storage sites according to criteria based, in particular, on the half-lives of the contained radionuclides. Although surface storage methods for low-level wastes containing only short-lived radionuclides will continue to be used, appropriate geological formations (salt, limestone, etc.) will have to be selected for the storage of very long-lived radionuclides such as plutonium. It will be possible to bury short-lived but highly-active wastes either very deep underground, or near the surface, in especially designed bunkers, but always after solidification. In order to carry through this policy successfully, it will be necessary to establish a mechanism for collaboration at international level in a variety of fields such as adoption of common standards, internationalization of storage centers or joint studies of certain storage methods. Thorough studies must continue on elimination of krypton from gas released by reprocessing plants, or on the safe storage of tritiated effluents. The main obstacle likely to be encountered when implementing this policy will be the local populations's opposition to the implantation of ultimate storage controls. (Auth)

<422>
Wervers, H.J., Stichting Reactor Centrum Netherlands, The Hague, Netherlands. 1976, July-August

Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland. Atoomenergie en Haar Toepassingen, 16(7-8), 166-174. (Dutch)

Long and medium term radioactive wastes are defined as wastes with activity greater than 0.2 R/h with insignificant content of alpha sources. There is sufficient space in Holland for storage of the expected waste of these types for the next 50 years, on reasonable assumptions of development of nuclear energy. (NL)

<423>
Williams, L.D., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, November

Transportation Safety Studies. BNWL-1952; Part of Platt, A.M. (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 43-51), 51 p.

Assessment of the risk in the shipment of plutonium oxide and liquid plutonium nitrate by truck and rail have been completed. A model was developed and used to calculate the risks associated with the shipping of radioactive materials. System descriptions

<423>

WASTE DISPOSAL AND MANAGEMENT

<423> CONT.
have been completed for use in assessing the risks in the shipment of non-high-level wastes. Three types of waste (beta-gamma, alpha, and alpha-beta-gamma) were considered in the assessment. The risk analysis code HEAD was modified to increase its utility. (ND)

<424>
Franz, J.A., and L.L. Burger, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1975, May 15

Polymeric Media for Tritium Fixation. BNWL-B-430; 24 p.

The synthesis and leach testing of several polymeric media for tritium fixation are presented. Tritiated bakelite, poly(acrylonitrile) and polystyrene successfully fixed tritium. Tritium leach rates at the tracer level appear to be negligible. Advantages and disadvantages of the processes are discussed, and further bench scale investigations underway are reported. Rough cost estimates are presented for the different media and are compared with alternate approaches such as deep-well injection and long-term tank storage. Polymeric media costs are high compared to deep-well storage and are of the same order of magnitude per liter of water as for isotopic enrichment. With this limitation, polymeric media can be economically feasible only for highly concentrated tritiated wastes. It is recommended that the bakelite and polystyrene processes be examined on a larger scale to permit more accurate cost analysis and process design. (Auth)

<425>
Groenier, W.S., R.E. Blanco, R.C. Dahlman, B.C. Finney, A.H. Kibbey, and J.P. Witherspoon, Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN; Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN. 1975, May

Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium. ORNL-TM-4904; 140 p.

A cost-benefit study was made to determine the cost and effectiveness of radioactive waste (radwaste) treatment systems for decreasing the release of radioactive materials from a model light-water plutonium recycle reactor fuel fabrication plant, and to determine the radiological impact (dose commitment) of the released materials on the environment. The study is designed to assist in defining the term "as low as practicable" in relation to limiting the release of radioactive materials from nuclear facilities. The base case model plant is representative of current plant technology and has an annual capacity of 300 metric tons of LWR plutonium recycle fuel. Additional radwaste treatment equipment is added to the base case plants in a series of case studies to decrease the amounts of radioactive materials released and to reduce the radiological dose commitment to the population in the surrounding area. The cost for the added waste treatment operations and the corresponding dose commitment are calculated for each case. In the final analysis, radiological dose is plotted vs the annual cost for treatment of the radwastes. The status of the radwaste treatment methods used in the case studies is discussed. Some of the technology used in the advanced cases is in an early stage of development and is not suitable for immediate use. The methodology used in estimating the costs and the radiological doses, detailed calculations, and tabulations are presented in appendices A and B. (Auth)

Table 7.9 shows percent contributions of inhaled and injested radionuclids from the gaseous effluent of a model mixed-oxide fuel fabrication plant to individual organ (bone, kidney, lung, liver) doses. Table 7.8 shows major radionuclides (Pu 238, Pu 239, Pu 240, Pu 241, Am 241) contributing to dose to individuals from gaseous effluents via terrestrial pathways at 0.5 mile from a model mixed-oxide fuel fabrication plant.

<426>
Peters, A.H., Jr., Savannah River Plant, Aiken, SC. 1974, April

Savannah River Plant Effluent Reduction Program. CONF-740406; WASH-1332 (74); DPSPU-74-30-15; Part of Proceedings of the 2nd AEC Environmental Protection Symposium held in Albuquerque, New Mexico, April 16-19, 1974, (p. 47-62), 1151 p.

Approaches to the radioactive effluent reduction program at the Savannah River Plant and their effectiveness are discussed. Organizational structure, procedural control, and operations evaluation are key factors. (Auth)

<427>
Reisenauer, A.E., and L.L. Ames, Hanford Atomic Products Operation, Richland, WA. 1961, January; 1961, June

Removal of Plutonium from 234-5 Building Waste. HW-70806-RD; Part of Haney, W.A. (Ed.), Chemical Effluents Technology Waste Disposal Investigations, January-June, 1961, (p. 7), 17 p.

An exchange column of Florida pebble phosphate, a commercially available natural apatite, was found to adsorb plutonium from 234-5 Building sump waste in laboratory tests (HW-70041). Approximately 90 per cent of the plutonium from 415 column volumes was adsorbed on a phosphate mineral bed through which waste was passed at a flow rate which provided a residence time of 3.25 minutes. Prompt elution of the mineral with 1M Na_2CO_3 recovered more than 90 per cent of the adsorbed plutonium in 2.8 column volumes. Elutions performed after a time lapse of three days removed only about 10 per cent of the plutonium, probably because of diffusion along radial crystal boundaries. Recharging the pebble phosphate bed with Na_2HPO_4 was necessary before reloading with plutonium. No visible deterioration of the bed occurred during three charge-recharge cycles. If prompt elution of the plutonium-loaded bed is not practical, the column may be dissolved in four column volumes of 6N HNO_3 to recover the plutonium. (Auth) (Complete Text)

AUTHOR INDEX

Abrams, R. 1, 2

Adriano, D.C. 160

Akatsu, J. 176

Al-Bedri, M.B. 255

Ames, L.L. 427

Anderson, E.C. 3

Anderson, H.F. 313

Anderson, J.I. 309

Angel, K.C. 313

Anspaugh, L.R. 377, 384

Appleby, E.R. 85

Arnold, J.S. 44, 45, 140

Atherton, D.R. 59, 60, 110, 120, 121, 178

Au, F.H.F. 161

Audren, M.L. 266

Babcock, K.L. 171

Bahr, W. 406

Bair, J.K. 358

Bair, W.J. 4, 16, 88, 141, 142

Baisogolov, G.D. 5, 264

Ballada, J. 177

Ballou, J.E. 6, 111

Balser, D. 10

Barker, C.J. 331

Barr, N.F. 256, 310

Barron, E.S.G. 81

Barron, E.S.G., et al 143

Barth, J. 134, 192

Bartlett, J.W. 407

Baturin, G.N. 193

Baxter, D.W. 57, 95

Beatley, J.C. 200, 201

Beckert, W.F. 161

Benjamin, S.A. 275

Bennett, S. 31

Berliner, D.L. 98, 99, 116, 117

Bilkiewicz, J. 40

Blake, L.W. 155

Blanco, R.E. 425

Blane, D.E. 415

Blaylock, B.G. 135

Bliss, W.A. 314

Bloom, S.G. 273

Bloomster, C.H. 399

Boecker, B.B. 7

Boni, A.L. 160

Bootmaun, W.R. 388

Borduin, L.C. 408

Borisova, V.V. 108

Boswell, R.N. 254

Bowen, V.T. 182

Boyd, H.A. 70, 184, 185, 275

Brackenbush, L.W. 223

Bradley, W.G. 202

Brady, D.N. 315, 317

Brauer, F.B. 175

Breslin, A.J. 388

Bretthauer, E.W. 114

Brightwell, J. 8, 153, 293

Brooks, A.L. 9, 90

Brown, C.L. 223

Brown, D.A. 237

Brown, F. 385

Brown, H. 93

Bruenger, F.W. 118, 119, 120, 121, 178, 187

Buell, U. 10

Buldakov, L.A. 76, 77, 268

Bultynck, H. 387

Burger, L.L. 424

Busch, R.H. 29

Buset, K. 316

Buster, D.S. 121

Butler, E.G. 130

Cahoon, E.J. 365

Campbell, E.E. 247, 257

Carter, R.F. 8

Cason, J.E. 205

Cataldo, D.A. 162, 163, 174

Cerny, E.A. 96

Chanteur, J. 216

Chapman, L.D. 258

Chasanov, M.G. 380

Cherry, R.D. 194

Chladek, D.L. 93

Church, B.W. 315, 317

Claiborne, H.C. 409

Clark, L., Jr. 249

Clarke, W.J. 111

Cline, J.F. 175

Cochran, T.B. 307

Cochran, T.H. 46

Cohen, L.K. 191

Cole, K.S. 11, 12, 136, 147, 148, 158, 403

Coles, D.G. 303

Colvin, M.C. 13

Conche, R. 410

Corey, J.C. 160

Crawley, F.E.H. 153

Cross, F.T. 399

Cuddihy, R.G. 66, 258, 275

Dabrowski, T.E. 318

Dagle, G.D. 14, 15

Dahlman, R.C. 425

Dai Pra, G. 228

Daly, G.H. 411

Dean, P.N. 3, 259, 319

Delaney, H. 100

Denham, D.H. 320

Dilley, J.V. 16

Dillman, L.T. 321

Dillon, R.L. 412

Dockum, N.L. 17

Doher, L.W. 179

Dolphin, G.W. 386

Dougherty, J.H. 18

Dougherty, T.F. 19, 20, 21, 22, 23, 24, 47

Drake, G.A. 3

Draper, W.E. 408, 413

Drucker, H. 166, 167, 169, 170

Dugan, V.L. 258

Duggan, J.L. 358

Dunaway, P.B. 221

Duport, P. 322

Eberhardt, L.L. 326

Eggers, P.E. 210

El-Ezaby, M.S. 180

Elderkin, C.E. 232

Engstrom, D.E. 212, 323

Enomoto, S. 211

Erokhin, R.A. 25

Essington, E.H. 324, 326

Eto, K. 26

AUTHOR INDEX

Evans, F.G. 155
Evans, R.D. 260
Everts, J.M. 13
Fager, J.E. 175
Falk, R.B. 248
Faust, L.G. 223
Fearon, T. 375
Fedorova, A.V. 108
Fedorova, M.N. 54
Feinendegen, L.E. 261
Fellows, M.H. 249
Fieuw, G. 387
Finkel, M.P. 27, 28, 106
Finkle, R.D. 113
Finney, B.C. 425
Fleischer, R.L. 262
Folsom, T.R. 164
Foreman, H. 294
Forker, L.L. 2
Foster, M.S. 380
Fowler, E.B. 324, 326
Fradkin, G.Ye. 144
Franklin, R.E. 382
Franks, L.A. 357
Franz, J.A. 424
Frazier, M.E. 29
Frey, K.W. 10
Fried, S. 229
Friedman, A.M. 229
Frindik, O. 325
Fryxell, R. 183
Gabelnick, S.D. 380
Galpin, F.L. 360
Garden, N.B. 146
Garg, S.P. 362
Garland, T.R. 166, 167, 169, 170, 174
Gast, R.G. 233
Geesaman, D.P. 30, 263
George, A.C. 203
Gera, F. 409
Gerrard, M. 165
Geue, P.J. 181, 400
Gies, R.A. 6
Gilbert, R.O. 209, 326
Gimbert, J.L. 55, 149
Glauberman, H. 388
Godement, A. 338
Goldberg, E.D. 198
Goldthorpe, H.C. 31
Gomez, L.S. 14
Good, P.T. 385
Greaves, J.T. 144
Green, D. 32
Greenberg, D. 2
Greene, D. 327
Griffin, B.I. 124
Griffin, J.J. 198
Groenier, W.S. 425
Groer, P.G. 272
Gromov, V.V. 165
Gudiksen, P.H. 328
Gurney, M.E. 164, 250
Gus'kova, A.K. 264
Hahn, F.F. 275
Hamilton, J.G. 33, 34, 35, 36, 145, 146, 148, 403
Hamilton, J.G., et al 37
Hamilton, M. 374
Hammer, W.M. 155
Hanson, W.C. 253
Harley, J.H. 265
Harley, N.H. 265
Harris, S.J. 255
Hart, J.C. 329
Hart, L.J. 233
Hauschildt, W.H. 197
Hayet, L. 410
Healy, J.W. 186
Hedlund, J.D. 175
Hegelson, G.L. 330
Hendrickson, P.L. 399
Henry, H.F. 401
Herceg, J.E. 414
Hild, W. 406
Hinchliffe, L. 203
Hinckley, J.S. 83
Hinds, W.T. 175
Hirsch, G.M. 106
Hobbs, C.H. 69, 70, 71
Hodge, V.F. 164, 250
Holaday, D.A. 389
Holland, L.M. 3
Hollins, J.G. 38
Holm, E. 204
Holmes, R.H. 271
Holt, E. 121
Hornath, A.A. 61
Hornbacher, D.D. 331
Horst, T.W. 230, 231, 232
Horton, J.H. 160
Horvath, A.A. 55, 149
Howard, E.B. 88
Howells, G.R. 32
Huckaby, G. 252
Humphreys, E.R. 32
Hunt, S.E. 213
Hynie, I. 25
Ishimori, T. 176
Isler, R.J. 390
Iyer, P.S. 251
Jacobs, D.G. 172
Jacobson, L.O. 39, 136, 147, 148, 158
Jaenke, R. 15
Jakubowski, F.M. 314
Jansen, G. 238, 239
Jaquish, R.E. 344
Jaworowski, Z. 40
Jeanmaire, L. 177, 266
Jee, W.S.S. 17, 41, 42, 43, 44, 45, 46, 47, 48, 49, 122, 130, 155, 249
Jett, J.H. 319
Jockey, P. 55, 149
Johnson, C.E. 380
Johnson, L.J. 205, 267
Jones, R.K. 275
Jones, T.D. 321
Kalesperis, G.S. 57, 95
Kalmykova, Z.I. 50, 51
Kamada, H. 332
Kanapilly, G.M. 185
Kapur, D.K. 362
Karpova, V.N. 51
Katz, J. 52

Kauffman, P.E. 333
Kaye, S.V. 345
Keehan, T.K. 408
Kemper, R.S. 412
Khalturin, G.V. 268
Kibbey, A.H. 425
Kinnear, J.E. 209, 326
Kinnel, D.B. 249
Kleinman, M. 337
Klepper, E.L. 175
Kluk, A.S. 411
Knapp, W.G. 359
Kneip, T.J. 191
Knox, J.B. 305, 334, 335
Koch, J. 206
Koenig, R.A. 408
Koenst, J.W. 415
Koide, M. 198
Konstantinova, V.V. 53
Kcshurnikova, N.A. 25, 76, 77
Kownacka, L. 336
Kremer, W.A. 375
Kreslov, V.V. 128
Krey, P.W. 337
Krivolutskii, D.A. 54
Kukacka, L.E. 390
Kunzle-Lutz, M. 55, 149
Kurtz, S.T. 227
Labeyrie, L.D. 182
Lachker, J. 376
Lafuma, J. 65, 269, 295
Lambert, S.L. 414
Lamson, K.C. 303
Landa, E.R. 233
Langham, W. 270
Langham, W.H. 183
Larsen, R.P. 312
Latven, R.K. 185
Lawrence, B. 113
Lawrence, J.H. 146
Lawrence, J.N.P. 267
Leaf, A.C. 246
Lebel, J.L. 14, 15
Lee, K.D. 341
Lefeore, H. 338
Lemberg, V.K. 25, 56
Levanthal, L. 171
Lindeken, C.L. 339, 363, 369
Lindenbaum, A. 57, 93, 94, 95, 190
Linnemann, R.E. 271
Lins, W. 340
Lisco, H. 58
Liskey, R.W. 248
Lister, B.A., Jr. 308
Livingston, H.D. 182
Lloyd, F.D. 242, 243, 395, 396
Lloyd, R.D. 59, 60, 110, 296
Lohr, W. 2
London, J.E. 3
Long, A.B. 402
Lorenz, E. 136, 148
Loveless, B.L. 153
Low-Beer, B.V. 148
Low-Beer, B.V.A. 146
Lowe, M. 17, 44, 48
Lutz, M. 61
Lynch, O.D.T., Jr. 328
Lynn, J.C. 286
Lyubchanskii, E.R. 62, 63, 64
Lyubimova-Gerasimova, R.M. 79
Madelaine, G. 322
Magno, P.J. 333
Magri, G. 228
Maillie, H.D. 375
Major, D. 327
Major, W.J. 341
Maninger, R.C. 379
Marshall, J.H. 105, 272
Marshall, R.P. 195
Martin, J. 65
Martin, W.E. 273
Masse, R. 65, 68
Matlack, G.M. 236
Matthess, G. 306
Mauderly, J.L. 66, 275
Maugeri, S. 274
Maxwell, E. 183
Mays, C.W. 17, 59, 60, 67, 110, 296
McBride, J.D. 179
McClanahan, B.J. 112
McClearen, H.A. 342
McClellan, R.O. 9, 69, 72, 90, 150, 258, 275
McDowell, W.P. 359
McInroy, J.I. 257
McIntyre, D.R. 303, 363
McLain, M.E. 414
McLeod, K.W. 160
Mead, D.K. 9
Meadows, J.W. 363
Medling, E.S. 317
Meier, D.M. 102
Mellinger, P.J. 207
Mendoza, B. 303
Metevier, H. 68
Metivier, H. 55, 149
Mewhinney, J.A. 66, 69, 70, 71, 72, 184, 275
Mewissen, D.J. 73
Mical, R. 44, 46, 48
Mical, R.S. 17
Miera, F.R., Jr. 235
Miglio, J.J. 66, 69, 72, 184
Mijnheer, B.J. 343
Miller, E.R. 146
Milligan, M.F. 257
Mishima, J. 383
Mishra, U.C. 355
Moden, D.D. 344
Molemkamp, C.R. 305
Moor, K.S. 202
Moore, P.R. 391
Moore, R.E. 345
Moretti, E.S. 57, 93, 95, 96
Morgan, K.Z. 297
Morrow, W.G. 6
Moskalev, Yu.I. 74, 75, 76, 77, 78, 79, 80, 97
Moss, W.D. 247, 257
Motta, E. 100
Moyer, B. 146
Mudge, L.K. 416
Muggenburg, B.A. 72, 275
Mullins, J.W. 344
Muntz, J. 81

Mushkacheva, G.S. 128

Myers, D.S. 303

Nabors, C.J., Jr. 82, 83

Nagarajan, P.S. 251

Nauche, P. 177

Nelsen, J.J. 365

Nelson, D.M. 370

Nelson, G.B. 236

Nelson, I.C. 399

Newton, C.E., Jr. 277

Newton, G.J. 378

Nichols, C.E. 346

Nickson, J.J. 84, 136, 148, 403

Nifatov, A.P. 25, 76, 77

Nishita, H. 374

Nolibe, D. 55, 61, 65, 68, 85, 149

Nooteboom-Beckman, 2.M. 234, 392

Norwood, W.D. 276, 277

Not given 86, 137, 159, 199, 208, 224, 225, 278, 279, 280, 281, 298, 299, 300, 311, 347, 348, 349, 350, 351, 352, 353, 354, 393, 404, 405, 417

Nyhan, J.W. 235

O'Toole, J.J. 249

Oen, C.J. 214

Ohlenschlager, L. 282

Oldham, R.D. 312

Oltman, B.G. 285, 302

Orgill, M.M. 244

Painter, E.E. 87

Palotay, J.L. 112

Park, J.F. 4, 16, 88, 124

Parker, J.B. 385

Parks, J.E. 57

Parzyck, D.C. 373

Pasternack, B.S. 265

Patin, Y. 376

Patterson, J.H. 236

Patti, F. 266

Patzer, R.G. 192

Percival, D.R. 309

Perkins, R.W. 218

Persson, R.B.R. 204

Petany, G. 61

Peters, A.H., Jr. 426

Peterson, K.R. 304

Petrovich, I.K. 79, 80

Pfleger, R.C. 275

Pfuderer, H.A. 214

Phelps, P.L. 377, 384

Phemister, R.D. 14, 15

Phillipin, R. 410

Pinder, J.E. 160

Platt, A.M. 418

Podgorodetskaya, V.N. 5

Pollard, D.C. 330

Popplewell, D.S. 153, 301

Postel, S. 2

Potts, A.M. 2

Price, K.W. 316

Prosser, C.L. 11, 12

Purrott, R.J. 153, 283

Puzyrev, A.A. 25

Raabe, O.G. 66, 184, 185, 378

Radwan, I. 40

Ragan, H.A. 112

Rahman, Y.E. 96

Rangarajan, C. 355

Rannaud, J.C. 61

Rarrick, H. L. 394

Rateau, G. 68

Rehfeld, C.E. 89, 155

Reichert, J.K. 356

Reimer, A. 356

Reisenauer, A.E. 427

Relyea, J.F. 237

Renoux, A. 322

Reshetov, G.N. 76, 77

Retherford, J.C. 90

Rhoades, R. 91

Rhoads, W.A. 357

Richmond, C.R. 151, 215

Rickard, W.H. 175

Ridihalgh, J.L. 210

Ritchie, R.H. 329

Robinson, A.V. 166, 167, 238, 239

Robinson, E.L. 358

Robinson, J.J. 312

Robison, W.L. 196

Romney, E.M. 168, 173, 209, 326

Rose, J.E. 403

Rosenberry, C.E., Jr. 222

Rosenthal, M.A. 205

Rosenthal, M.W. 57, 92, 93, 94, 95, 96

Roth, S.J. 252

Rouffet, G. 410

Routson, R.C. 238, 239, 419

Rudnitskaya, E.I. 79, 97

Ruhmann, A.G. 98, 99

Rundo, J. 312

Rupprecht, F.C. 150

Rusch, G.K. 359

Russell, E.R. 87, 100

Russell, J.J. 57, 93, 95

Russell, J.L. 360

Rust, J.H. 73

Rysina, T.N. 128

Saccomanno, G. 284

Saiki, M. 332

Sanders, C.L. 101, 102

Sanders, C.L., Jr. 103

Sanders, C.T. 214

Sansom, B.F. 104

Scars, K. 48

Scheffler, K. 406

Schieferdecker, H. 282

Schlenker, R.A. 105, 272, 285, 302

Schneiderman, G.S. 169, 170

Schofield, G.B. 286

Schreckhise, R.G. 175

Schubert, J. 106

Schulte, H.F. 257

Schultz, V. 207

Schulz, R.K. 171

Schwendiman, L.C. 186

Scott, A.G. 356

Scott, K.G. 36

Seaborg, G.T. 287

Sedaghat, B. 65

Sedlet J. 312

Sehmel, G.A. 240, 241, 242, 243, 244, 361, 395, 396

Sehmel, G.A.: Lloyd, F.D. 245

Seibert, H.C. 2

Semenov, A.I. 78, 80

Semenov, D.I. 127

AUTHOR INDEX

Sevc, J. 107
Sevostiyanova, E.P. 268
Shabestari, L.R. 59
Shalmon, E. 216
Shannon, L.V. 194
Sharma, R.C. 362
Sheth, A. 380
Shubik, V.M. 108
Sigaud, J. 376
Sill, C.W. 309
Silver, W.J. 303, 363
Simmons, E.L. 39
Simon-Vermot, A. 55, 149
Simpson, O.D. 364
Sladowski, R. 203
Slauson, D.O. 66, 69, 70
Smith, B. 31
Smith, D.D. 109, 192
Smith, J.M. 110
Smith, M.H. 160
Smith, R.C. 378
Smith, V.H. 111, 112
Smithwick, G.A. 365
Snyder, R.H. 113
Snyder, W.S. 288
Soldat, J.K. 175, 320
Somasundaram, S. 362
Sorenson, F.M. 89
Scusselier, Y. 420, 421
Spalding, J.F. 152
Spitsyn, V.I. 165
Stanley, R.E. 114
Stannard, J.N. 115, 289
Starzyk, P.M. 312
Stather, J.W. 138, 153
Stevens, W. 116, 117, 118, 119, 120, 187
Stewart, G.L. 217
Stewart, K. 154
Stone, R.S. 146
Storr, M.C. 38
Stover, B.J. 49, 118, 119, 120, 121, 122, 178, 180, 187
Stradling, G.N. 153, 290
Strel'tsova, V.N. 80, 123
Stuart, B.O. 16
Sullivan, E.M. 215
Sundbeck, C.W. 339
Surendran, T. 362
Surina, A.G. 128
Sutton, W.W. 114
Swinth, K.L. 124
Tamplin, A.R. 307
Tamura, T. 366
Taube, M. 397
Taylor, G.N. 59, 60
Taysum, D.H. 155
Teague, S.V. 378
Tegge, R. 17
Terry, J.L. 132, 154
Tewes, H.A. 367
Thomas, C.W. 188, 218, 368, 381
Thomas, D.M.C. 154
Thomas, R.G. 125
Thomas, W.A. 172
Thompson, R.C. 111
Tiernan, M.W. 372
Tobias, C.A. 146
Togge, R. 48
Tokarskaya, Z.B. 133
Tombropoulos, E.G. 4
Tompkins, G.A. 171
Toussaint, C.R. 365
Toy, A.J. 339, 369
Tregubenko, I.P. 126, 127
Tseveleva, I.A. 128
Twente, J. 44
Twente, J.A. 129, 130
Tyree, W.H. 248
Ulrikson, G.U. 219
Umbarger, C.J. 413, 414
Unruh, C.M. 398
Ushakova, V.F. 144
Vanderbeek, J.W. 291
Varnadore, E.S. 329
Vaughan, B.E. 162, 163
Vaughan, J. 156
Verkerk, B. 234, 392
Voelz, H.L. 151
Volchok, H.L. 189, 220
Volf, V. 131
Wada, N. 211
Wahlgren, M.A. 370
Waite, D.A. 371
Wakakuwa, S. 374
Walkup, P.C. 416
Wallace, A. 168, 173, 209
Warner, C.L. 408, 413
Watson, D.G. 175
Watters, R.L. 14, 15, 382
Watts, L. 153
Watts, L.M. 157
Wayland, J.R. 258
Weeber, R. 229
Weinlander, W. 340
Welty, C.G., Jr. 372
Wervers, H.J. 422
Wessman, R.A. 341
Westfall, W. 190
Weymoth, P. 146
White, J.H. 339
White, M.G. 221
White, M.R. 106
Wildung, R.E. 163, 166, 167, 169, 170, 174
Wilkinson, C.J. 184, 378
Willard, D.H. 16
Willes, E.H. 363
Williams, L.D. 423
Willrich, M. 226
Wilson, J.S. 3
Wilson, R.H. 132, 154, 292
Wireman, D.L. 222
Witherspoon, J.P. 135, 373, 425
Wood, C.B. 248
Wood, R.A. 374
Woodhead, D.S. 139
Wright, S.R. 365
Yelkina, N.I. 133
Yukawa, M. 332
Zalikin, G.A. 78, 79, 80
Zhorova, E.S. 80
Zhuravleva, A.K. 268

GEOGRAPHIC LOCATION INDEX

Asia (E), Japan (C), Chiba 332

Asia (S), India 355

Asia (S), India (W), Trombay 362

Atlantic Ocean 182

Canada (C), Manitoba, Pinawa, Whiteshell Nuclear Research Establishment 356

Europe (C), Germany 340

Europe (C), Germany (E), Karlsruhe, Rhine Valley 325

Europe (N), Finland 204

Europe (NW) Norway 204

Europe (NW), Holland 422

Europe (NW), Sweden, Lake Rogen District 204

Europe (S), Italy 352

Europe (W), France (N), Fontenay-aux-Roses 410

Greenland 207

Irish Sea 139

Pacific Ocean 165

Pacific Ocean (W), Marshall Islands (SE), Bikini Atoll 195

Pacific Ocean (W), Marshall Islands (NW), Enewetak Atoll 196, 207, 328

Russia 64

Russia, Semipalatinsk Nuclear Test Area 225

United Kingdom (W), Wales (N), Lake Trawsfynydd 139

United States (C), Missouri (NW), St. Joseph 314

United States (NC), South Dakota (NE), Aberdeen 314

United States (NE), Lake Michigan 370

United States (NE), Ohio (SW), Miamisburg 189

United States (NE), Ohio (SW), Miamisburg, Mound Laboratory 313, 348, 353, 354

United States (NE), Ohio (W), Miamisburg, Great Miami River 348, 353

United States (NW), Alaska (N), Point Barrow 368

United States (NW), Alaska, Anaktuvuk Pass 175

United States (NW), Oregon (SW), Medford 314

United States (NW), Washington (E) 238

United States (NW), Washington 239

United States (NW), Washington (SE), Richland, Hanford Reservation 244

United States (NW), Washington (E), Spokane 314

United States (NW), Washington (SE), Hanford Project Area 320

United States (NW), Washington (SE), Richland 320, 368

United States (NW), Washington (SE), Pasco 320

United States (SC), Texas (C), Austin 314

United States (SE), South Carolina (SW), Aiken, Savannah River Plant 160, 391, 426

United States (SE), South Carolina 238, 239

GEOGRAPHIC LOCATION INDEX

United States (SW) California (S), Mojave Desert 201
United States (SW), California, Soledad Basin 198
United States (SW), California, Santa Barbara Basin 198
United States (SW), California, La Jolla, Scripps Pier 250
United States (SW), California (W), Livermore 303
United States (SW), California, Barstow 314
United States (SW), California (W), Livermore (SE), Site 300 353
United States (SW), California (W), Livermore, Lawrence Livermore Laboratory 363
United States (SW), California 368

United States (SW), Colorado (C), Golden, Rocky Flats 192, 197, 243, 331, 361, 396
United States (SW), Colorado (W), Grand Junction 390

United States (SW), Great Basin Desert 201
United States (SW), Nevada (E) 314

United States (SW), Nevada, Nevada Test Site, Area 13 109, 192, 202, 209, 222, 324, 326, 366
United States (SW), Nevada, Nevada Test Site 134, 168, 171, 201, 207, 221, 225, 273, 316, 317, 372, 384, 405

United States (SW), Nevada, Nevada Test Site (S) Frenchman Flat 201, 314

United States (SW), Nevada, Nevada Test Site, Area 5 202, 315
United States (SW), Nevada, Nevada Test Site, Area 11 202, 222, 324
United States (SW), Nevada, Nevada Test Site, Area 11-D 209, 357
United States (SW), Nevada, Nevada Test Site, Area 11-C 209

United States (SW), Nevada, Nevada Test Site, Area 11-B 209
United States (SW), Nevada, Nevada Test Site, Area 5, GMX Area 209, 222, 324, 326, 377

United States (SW), Nevada, Nevada Test Site (S) 314
United States (SW), Nevada, Nevada Test Site, Fortymile Canyon 314

United States (SW), Nevada, Tonopah Test Range 154, 168, 202, 209, 222, 324, 326
United States (SW), Nevada, Tonopah Test Range, Roller Coaster Site 192

United States (SW), New Mexico, Los Alamos 151
United States (SW), New Mexico (W), Grants 203
United States (SW), New Mexico, Los Alamos 205, 215
United States (SW), New Mexico, Alamogordo, Trinity Site 235
United States (SW), New Mexico, Los Alamos, Los Alamos Scientific Laboratory 253, 413
United States (SW), New Mexico (C), Albuquerque 314
United States (SW), New Mexico 409

United States (SW), Utah 314
United States (SW), Utah (NC), Provo 314
United States (W) 200
United States(NW), Washington (SE), Richland, Hanford Reservation 419

ABERRATIONS 13, 86, 151, 215, 299

ABSORPTION 1, 2, 8, 13, 33, 34, 52, 100, 112, 113, 126, 131, 136, 138, 143, 165, 192, 246, 256, 274, 292, 333, 375, 403

ACCIDENTS 185, 206, 207, 243, 269, 271, 275, 282, 283, 286, 299, 303, 307, 383, 409

ACCIDENTS, POTENTIAL 404

ACCUMULATION 15, 16, 44, 78, 135, 159, 165, 174, 198, 257, 258, 299, 419

ACCURACY 288, 327

ACIDS 137, 144

ACTINIDES 194, 297, 360, 380, 412

ACTINIUM 227 194

ACTINIUM 228 188, 194

ACTINIUM 41 281

ADRENAL GLANDS 86, 143

ADRENALINE 127

ADSORPTION 165, 217, 237, 403, 427

AEROSOLS 1, 2, 4, 8, 16, 34, 65, 66, 68, 69, 70, 71, 72, 84, 88, 103, 124, 125, 136, 138, 143, 148, 150, 153, 162, 163, 184, 185, 198, 203, 215, 244, 263, 305, 322, 371, 378, 403

AGE 63, 73, 86, 89, 122, 228, 298

AGING 86

AGRICULTURE 365

AIR 142, 160, 201, 203, 206, 212, 215, 216, 218, 220, 224, 230, 265, 275, 281, 307, 314, 318, 322, 329, 331, 337, 344, 345, 346, 348, 349, 351, 352, 353, 354, 355, 356, 361, 368, 369, 371, 384, 387, 388, 389, 393, 397, 405, 417

AIRCRAFT 206, 207

ALBUMINS 81, 84, 118, 119

ALGAE 135, 151, 164, 165, 215

ALPHA PARTICLES 30, 44, 50, 67, 107, 115, 122, 129, 132, 138, 153, 176, 177, 186, 188, 194, 195, 250, 255, 260, 263, 265, 271, 282, 283, 290, 294, 296, 307, 325, 331, 338, 358, 379, 397, 399, 406, 416, 418, 420

ALTITUDE 201, 361

AMERICIUM 86, 146, 177, 185, 250, 290, 294, 301, 362, 381, 382, 384, 386

AMERICIUM CHLORIDES 97

AMERICIUM CITRATES 9

AMERICIUM NITRATES 295

AMERICIUM OXIDES 70, 246

AMERICIUM 241 9, 19, 43, 51, 59, 60, 70, 79, 83, 97, 115, 153, 168, 171, 173, 188, 189, 194, 195, 196, 209, 211, 218, 232, 238, 239, 246, 248, 252, 255, 256, 258, 275, 281, 287, 295, 310, 315, 319, 323, 326, 338, 341, 345, 358, 368, 373, 378, 422, 425

AMERICIUM 242 422

AMERICIUM 243 188, 422

AMINES 128, 178

AMINO ACIDS 215

ANDROGINS 19

ANEMIA 39, 86

ANIMALS 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 136, 137, 137, 138, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 184, 190, 192, 202, 204, 205, 205, 206, 215, 249, 254, 258, 264, 273, 285, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 304, 307, 311, 319, 324, 341, 351, 363, 365, 389, 399, 401, 402, 403

ANIMALS, SMALL 212, 222

ANTIBODIES 86, 108, 137

ANTIMONY 74

ANTIMONY 122 320

ANTIMONY 124 150

AQUATIC ORGANISMS 135, 175, 191, 348

AQUATIC SYSTEMS 405

ARSENIC 74 152, 215

ARSENIC 76 281, 320

ARTHROPODS 54

ASHING 183, 325, 341

ASHING, WET 374

ASTATINE 211 145, 281

AUTOPSIES 257, 277

BABOONS 55, 85, 142, 149, 293

BACKGROUND 252, 329, 342, 362, 369

BACTERIA 137, 151, 165, 167, 170, 215, 233

BADGERS 202

BAL 146

BARIUM 74, 146

BARIUM 137 281

BARIUM 140 123, 159, 220, 281

BARLEY 168, 171, 175

BEACHES 328

BEANS 162, 163, 172, 173

BEANS, BUSH 173

BEES 205, 215

BEHAVIOR 207

BERKELIUM 386

BERYLLIUM 280, 363

BERYLLIUM 7 220, 244, 281

BETA PARTICLES 76, 159, 271, 294, 307, 321, 331, 355, 363, 379

BIBLIOGRAPHY 181, 199, 380, 389, 400

BINDING 119, 187, 190, 301

BIOASSAY 247, 399

BIOCHEMISTRY 137, 159

BIOINDICATORS 215

BIOLOGICAL FLUIDS 134

BIOLOGICAL HALF-LIFE 1, 2, 35, 37, 60, 62, 63, 84, 88, 106, 270, 274, 319

BIOLOGICAL MATERIALS 178, 325

BIOLOGICAL STRESS 39, 61, 86, 133, 150, 152, 155, 215, 264, 294

BIOLOGICAL TRANSPORT 74, 138, 153, 160, 161, 165, 167, 168, 220, 273, 301

BIOSYNTHESIS 19, 107, 137, 151

BIRDS 175, 202, 207, 320

BISMUTH 207 195

BISMUTH 211 194

BISMUTH 212 194, 194

BISMUTH 214 322

BLOOD 5, 10, 12, 18, 19, 22, 26, 38, 39, 50, 57, 62, 75, 80, 84, 86, 102, 106, 108, 111, 112, 120, 123, 136, 137, 140, 142, 147, 150, 152, 158, 159, 266, 268, 269, 270, 277, 281, 283, 292, 333, 344

BLOOD CELLS 5, 18, 97, 100, 119, 137

BLOOD CELLS, RED 5, 26, 39, 87, 91, 143

BLOOD CELLS, WHITE 5, 26, 39, 87, 143, 151, 215

BLOOD PLASMA 57, 81, 82, 100, 118, 119

BLOOD SERUM 19, 22, 31, 98, 99, 117, 133, 187, 301

BLOOD VESSELS 45, 46, 48, 84, 86

BODY 124, 196, 202, 213, 268, 273,

KEYWORD INDEX

BODY 278, 345, 362, 372, 373, 397

BODY BURDEN 4, 16, 71, 85, 88, 90, 94, 103, 124, 141, 215, 220, 257, 275, 277, 281, 282, 283, 288, 292, 330

BONE FRACTURES 45, 260

BONE MARROW 5, 19, 73, 84, 88, 94, 108, 114, 120, 120, 129, 137, 140, 152, 249

BONE REMODELING 42, 45, 48

BONES 1, 2, 4, 7, 8, 10, 11, 12, 16, 17, 18, 19, 20, 21, 22, 23, 27, 29, 32, 33, 34, 37, 38, 41, 42, 43, 44, 45, 46, 47, 48, 49, 52, 56, 59, 60, 62, 63, 64, 67, 69, 72, 74, 76, 78, 79, 84, 86, 88, 93, 94, 95, 96, 102, 103, 105, 106, 110, 111, 114, 115, 120, 121, 122, 126, 127, 129, 130, 131, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 156, 158, 192, 194, 196, 204, 215, 220, 249, 256, 257, 260, 266, 268, 270, 272, 273, 277, 278, 281, 285, 287, 296, 297, 298, 299, 302, 303, 310, 321, 355, 373, 397, 399, 403, 425

BRAVO EVENT 195

BUILDINGS 390

BURDEN 66, 69, 70, 110, 273

BURIAL 318, 406, 407, 411, 417, 418, 420, 421

BURNING 408

CADMIUM 280

CADMIUM 109 220, 281

CALCIUM 26, 31, 34, 74, 122, 220

CALCIUM DTPA 294

CALCIUM EDTA 36, 294

CALCIUM NITRATE 239

CALCIUM 45 140, 156, 281

CALCULATIONS 26, 67, 230, 252, 278, 288, 291, 319, 345, 360, 367, 425

CALGON 1

CALIBRATION 179, 246

CALIFORNIUM 386

CALIFORNIUM 252 80, 150, 211, 251, 287, 321, 327, 343

CARBOHYDRATES 23, 31, 128

CARBON DIOXIDE 169

CARBON 13 151

CARBON 14 83, 107, 139, 196, 220, 281, 381

CARCINOGENESIS 30, 73, 75, 86, 137, 260, 263, 289, 298, 299, 307, 311, 392

CARCINOMAS 30, 41, 260, 284, 295, 307

CARCINOMAS, ADENO 73, 103

CARRIERS 92

CARTILAGE 46, 140

CASE HISTORIES 292

CATTLE 75, 114, 119, 134, 192, 273, 304, 341

CATTLE, DAIRY 104

CATTLE, RANGE 109

CELLS, ALVEOLAR 4, 16, 61, 65, 141, 263

CELLS, BIOLOGICAL 22, 44, 45, 48, 57, 96, 128, 137, 151, 161, 215, 265

CELLS, CULTURED 29, 153, 301

CELLS, EPITHELIAL 141

CELLS, HELA 153, 301

CELLS, LYMPH 141

CENSUS 202

CERIUM 300

CERIUM 141 220, 422

CERIUM 144 4, 74, 76, 77, 127, 150, 220, 349

CESIUM 26, 309

CESIUM 134 135, 422

CESIUM 135 381

CESIUM 137 74, 75, 123, 135, 137, 150, 151, 152, 175, 195, 196, 207, 215, 218, 220, 278, 281, 293, 304, 319, 328, 349, 352, 355, 370, 381, 387, 419

CESIUM 144 40, 123, 281

CHARACTERIZATION 205

CHELATES 1, 2, 4, 36, 57, 74, 86, 95, 96, 102, 127, 131, 131, 138, 144, 144, 153, 167, 169, 170, 173, 269, 276, 286, 294, 300, 397

CHELATION 75, 276, 282, 294, 300, 301

CHEMICAL ANALYSIS 177, 257, 308, 309, 324, 333, 341, 348, 349, 350, 397, 403

CHEMICAL FORM 164, 165, 166, 167, 170, 268, 382

CHEMICAL PROPERTIES 7, 235, 268, 380, 383, 398, 424

CHEMICAL TOXICITY 115, 306

CHEMICALS 415, 424

CHEMISTRY 181, 301

CHEST 362

CHICKENS 86, 137

CHILDREN 298

CHINCHILLAS 21

CHINESE 13

CHLORINE 36 281

CHROMATOGRAPHY 83, 151, 166, 167

CHROMIUM 306

CHROMIUM 51 71, 90, 125, 150, 184, 281, 320

CHROMOSOMES 9, 13, 86, 137, 151, 153, 215, 283, 299

CIRRHOSIS 77, 133

CITRATES 2, 153, 301

CITRIC ACID 366

CLAYS 217

CLEAN SLATE 1 222, 326

CLEAN SLATE 2 154, 202, 222, 326

CLEAN SLATE 3 222, 326

CLEARANCE 10, 14, 62, 95, 96, 120, 142, 153, 154, 157, 263, 274, 279

CLIMATE 201, 213

CLINICAL STUDIES 267, 270, 272, 282, 309, 358

CLOUDS 336

CLOUDS, RADIOACTIVE 335

COAGULATION 415

COAL 224

COBALT 57 3, 151, 220

COBALT 58 220

COBALT 60 86, 137, 150, 151, 195, 196, 207, 281, 328, 330, 381, 419

COLLAGEN 107

COLLOIDS 92, 107, 190

COMMUNITIES 175, 201

COMPLEXES 144

COMPUTER PROGRAMS 151, 215, 288, 319, 323, 345, 385, 417

CONCENTRATION 191, 204, 205, 320, 356, 412

CONCENTRATION FACTOR 134, 140, 161, 168, 173, 175, 205, 382

CONCENTRATION RATIO 162, 171, 174, 209, 303

CONNECTIVE TISSUE 137, 156

CONTAINERS 406

CONTAINMENT 409

CONTAMINATION 55, 109, 134, 159, 202, 205, 209, 218, 266, 269, 271, 274, 276, 282, 286, 294, 307, 308, 309, 313, 318, 320, 326, 328, 330, 342, 345, 351, 352, 355, 369, 373, 388, 394, 396, 403, 405, 409

CONTENT 10, 12, 36, 40, 50, 60, 62, 63, 76, 82, 95, 100, 104, 106, 116, 122, 129, 130, 136, 143, 148, 158, 160, 171, 179, 183, 189, 190, 191, 193, 194, 195, 196, 205, 218, 235, 257, 266, 270, 273, 278, 302, 306, 312, 318, 333, 336, 342, 366,

CONTENT 368, 370, 378, 381

CONTROL 179, 313, 324, 385, 400, 417, 426

COPPER 306

COPPER 64 281, 320

CORALS 194, 195, 228

CORN 173

CORROSION 417

CORTISOL 82, 83

CORTISONE 83

COST-BENEFIT 210, 254, 399, 425

COUGARS 202

COYOTES 192, 202

CRATERS 195, 213

CREOSOTE BUSH 209

CRITICAL ORGANS 26, 115, 274, 278, 297

CRITICALITY 223

CROPS 244, 314

CULTURE MEDIA 165

CUPFERRON 2

CURIUM 135, 146, 177, 290, 301, 360, 381, 382

CURIUM 242 153, 172, 194, 232, 256, 258, 281, 310, 374, 422

CURIUM 243 422

CURIUM 244 78, 115, 194, 210, 211, 232, 256, 258, 295, 310, 345, 422

CYTOLOGY 284, 399

DATING 228

DEBRIS 394

DECAY PRODUCTS 356, 379, 390

DECAY, ALPHA 310

DECAY, ALPHA: MODELS, MATHEMATICAL 262

DECAY, RADIOACITVE 379

DECAY, RADIOACTIVE 220

DECONTAMINATION 6, 11, 14, 33, 34, 36, 51, 64, 74, 75, 92, 93, 95, 96, 144, 146, 153, 206, 269, 276, 282, 293, 294, 300, 301, 320, 351, 360, 390, 391, 398, 406, 412, 418, 420

DEHYDROGENASES 22, 98, 99

DEPOSITION 1, 2, 7, 8, 11, 17, 19, 32, 33, 34, 37, 44, 45, 46, 48, 52, 58, 59, 60, 62, 63, 67, 71, 75, 78, 84, 88, 101, 103, 105, 106, 114, 117, 120, 121, 125, 127, 129, 138, 140, 141, 143, 145, 146, 148, 152, 162, 163, 164, 204, 215, 218, 230, 255, 258, 260, 265, 277, 278, 279, 292, 303, 304, 305, 335, 342, 345, 349, 365, 371

DEPTH 105, 328

DESERTS 201, 221

DESIGN 113, 179, 210, 223, 242, 248, 338, 340, 346, 393, 398, 408, 417

DETECTION 153, 250

DIAGNOSIS 151, 215, 264, 287, 300

DIET 34, 75, 89, 104, 109, 220, 273

DIFFUSION 106, 237, 356, 419

DISEASES 39, 47, 69, 70, 77, 86, 89, 97, 133, 137, 151, 156, 215, 274, 293

DISPERSION 229, 417

DISTRIBUTION 1, 2, 4, 16, 18, 35, 36, 42, 46, 47, 49, 66, 71, 72, 75, 81, 84, 90, 94, 95, 102, 110, 118, 120, 123, 124, 130, 151, 159, 160, 164, 171, 173, 182, 190, 192, 194, 195, 203, 204, 215, 220, 235, 238, 239, 258, 270, 274, 292, 302, 304, 305, 314, 328, 369, 371, 375, 378

DISTRIBUTION, GEOGRAPHIC 243

DIURETICS 127

DNA 137, 151, 215

DOGS 4, 5, 12, 19, 20, 21, 24, 31, 41, 56, 57, 68, 74, 75, 79, 81, 84, 87, 97, 100, 123, 124, 129, 130, 132, 133, 140, 142, 152, 154, 215, 293, 296, 307

DOGS, BEAGLE 14, 15, 16, 17, 18, 22, 23, 29, 30, 42, 43, 44, 45, 46, 47, 48, 49, 59, 60, 72, 82, 83, 86, 88, 89, 95, 98, 99, 105, 116, 117, 118, 119, 120, 121, 122, 137, 141, 142, 150, 151, 156, 157, 215, 249, 285, 302, 307

DOGS, BEAGLE, BONES 155

DOGS, BEAGLES 67

DONKEYS 132, 154

DOSE DEPENDENCE 153, 283, 289

DOSE RATE 17, 18, 40, 67, 86, 129, 130, 139, 152, 215, 220, 223, 251, 255, 256, 260, 265, 273, 287, 293, 296, 297, 298, 304, 307, 372, 375

DOSIMETERS 137, 339, 343, 357

DOUBLE TRACK 154, 202, 209, 222, 326

DRAINAGE 314

DRINKING WATER 220, 320, 352, 353, 397

DRUGS 51, 64, 86, 151

DTPA 4, 6, 14, 57, 93, 94, 95, 96, 102, 111, 131, 137, 138, 153, 167, 169, 170, 173, 266, 269, 275, 276, 282, 286, 290, 301

DUST 55, 107, 154, 198, 234, 279, 303, 377, 384, 388

DUST, AIRBORNE 240, 332

EARS 41

ECONOMICS 309, 390, 420, 424

ECOSYSTEM ANALYSIS 363

EDTA 74, 127, 397

EFFICIENCY 55, 124, 346, 362

EFFLUENTS 135, 139, 224, 250, 258, 318, 329, 331, 360, 363, 364, 372, 426

EGGS 348

EINSTEINIUM 386

ELECTRICITY 226

ELECTRODEPOSITION 186, 188, 324

ELECTRON MICROSCOPY 61, 137, 378

ELECTROPHORESIS 81, 118, 159, 166, 167

ELECTROSTATIC PRECIPITATORS 405

EMBRYOS 137

EMERGENCIES 394, 398

EMULSIONS 186

ENDOCRINE GLANDS 22, 123

ENRICHMENT 135

ENVIRONMENT 175, 182, 208, 212, 214, 219, 221, 224, 253, 254, 257, 258, 299, 318, 329, 350, 353, 355, 360, 363, 425

ENZYMES 19, 22, 51, 53, 98, 116, 117, 133, 137, 151

EPIDEMIOLOGY 399

EQUATIONS 196, 217, 278, 282, 288, 336

EQUATIONS, DERIVED 67, 180, 385

EQUILIBRIUM 191

EQUIPMENT 364, 417, 426

EROSION 356, 366

EUROPIUM 154 281

EUROPIUM 155 195

EVALUATION 144, 192, 247, 248, 252, 254, 266, 280, 286, 297, 300, 305, 308, 315, 322, 392

EVAPORATION 176

EXCRETION 2, 3, 4, 7, 10, 11, 16, 33, 34, 35, 36, 51, 52, 57, 59, 60, 63, 75, 84, 87, 93, 95, 100, 102, 104, 111, 112, 126, 127, 132, 136, 138, 141, 143, 145, 147, 148, 151, 152, 153, 178, 183, 192, 215, 266, 270, 274, 275, 278, 278, 282, 286, 288, 290, 292, 293, 294, 300, 309, 312, 371

EXHAUST GASES 331

EXPERIMENTAL STUDIES 217, 376

EXPLOSIONS, NUCLEAR 195, 218, 299, 305, 336

EXPLOSIONS, NUCLEAR, ATMOSPHERIC 304

EXPLOSIONS, NUCLEAR, CHINESE 368

EXPLOSIONS, NUCLEAR, SOVIET 225

EXPLOSIONS, NUCLEAR, UNDERGROUND 208, 225, 227, 334, 367

EXPOSURE, ACUTE 75, 97

EXPOSURE, CHRONIC 26, 75, 78, 97, 151, 273, 401

EXPOSURE, EXTERNAL 152, 269, 271

EXPOSURE, INTERNAL 114, 150, 152, 155, 232, 256, 260, 271, 298, 300, 307

EXPOSURE, OCCUPATIONAL 11, 136, 143, 147, 158, 159, 203, 215, 257, 260, 275, 277, 283, 292, 299, 307, 330, 387, 388, 389, 399, 402

EXPOSURE, POPULATION 215, 256, 299, 329, 345, 360, 368, 372, 373, 386, 387, 404

EXTRACTION METHODS 176, 178, 180, 183, 350, 374

EYES 43, 281

FABRICATION PLANTS 373

FABRICATION PLANTS, NUCLEAR 382, 425

FABRICATION, FUEL ELEMENT 135

FALLOUT 160, 182, 198, 204, 207, 209, 215, 220, 235, 252, 257, 274, 304, 307, 328, 334, 335, 336, 349, 352, 355, 367, 370, 404

FASTING 102

FATS 137, 277, 281

FAULTS 409

FECES 8, 11, 12, 16, 52, 57, 63, 84, 87, 93, 95, 100, 102, 104, 112, 120, 126, 136, 141, 143, 148, 157, 177, 183, 266, 269, 270, 275, 276, 278, 282, 308, 309, 312

FERMIUM 386

FERTILITY 139

FERTILIZERS 303

FETUSES 29, 52, 114

FIDLER 317, 357

FIELD STUDIES 160, 164, 175, 192, 198, 203, 204, 220, 235, 240, 242, 243, 244, 245, 320, 328, 348

FILTERS 177, 215, 275, 313, 363, 393, 397, 405

FILTERS, HEPA 360

FINGERS 276

FIRES 244, 307, 405

FISH 26, 135, 137, 139, 191, 194, 196, 213, 298, 320, 352, 353, 426

FISSION 299, 367, 376, 379, 407

FISSION PRODUCTS 75, 84, 159, 218, 304, 332, 356, 363, 376, 381, 394, 420

FISSION TRACK ANALYSIS 249, 343

FLIES 86

FLOW COUNTERS 319

FLUORESCENCE 287, 358

FLUORINE 18 281

FOOD 153, 159, 273, 304, 320, 325, 333, 345, 352, 353, 355

FOOD CHAINS 172, 194, 196, 204, 274, 304, 310, 368

FORAGING 109, 134, 192, 304

FORBES 109

FORESTS 175, 220

FOXES 192, 202

FRACTIONATION 217, 404

FRESHWATER SYSTEMS 139, 175, 220, 426

FRUIT 314

FUEL ELEMENTS 213, 216, 226, 373, 380, 382, 412

FUELS, FOSSIL 224

FUNGI 161, 166, 167, 169, 170

FUSION, NUCLEAR 367

GADOLINIUM 152 194

GALL BLADDER 84

GALLIUM 72 281

GASES 394

GASTROINTESTINAL TRACT 1, 33, 52, 62, 73, 75, 102, 114, 123, 126, 134, 192, 202, 204, 256, 273, 320, 321, 333, 403

GAVAGE 8, 114

GENETICS 26, 86, 115, 135, 137, 139, 151, 200, 215, 216, 258, 283, 298, 299, 310, 399, 401

GEOCHEMISTRY 182

GEOLOGIC STRUCTURES 227, 421, 422

GEOLOGY 227, 420, 422

GERMANIUM 71 281

GLASS 177

GLOBULINS 31, 81, 84, 119

GLOVE BOXES 176, 313, 343, 378, 393, 397, 398, 405, 406

GLUCAN 57, 93, 95

GOATS 109, 192

GOLD 198 281

GOLD 199 281

GOLDFISH 159

GONADS 26, 110, 115, 256, 257, GONADS 310, 321

GOPHERS 202

GRANITES 420

GRASSES 109, 172, 175, 192, 205, 348, 353, 368, 387

GRASSES, GALLETA 109

GRASSES, INDIAN RICE 109

GROUNDWATER 306, 409, 419

GROWTH 167

GUINEA PIGS 74, 159

HAFNIUM 174 194

HAIR 40, 202

HAMSTERS 9, 13, 69, 70, 71, 86, 90, 125, 137, 138, 150, 152, 184, 293

HANDLING 197, 210

HANDS 159, 267, 269, 291, 343

HAZARD ANALYSIS 68, 115, 136, 142, 159, 213, 215, 220, 232, 246, 258, 263, 273, 274, 280, 305, 311, 340, 351, 360, 371, 382, 383, 387, 389, 392, 394, 397, 399, 401, 405, 418, 420

HEAD 62

HEALTH PHYSICS 159, 220, 255, 273, 311, 313, 339, 399

HEART 97, 137

HEAT 211, 213, 223

HEAT SOURCES 340

HEIGHT 243, 245, 396

HEMATOLOGY 18, 39, 43

HEMATOPOIETIC SYSTEM 86, 91, 123, 137, 151, 152, 215, 292

HEMOGLOBINS 39, 119, 143

HISTOLOGY 15, 17, 27, 42, 47, 48, 49, 56, 91, 122, 129, 159

HOLMIUM 166 281

HORMONES 23, 137

HOT PARTICLES 115, 220, 307

HOT SPOTS 311, 334

HYDROGEN 191

HYDROLOGY 217

HYDROXYPROLINE 128

IMMUNE RESPONSE 86, 108, 298, 299

IMPACTION 378

INFORMATION 212, 214, 219, 222

INGESTION 7, 33, 52, 75, 108, 112, 144, 158, 192, 196, 204, 256, 258, 260, 273, 276, 278, 300, 303, 310, 345, 373

INHALATION 2, 3, 4, 6, 7, 8, 16, 29, 34, 35, 50, 52, 55, 61, 62, 64, 66, 68, 69, 70, 72, 74, 75,

KEYWORD INDEX

INHALATION 85, 88, 101, 103, 125, 126, 128, 132, 141, 142, 143, 149, 150, 151, 152, 153, 154, 157, 215, 232, 256, 258, 273, 275, 276, 277, 278, 283, 286, 292, 293, 295, 300, 303, 307, 309, 310, 345, 371, 399, 402, 403

INJECTION 3, 17, 19, 20, 21, 22, 23, 29, 31, 33, 41, 42, 105, 111, 116, 121, 123, 129, 130, 151, 190, 260, 292, 302

INJECTION, INTRAMUSCULAR 35, 37, 52, 81, 87, 100, 125, 131, 145, 146, 312

INJECTION, INTRAPERITONEAL 32, 39, 53, 63, 96, 101, 102, 103, 110, 143, 144, 215

INJECTION, INTRAPLEURAL 101, 103

INJECTION, INTRAPULMONARY 52

INJECTION, INTRATRACHEAL 25, 51, 75, 103, 138, 143

INJECTION, INTRAVENOUS 5, 9, 10, 12, 16, 18, 24, 27, 32, 38, 39, 43, 44, 45, 46, 47, 48, 49, 56, 57, 59, 60, 80, 81, 83, 84, 87, 90, 91, 93, 94, 95, 96, 98, 100, 106, 107, 108, 113, 117, 118, 120, 133, 138, 140, 142, 143, 148, 152, 215, 215, 249, 270, 272, 286, 312

INJECTION, SUBCUTANEOUS 14, 15, 52, 73, 78, 276

INJURIES 58, 79, 86, 152, 215, 282, 294

INSECTS 54, 205, 298

INSTRUMENTS 68, 203, 215, 236, 246, 250, 309, 313, 316, 317, 322, 323, 332, 338, 346, 359, 371, 400, 414

INTESTINES 112, 114

INTUBATION 101, 153

INVERTEBRATES 135, 194, 196

IODINE 26, 146, 299, 309, 358

IODINE 127 175

IODINE 129 175, 196, 216, 373, 381, 407, 418

IODINE 131 207, 220, 278, 280, 281, 320, 360, 368, 387

ION EXCHANGE 118, 427

ION FISSION PRODUCTS 213

IONIZATION CHAMBERS 327

IONS 165

IRIDIUM 190 281

IRIDIUM 192 281

IRON 153, 173, 187

IRON 55 182, 196, 220, 281, 381

IRON 59 281

ISOTOPE RATIO 168, 198, 275

KELP 164

KIDNEYS 1, 10, 13, 19, 31, 33, 37, 38, 46, 52, 60, 73, 74, 78, 79, 86, 97, 102, 114, 131, 137, 138, 143, 144, 159, 256, 257, 268, 269, 273, 277, 281, 373, 425

KINETICS 14, 75, 78, 181, 376

KRYPTON 421

KRYPTON 85 216, 310, 360

LABORATORIES 253, 323, 348, 351, 354, 365, 369, 406, 415

LABORATORY STUDIES 2, 3, 5, 6, 7, 8, 10, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 31, 32, 33, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 56, 57, 58, 59, 60, 61, 62, 63, 64, 66, 68, 69, 70, 72, 73, 74, 75, 78, 80, 81, 82, 84, 85, 86, 87, 88, 89, 91, 92, 94, 95, 96, 97, 98, 100, 101, 106, 107, 108, 110, 113, 116, 120, 121, 128, 129, 130, 131, 133, 137, 142, 143, 144, 150, 151, 152, 153, 155, 159, 162, 163, 164, 167, 168, 171, 174, 178, 180, 183, 215, 229, 233, 237, 238, 241, 246, 249, 255, 277, 290, 303, 313, 322, 403, 415

LACTATION 34

LAKES 139, 220, 370

LAND 216

LANTHANUM 74

LANTHANUM 140 123, 146, 159, 281

LATENT EFFECTS 23

LATEX BEADS 103

LEACHING 163, 366, 409, 419, 424

LEAD 280, 349

LEAD 203 281

LEAD 210 40, 139, 198, 220, 399

LEAD 211 194

LEAD 212 194

LEAD 214 322

LEAKAGE 313, 405

LEAVES 162, 163, 172, 173, 174, 175

LEGAL ASPECTS 226

LET 283, 375

LETHAL DOSE 53, 76

LETHAL DOSE 50 27, 84, 86, 137, 152, 215, 295

LEUKEMIA 73, 77, 79, 86, 123, 298, 299

LICHENS 204

LIFE-SPAN 70

LIFESPAN 69

LIGHTNING 316

LIPIDS 96, 128, 143

LIQUIDS 338, 364, 419

LITTER 175

LIVER 1, 2, 4, 8, 9, 10, 11, 12, 16, 19, 23, 31, 32, 33, 37, 38, 43, 46, 52, 53, 57, 59, 60, 62, 63, 64, 69, 72, 73, 74, 76, 77, 78, 79, 84, 86, 88, 90, 93, 95, 96, 97, 102, 106, 107, 108, 110, 111, 113, 114, 115, 117, 120, 123, 126, 127, 131, 133, 137, 138, 139, 141, 142, 143, 144, 146, 147, 150, 153, 159, 192, 204, 256, 257, 268, 270, 273, 277, 281, 299, 301, 303, 306, 310, 321, 373, 403, 425

LIZARDS 202

LUNGS 1, 2, 4, 7, 8, 13, 16, 25, 30, 34, 35, 37, 46, 50, 55, 58, 61, 62, 64, 65, 66, 69, 70, 71, 72, 73, 74, 85, 88, 101, 102, 115, 126, 128, 136, 138, 141, 142, 143, 148, 149, 150, 151, 152, 153, 154, 157, 192, 215, 256, 257, 259, 262, 263, 265, 273, 275, 277, 278, 279, 281, 284, 293, 297, 298, 299, 303, 307, 310, 311, 319, 321, 330, 362, 371, 373, 397, 399, 402, 425

LUTETIUM 177 281

LYMPH NODES 4, 14, 15, 16, 29, 72, 84, 88, 91, 101, 141, 142, 257, 273, 277, 278, 297, 299

LYMPH SYSTEM 19, 402

LYMPHOCYTES 153, 283

LYMPHOPENIA 88, 141

LYSOSOMES 153

MACROPHAGES 15, 61, 120, 129, 140, 141, 275, 293

MAMMALS 39, 145, 152, 154, 298, 300

MAMMALS, MARINE 194

MAMMALS, SMALL 202

MAMMARY GLANDS 103, 123, 137, 298

MAN 23, 86, 136, 140, 142, 143, 147, 148, 151, 152, 153, 154, 156, 157, 159, 175, 177, 186, 187, 196, 213, 215, 216, 220, 247, 248, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 296, 297, 298, 299, 300, 301, 302, 304, 305, 306, 307, 308, 309, 310, 311, 312, 319, 320, 321, 330, 333, 343, 351, 361, 362, 368, 371, 372, 386, 389, 394, 397, 398, 399, 401, 402, 404, 417, 425

MANGANESE 54 220, 381

MANGANESE 56 281

MARINE ORGANISMS 194, 220

MARINE SEDIMENTS 182, 198

MARINE SYSTEMS 139, 164, 182, 196, 220, 250

KEYWORD INDEX

MATHEMATICS 288, 369

MAXIMUM PERMISSIBLE BODY BURDEN 213, 291, 297, 330, 386, 397, 402

MAXIMUM PERMISSIBLE CONCENTRATION 115, 265, 280, 281, 306, 307, 322, 360, 361, 386, 397, 402

MAXIMUM PERMISSIBLE DOSE 255, 273, 307, 387

MAXIMUM PERMISSIBLE VALUE 387

MEAN RESIDENCE TIME 370

MEASUREMENT 10, 50, 60, 62, 63, 82, 116, 129, 130, 143, 157, 179, 183, 186, 188, 189, 199, 203, 206, 218, 220, 239, 246, 250, 252, 259, 267, 290, 292, 315, 317, 318, 322, 323, 325, 330, 333, 338, 339, 342, 343, 344, 346, 357, 360, 364, 366, 369, 371, 374, 378, 400, 406

MEATS 304, 320, 352

MEDICAL MANAGEMENT 271, 397

MEDICINE 261, 329

MERCURY 306, 309

METABOLISM 2, 19, 31, 33, 52, 53, 59, 83, 86, 110, 113, 136, 137, 138, 150, 151, 152, 159, 191, 215, 220, 300, 309

METALS 306, 363

METAPLASIA 284, 295

METASTASIS 29

METEORITES 409

METEOROLOGY 159, 201, 220, 224, 316, 345, 356, 384, 396

METHODS 24, 66, 71, 110, 113, 125, 177, 183, 184, 185, 186, 188, 203, 204, 220, 236, 246, 246, 247, 249, 250, 285, 290, 308, 315, 316, 317, 321, 323, 327, 341, 344, 374, 391, 400, 403, 418, 426

MICE 27, 28, 32, 39, 52, 73, 74, 84, 86, 91, 93, 94, 96, 107, 110, 136, 137, 138, 140, 143, 146, 147, 150, 151, 158, 159, 190, 296, 403

MICE, CACTUS 202

MICE, CANYON 202

MICE, DEER 202

MICE, GRASSHOPPER 202

MICE, KANGAROO 202

MICE, POCKET 202

MICROORGANISMS 161

MICROSPHERES 151, 152, 215

MILK 28, 86, 104, 220, 304, 320, 333, 344, 348, 349, 352, 353, 355, 368, 387

MILLING 135, 373

MINERALS 122, 217

MINING 135, 203, 284, 322, 389,

MINING 399

MITOCHONDRIA 137

MITOSIS 137, 151, 215

MODELS 139, 157, 220, 255, 265, 279, 299, 304, 305, 321, 335, 336, 342, 345, 367, 373, 384, 399, 402, 417, 418, 423, 425

MODELS, MATHEMATICAL 38, 135, 139, 227, 231, 232, 258, 259, 263, 272, 273, 377

MOISTURE 344

MOLLUSKS 194, 352

MOLYBDENUM 245, 309

MOLYBDENUM 99 281

MONITORING 136, 146, 147, 158, 159, 224, 309, 331, 338, 346, 354, 355, 356, 359, 364, 365, 372, 387, 393, 394, 403, 405, 419

MONKEYS 68, 151, 152, 215

MONOMERS 57, 94, 105, 187

MORPHOLOGY 200, 235

MORTALITY 11, 69, 70, 86, 89, 141

MOSSES 204

MUSCLES 4, 10, 29, 62, 63, 114, 137, 192, 194, 196, 207, 277, 281

MUTATIONS 135, 299, 307

NATURAL GAS 344

NEODYMIUM 144 194

NEOPLASMS 18, 19, 43, 44, 79, 83, 86, 86, 97, 101, 129, 141, 151, 152, 215, 258, 277

NEOPLASMS, BENIGN 25

NEOPLASMS, MALIGNANT 17, 22, 25, 27, 29, 30, 41, 49, 56, 58, 73, 77, 86, 88, 94, 99, 103, 115, 123, 142, 156, 260, 284, 287, 296, 298, 299, 307, 399

NEPTTNIUM 237 194

NEPTUNIUM 180, 381

NEPTUNIUM 235 146

NEPTUNIUM 237 145, 238, 239, 338

NEPTUNIUM 239 320, 368

NERVOUS SYSTEM 306

NEUTRON ACTIVATION 207, 367, 375

NEUTRONS 84, 159, 211, 249, 251, 287, 321, 327, 343, 358, 375

NICKEL 306

NICKEL 59 281

NICKEL 63 381

NIOBIUM 135, 244

NIOBIUM 93 381

NIOBIUM 95 74, 123, 281, 332

NITRATES 133

NITRIC ACID 366

NITROGEN 31

NOSE 41

NUCLEAR EXPLOSIONS, CHINESE 363

NUCLEAR FACILITIES 135, 197, 208, 218, 219, 224, 236, 253, 307, 320, 325, 331, 339, 345, 359, 364, 365, 372, 373, 378, 387, 388, 393, 398, 406, 408, 413, 415, 417, 418, 426

NUCLEAR POWER 213, 226, 329, 400

OATS 86

OCEANS 139, 165, 198, 199, 220, 349

OPERATION ROLLER COASTER 132, 154, 202, 209, 222, 326, 394

ORGANIC COMPOUNDS 180

ORGANIC MATTER 233

ORGANS 36, 60, 62, 63, 76, 78, 145, 215, 264, 273, 277, 278, 291, 321, 345, 372, 373, 397, 402, 425

OVARIES 73

OXYGEN 50

OXYGEN ENHANCEMENT RATIO 251

PACEMAKERS 340

PACKAGING 223

PALLADIUM 103 281

PANCREAS 277

PARTICLE SIZE 7, 9, 34, 55, 58, 71, 88, 103, 104, 125, 138, 154, 157, 198, 203, 209, 236, 240, 243, 245, 263, 265, 279, 305, 359, 361, 366, 370, 378, 396

PARTICLES 61, 90, 154, 163, 171, 184, 185, 220, 262, 265, 279, 309, 310, 328, 336, 345, 356, 371, 405

PARTICLES, AIRBORNE 138, 236, 243, 244, 245, 293, 331, 347, 359, 361, 364, 369, 383, 395, 396

PATHOLOGY 15, 17, 19, 20, 21, 22, 42, 44, 45, 47, 49, 56, 58, 69, 70, 75, 88, 89, 112, 123, 141, 156, 159, 215, 264, 399

PEAS 175

PERSONNEL 143, 159, 177, 213, 248, 267, 276, 283, 309, 330, 343, 394, 397, 398, 401

pH 161, 167, 173, 190, 270, 324, 415

PHAGOCYTOSIS 15, 61

PHANTOMS 124, 321, 362, 371, 375

PHOSPHATES 10, 122, 127, 427

PHOSPHOLIPIDS 143

PHOSPHORUS 26, 31, 34, 159, 180, 193

PHOSPHORUS 32 84, 146, 220, 281,

PHOSPHORUS 32 320

PHYSICAL FORM 110, 164, 165, 170, 382

PHYSICAL PROPERTIES 7, 156, 194, 235, 309, 380, 383, 398

PHYSIOLOGY 200, 207, 306, 397

PIGMENTS 159

PLACENTAS 28

PLAICE 139

PLANKTON 164, 194

PLANT-SOIL INTERACTION 303

PLANTS 86, 109, 134, 135, 136, 137, 151, 160, 162, 163, 165, 168, 170, 171, 172, 173, 174, 175, 191, 200, 201, 204, 205, 209, 212, 213, 215, 220, 222, 258, 273, 303, 320, 324, 326, 344, 348, 351, 352, 353, 357, 363, 365, 369, 382, 419

PLANTS, NUCLEAR 197

PLASTICS 265

PLATINUM 190 194

PLOWSHARE 207

PLUTONIUM 1, 2, 3, 8, 11, 26, 28, 29, 29, 33, 41, 57, 65, 84, 86, 91, 92, 109, 113, 120, 126, 132, 133, 134, 135, 136, 137, 142, 143, 146, 147, 148, 155, 158, 160, 166, 176, 177, 178, 179, 183, 186, 187, 188, 190, 197, 202, 205, 206, 209, 215, 221, 222, 223, 232, 247, 248, 250, 257, 259, 266, 267, 268, 273, 277, 280, 283, 286, 288, 291, 292, 299, 301, 309, 311, 313, 314, 315, 317, 324, 326, 331, 350, 357, 359, 360, 362, 365, 366, 371, 372, 377, 380, 382, 384, 388, 392, 394, 396, 401, 403, 405, 406, 419, 421, 427

PLUTONIUM CARBONATES 128

PLUTONIUM CHLORIDES 35, 37, 52, 84, 104

PLUTONIUM CITRATES 38, 48, 50, 52, 62, 63, 81, 87, 100, 106, 110, 114, 120, 138, 161, 162, 163, 190, 270, 312

PLUTONIUM COMPOUNDS 380

PLUTONIUM FLUORIDES 16, 141, 142

PLUTONIUM NITRATES 1, 2, 4, 5, 6, 12, 16, 25, 27, 35, 52, 53, 56, 84, 100, 107, 126, 131, 138, 141, 142, 161, 162, 163, 169, 237, 269, 282, 286, 294, 312, 383, 418, 423

PLUTONIUM NITRIDES 380

PLUTONIUM OXALATES 138

PLUTONIUM OXIDES 2, 7, 9, 14, 15, 16, 30, 34, 35, 37, 52, 55, 58, 61, 66, 68, 69, 71, 85, 88, 90, 101, 103, 104, 112, 114, 125, 138, 141, 142, 149, 150, 152, 157, 161, 162, 163, 184, 185, 223, 236, 262, 263, 265, 278, 286, 295, 307, 373, 378, 383, 402, 418, 423

PLUTONIUM 236 164, 188

PLUTONIUM 237 110

PLUTONIUM 238 30, 36, 66, 69, 88, 101, 102, 103, 112, 142, 151, 152, 153, 162, 163, 169, 170, 175, 189, 192, 195, 196, 198, 204, 210, 211, 215, 218, 220, 229, 232, 235, 236, 237, 256, 258, 262, 263, 306, 310, 312, 319, 326, 337, 340, 342, 345, 347, 348, 349, 351, 353, 354, 363, 368, 373, 374, 381, 402, 413, 415, 417, 422, 425

PLUTONIUM 239 4, 5, 6, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 30, 31, 32, 38, 40, 42, 43, 44, 45, 46, 47, 48, 49, 50, 54, 56, 61, 62, 63, 64, 67, 68, 71, 72, 74, 75, 76, 77, 82, 88, 89, 90, 93, 95, 96, 98, 101, 103, 104, 105, 106, 107, 108, 110, 111, 115, 116, 117, 118, 119, 121, 122, 123, 124, 125, 127, 128, 129, 130, 131, 138, 140, 141, 142, 144, 150, 151, 152, 153, 156, 157, 164, 165, 167, 168, 169, 170, 171, 182, 184, 185, 192, 194, 195, 196, 198, 204, 207, 209, 213, 215, 218, 220, 224, 228, 232, 235, 243, 249, 252, 256, 258, 262, 263, 265, 269, 272, 273, 275, 276, 278, 281, 282, 285, 290, 293, 294, 295, 296, 297, 302, 303, 306, 307, 310, 312, 319, 326, 328, 333, 337, 338, 341, 342, 345, 346, 347, 349, 352, 361, 363, 369, 370, 376, 381, 397, 402, 406, 410, 413, 422, 425, 426

PLUTONIUM 240 168, 171, 182, 194, 195, 196, 198, 209, 218, 232, 235, 252, 256, 258, 290, 306, 310, 326, 337, 338, 361, 368, 376, 422, 425

PLUTONIUM 241 115, 218, 246, 258, 310, 338, 361, 373, 422, 425

PLUTONIUM 242 306, 338, 422

PLUTONIUM, METALLIC 154

PLUTONYL ACETATES 25

PLUTONYL NITRATES 113

POLONIUM 74

POLONIUM CHLORIDES 27

POLONIUM 210 27, 135, 139, 152, 194, 215, 220, 281, 348, 353, 354, 399

POLONIUM 212 194

POLONIUM 214 194

POLONIUM 215 194

POLONIUM 216 194

POLONIUM 218 194, 322

POLYCARBONATES 265

POLYMERS 57, 93, 94, 190, 424

PONIES 66

POPULATION 142, 215, 304, 307, 345, 372, 373, 425, 426

POPULATION DENSITY 54

POROSITY 227

POTASSIUM 319, 339

POTASSIUM 40 139, 355

POTASSIUM 42 281

POWER PLANTS 329

POWER PLANTS, NUCLEAR 135, 139, 191, 216, 299, 307, 381, 382

POWER SOURCES 210

PRASEODYMIUM 143 281

PRASEODYMIUM 144 4, 150

PRECIPITATION 163, 183, 201, 220, 236, 250, 334

PRECIPITATION, CHEMICAL 186

PRECIPITATION, ELECTROSTATIC 378

PRECIPITATION, SNOW 206

PREDICTIONS 273, 302, 335, 336, 342, 404

PREGNANCY 28, 29, 86

PREPARATION 324

PRIMATES 55, 68, 85, 86, 142, 149, 151, 152, 215, 293

PROCESSING 197

PROCESSING PLANTS 320, 424

PROCESSING PLANTS, NUCLEAR 391

PRODUCTIVITY 175

PROGENY 28, 29, 159

PROJECT RULISON 208

PROJECT 57 202, 209, 222

PROMETHIUM 74, 146

PROMETHIUM 142 281

PROMETHIUM 147 123, 152, 215

PROPHYLAXIS 264

PROPORTIONAL COUNTERS 246, 375

PROTACTINIUM 231 194

PROTECTIVE COVERING 159, 397

PROTEINS 31, 81, 84, 107, 119, 133, 137, 153, 159, 187, 301

PROTOZOA 137

PUNCTURE 131, 267

RABBITS 10, 30, 39, 40, 41, 61, 68, 74, 75, 84, 123, 128, 133, 137, 142, 159

RABBITS, JACK 192

RABBITS, WILD 202

RADIACTIVITY 274

RADIATION ALERT NETWORK 347

RADIATION DETECTION, IN VIVO 124, 150, 157, 248, 290

RADIATION DETECTORS 66, 151, 159,

RADIATION DETECTORS 179, 188, 247, 248, 249, 252, 317, 319, 330, 332, 346, 358, 362, 374, 379, 384, 414

RADIATION DOSE 9, 11, 12, 19, 20, 21, 22, 23, 26, 28, 42, 44, 47, 48, 49, 58, 59, 60, 67, 69, 70, 88, 89, 98, 99, 116, 121, 123, 128, 135, 147, 156, 158, 196, 213, 251, 264, 265, 273, 277, 278, 298, 299, 305, 311, 321, 327, 329, 345, 360, 363, 368, 372, 373, 390, 399, 404, 409, 425, 426

RADIATION DOSIMETRY 139, 156, 251, 279, 321, 327, 329, 398

RADIATION EFFECTS 22, 23, 26, 40, 42, 43, 44, 47, 48, 49, 51, 54, 58, 60, 65, 69, 70, 75, 76, 83, 89, 91, 97, 98, 107, 115, 123, 128, 133, 135, 137, 139, 142, 147, 150, 153, 155, 156, 159, 169, 170, 207, 216, 254, 260, 262, 274, 277, 280, 283, 295, 297, 298, 299, 307, 392, 404

RADIATION EFFECTS, ACUTE 79, 80, 88, 264

RADIATION EFFECTS, CHRONIC 79, 80, 264

RADIATION EFFECTS, LATENT 44, 45, 94, 122

RADIATION EFFECTS, SUBACUTE 5, 53, 80

RADIATION PROTECTION 309, 372, 390, 398

RADIATION SICKNESS 97, 123, 264

RADIATION, COSMIC 299, 339

RADIATION, GAMMA 86, 124, 151, 152, 159, 188, 215, 252, 271, 307, 309, 321, 327, 339, 343, 357, 358, 363, 379, 390, 410

RADIATION, LOW LEVEL 26, 73, 247, 317, 357, 401

RADIATION, NEUTRON 86, 249, 379

RADIATION, PHOTON 248, 287, 362

RADIATION, PROTON 379

RADIATION, X 40, 86, 124, 137, 146, 151, 159, 259, 307, 358

RADIOACTIVITY 85, 182, 199, 206, 213, 219, 258, 328, 337, 339, 355, 370, 372, 379, 383

RADIOAUTOGRAPHY 11, 17, 34, 35, 37, 42, 44, 46, 48, 57, 58, 84, 88, 129, 130, 136, 140, 146, 166, 167, 186, 247, 249, 285, 302, 403

RADIOBIOLOGY 151

RADIOCHEMISTRY 138, 153, 182, 195, 250, 312, 328

RADIOECOLOGY 205, 221

RADIOGRAPHY 152

RADIOLYSIS 417

RADIONUCLIDE CYCLING 182

RADIONUCLIDE RATIO 182, 218, 332, 363, 370, 381

RADIONUCLIDES 26, 27, 75, 82, 89, 135, 150, 175, 188, 196, 207, 224, 281, 289, 299, 307, 308, 309, 318, 328, 329, 330, 332, 337, 345, 349, 356, 367, 373, 379, 384, 385, 407, 418, 419, 422

RADIOSENSITIVITY 26, 44, 166, 169

RADIOTHERAPY 287

RADIUM 11, 39, 41, 74, 84, 140, 143, 147, 155, 299, 300

RADIUM CHLORIDES 27

RADIUM 222 139

RADIUM 223 194

RADIUM 224 19, 22, 98, 105, 194, 272

RADIUM 226 18, 19, 20, 21, 22, 23, 24, 27, 31, 40, 43, 44, 45, 47, 89, 98, 105, 135, 139, 156, 188, 194, 195, 220, 260, 272, 278, 281, 296, 297, 302, 373

RADIUM 228 19, 20, 21, 22, 23, 24, 31, 43, 44, 98, 139, 156, 260, 296

RADON 203, 279, 322, 356, 389, 390, 399

RADON DAUGHTERS 203, 389, 399

RADON 222 194, 281

RAINOUT 305

RARE EARTHS 300, 320, 419

RATES 113, 395

RATS 1, 2, 3, 4, 6, 7, 8, 11, 25, 30, 33, 34, 36, 38, 39, 40, 50, 51, 52, 53, 57, 58, 62, 63, 64, 65, 68, 74, 75, 77, 78, 80, 84, 86, 88, 101, 102, 103, 106, 108, 113, 115, 123, 125, 126, 127, 131, 136, 137, 138, 140, 142, 143, 144, 145, 146, 148, 150, 152, 153, 158, 159, 184, 215, 293, 294, 295, 296, 301, 307, 311, 403

RATS, KANGAROO 202

RATS, WOOD 202

REACTORS 213, 216, 258, 329, 330, 359, 364, 380, 381

REACTORS, BREEDER 392

REACTORS, LMFBR 256, 310

REDISTRIBUTION 193, 198, 231, 234, 244

REDOX 181

REINDEER 204

RELATIVE BIOLOGICAL EFFECTIVENESS 27, 76, 287, 298, 302

RELEASES, CONTROLLED 383, 387

REPROCESSING PLANTS 373

REPROCESSING PLANTS, NUCLEAR 135, 160, 250, 345, 360, 382, 406, 407, 418

REPRODUCTION 26, 86, 137, 159

REPTILES 202

RESORPTION 62, 89

RESPIRATION 384

RESPIRATORY SYSTEM 7, 86, 101, 126, 138, 153, 263, 279, 293

RESPIRATORY TRACT 265

RESUSPENSION 160, 205, 209, 215, 230, 232, 240, 241, 242, 243, 245, 256, 303, 310, 314, 361, 365, 373, 377, 383, 384, 388, 395, 396, 405, 417

RETENTION 1, 3, 6, 12, 14, 16, 17, 21, 24, 32, 33, 34, 35, 38, 43, 58, 59, 60, 61, 63, 66, 71, 72, 74, 76, 90, 101, 106, 110, 111, 114, 120, 125, 131, 132, 138, 141, 147, 148, 149, 151, 152, 158, 192, 196, 215, 229, 260, 278, 279, 300, 371

RETICULOENDOTHELIAL SYSTEM 46

REVIEW 7, 26, 30, 52, 75, 92, 142, 156, 157, 207, 208, 254, 261, 289, 293, 298, 299, 301, 307, 360, 389, 392, 399

RHENIUM 183 281

RHODIUM 102 220

RHODIUM 103 281

RHODIUM 105 281

RHODIUM 106 281

RIVERS 139, 193, 318, 353

RNA 151, 215

ROCKS 229

RODENTS 152, 202, 205

ROOTS 163, 168, 172

RUBIDIUM 26, 135

RUBIDIUM 86 281

RUBIDIUM 87 139

RUNOFF 135, 220

RUTHENIUM 300, 360

RUTHENIUM 106 74, 123, 165, 281, 304, 419

SAFEGUARDS 197, 223, 226, 385, 392, 393, 400

SAGEBRUSH 209

SALINITY 55, 95, 237, 275

SALT BUSH 209

SALT BUSH, FOUR-WINGED 109

SALT REPOSITORIES 213, 409, 420

SAMARIUM 147 194

SAMARIUM 151 281, 381

SAMPLES 189, 212, 314, 324, 341, 342, 366, 378, 395

SAMPLING 132, 136, 147, 158, 199, 205, 206, 215, 220, 292, 308, 315, 324, 328, 332, 333, 337,

SAMPLING 348, 349, 350, 353, 361, 363, 370, 385, 395, 396, 405

SARCOMAS 44

SARCOMAS, FIBRO 73

SARCOMAS, LYMPHO 73

SARCOMAS, OSTEO 17, 22, 29, 47, 49, 56, 73, 77, 86, 94, 99, 123, 156, 260, 296, 298

SCANDIUM 46 281, 320

SCANNING 66, 287, 315, 358

SCINTILLATION COUNTERS 62, 66, 124, 247, 267, 338, 379

SEA LEVEL 228

SEAS 182, 193, 228

SEASONS 234, 240, 304, 356

SEAWATER 139, 164, 165, 194, 199, 213, 220, 250

SEDIMENTATION 182

SEDIMENTS 139, 189, 191, 193, 195, 199, 205, 220, 366, 419

SEEDS 162, 163, 175

SELENIUM 79 381

SEMICONDUCTOR DETECTORS 379

SEPARATION PROCESSES 180, 184, 186, 187, 188, 190, 213, 324, 350

SEX 8, 82, 110

SHEEP 30, 75, 132, 154

SHIELDING 146, 210, 398, 405

SHOCK WAVES 227

SHOULDERS 63

SHRUBS 109, 192, 209, 357

SIALIC ACIDS 128

SILICA 394

SILICATES 65

SILT 348, 353

SILVER 105 281

SILVER 109 281

SILVER 111 281

SIMULATION 409

SITE EVALUATION 139, 235, 258, 328, 350, 426

SIZE 91, 124, 235

SKIN 1, 13, 30, 83, 86, 102, 103, 114, 151, 202, 255, 266, 277, 281, 294, 307, 387

SMALL BOY EVENT 394

SMOKE 2

SMOKE, CIGARETTE 284

SNAILS 135

SNAKES 202

SODIUM 8, 127, 138

SODIUM CARBONATES 239

SODIUM CITRATES 131

SODIUM NITRATES 239

SODIUM 22 220

SODIUM 24 281, 320

SOIL PROFILE 160, 235, 328, 365

SOIL TRANSPORT 205, 417

SOILS 54, 84, 160, 166, 168, 169, 171, 172, 173, 175, 188, 198, 205, 209, 212, 215, 217, 220, 222, 224, 233, 235, 236, 237, 239, 243, 245, 273, 303, 310, 314, 315, 323, 324, 325, 326, 328, 342, 344, 345, 348, 350, 351, 353, 355, 356, 361, 363, 366, 369, 373, 374, 377, 382, 394, 405, 417, 419

SOILS, CALCAREOUS 173

SOILS, SANDY LOAM 238

SOILS, SILT LOAM 170, 174

SOLIDIFICATION 420

SOLIDS 406

SOLUBILITY 103, 134, 138, 153, 169, 170, 185, 192, 262, 268, 293, 303, 306, 405

SOLUTIONS 55, 95, 237, 275, 383

SOLVENTS 178, 180, 183

SORPTION 233, 238, 239, 419

SOYBEANS 174

SPACE FLIGHT 210

SPACE GENERATORS 210

SPECIFIC ACTIVITY 305

SPECTROCSOPY, GAMMA 328

SPECTROSCOPY 255, 361, 364, 375

SPECTROSCOPY, ALPHA 105, 177, 246, 374, 378

SPECTROSCOPY, GAMMA 246

SPLEEN 1, 12, 19, 33, 37, 52, 63, 74, 84, 86, 90, 91, 96, 102, 114, 141, 143, 146, 148, 268, 277, 281, 403

SPORES 161

SPUTUM 284

SQUIRRELS 202

SQUIRRELS, GROUND 137

STACK EMISSIONS 224, 345, 360, 364, 425, 426

STANDARD MAN 273

STANDARDS 353, 363, 372

STANDARDS, FEDERAL LEVEL 276, 281, 307, 354, 402

STANDARDS, INTERNATIONAL LEVEL 297, 399, 402, 421

STATISTICS 5, 73, 220, 273, 298, 316, 324, 326, 378, 385, 399, 401, 418

STEMS 162, 172, 173, 174, 175

STERILIZATION 233

STEROIDS 82

STOMACH 8, 134, 139, 220

STORAGE 176, 213, 360, 385, 405, 410, 417, 419, 420, 421, 422, 424

STREAMS 331

STRONTIUM 26, 41, 155, 294, 299, 300

STRONTIUM 85 10

STRONTIUM 89 123, 147, 159, 220, 281, 349, 352

STRONTIUM 90 19, 20, 21, 22, 23, 24, 31, 43, 44, 47, 74, 75, 76, 77, 86, 98, 123, 150, 156, 196, 198, 207, 220, 278, 281, 304, 328, 349, 352, 355, 363, 370, 387, 419, 422

SULFUR 35 281

SURFACE WATER 348

SURFACE WATERS 224, 314, 320, 331, 344, 352, 354

SURGERY 267, 269, 282, 291, 294

SURVEYS 332

SURVIVAL TIME 18, 25, 27, 41, 88, 94, 152, 159, 298

SWINE 30, 111, 112, 137, 151, 175, 294

SYNERGISM 76, 77, 93, 127, 131

TAILINGS 390

TAXA 200

TECHNETIUM 10, 281, 309

TECHNETIUM 96 281

TECHNETIUM 99 165, 174, 233, 239, 364, 381, 407, 418

TEETH 43, 44, 46, 89, 137, 281

TELLURIUM 74

TELLURIUM 127 281

TELLURIUM 129 281

TEMPERATURE 72, 201, 356, 380

TESTES 32

TESTS 19

THALLIUM 207 194

THALLIUM 208 194

THEORETICAL STUDIES 217, 227, 231, 232, 234, 241, 259, 263, 304, 369, 385

THERAPY 4, 6, 55, 57, 64, 85, 86, 93, 94, 111, 131, 137, 144, 149, 151, 152, 153, 251, 269, 271, 275, 276, 282, 286, 290, 291, 293, 294, 300, 301, 343, 397

THICKNESS 255

THISTLES, RUSSIAN 109

THORIUM 146, 155, 188, 250, 278, 339, 343, 355, 372

THORIUM CHLORIDES 27

THORIUM CITRATES 46

THORIUM 227 194

THORIUM 228 19, 20, 21, 22, 23, 24, 27, 31, 43, 44, 45, 46, 98, 121, 139, 156, 194, 198, 296

THORIUM 230 135, 139, 194

THORIUM 232 121, 139, 194, 198

THORIUM 234 281

THORON DAUGHTERS 272, 356

THULIUM 170 281

THYMIDINE 73

THYMUS 86, 143

THYROID 10, 26, 60, 73, 137, 277, 281, 287, 299, 358, 368, 373

TIME FACTOR 51, 76, 111, 157, 241, 293, 404

TIN 113 281

TIN 126 381

TISSUE FACTOR 62

TISSUES 1, 2, 4, 21, 27, 35, 36, 40, 43, 46, 52, 58, 60, 67, 72, 78, 84, 86, 95, 102, 103, 103, 110, 111, 112, 114, 115, 120, 121, 124, 125, 126, 129, 132, 136, 137, 138, 139, 148, 152, 153, 172, 175, 190, 192, 194, 202, 255, 257, 264, 265, 270, 277, 324, 341, 344, 375

TOLERANCE 403

TOXICITY 7, 19, 20, 22, 23, 44, 79, 84, 115, 159, 169, 170, 287, 289, 306

TRACER STUDIES 37, 71, 107, 125, 146, 184

TRACERS 1, 245, 248, 261

TRACHEA 7, 58, 101

TRAJECTORIES 335

TRANSAMINASES 116

TRANSFERRIN 118, 187, 301

TRANSLOCATION 4, 14, 16, 34, 38, 52, 66, 69, 72, 101, 104, 131, 142, 152, 162, 163, 172, 268, 278, 299, 366, 371

TRANSPLANTS 23, 29

TRANSPLUTONIUM ELEMENTS 287, 386

TRANSPORATION 418

TRANSPORT 306, 383, 419

TRANSPORTATION 223, 410, 420, 423

TRANSURANIUM ELEMENTS 114, 115, 211, 214, 218, 221, 228, 258, 277, 297, 300, 310, 321, 381, 382, 398, 406, 408, 411, 412, 414, 417, 418

TRANSURANIUM REGISTRY, U.S. 277, 284

TRINITY SHOT 215, 235

TRITIUM 13, 40, 73, 83, 139, 189, 191, 205, 207, 216, 217, 220, 224, 261, 278, 280, 281, 289, 310, 331, 344, 348, 353, 354, 360, 363, 370, 372, 381, 418, 419, 421, 424, 426

TROPISMS 137

TROUT, BROWN 139

TUMORIGENESIS 29, 47, 49, 77, 79, 103

TUNGSTEN 181 220

TUNGSTEN 185 220

ULTRAFILTRATION 190, 290

UPTAKE 40, 114, 160, 161, 163, 164, 165, 168, 170, 171, 172, 173, 174, 175, 205, 278, 300, 302, 303, 314, 365, 417, 419

URANIUM 75, 135, 135, 159, 180, 181, 188, 193, 203, 213, 215, 220, 246, 250, 278, 278, 284, 290, 322, 324, 339, 355, 372, 373, 380, 382, 388, 389, 390, 399, 401

URANIUM COMPOUNDS 181, 241, 380

URANIUM NITRATES 27

URANIUM OXIDES 286, 373, 378

URANIUM 223 146

URANIUM 232 27

URANIUM 233 27, 115, 281

URANIUM 234 135, 139, 194, 195, 345, 373

URANIUM 235 135, 139, 194, 196, 306, 330, 345, 363, 373, 413

URANIUM 236 321

URANIUM 237 368

URANIUM 238 135, 139, 194, 195, 285, 306, 345, 363

URANIUM, NATURAL 281

UREA 31, 53, 133

URINE 10, 11, 12, 13, 16, 36, 52, 59, 60, 63, 84, 87, 93, 95, 100, 102, 104, 112, 120, 136, 141, 143, 145, 148, 153, 178, 186, 266, 269, 270, 275, 276, 277, 278, 282, 286, 288, 290, 292, 301, 308, 309, 312, 344, 397, 403

UTERUS 29

VALENCE 1, 2, 22, 33, 35, 36, 37, 52, 84, 87, 118, 119, 143, 180, 181, 187, 268, 270

VANADIUM 48 281

VEGETABLES 303, 314, 353, 355

VELOCITY 345

VENTILATION 389, 393, 405

VIRUSES 86, 151, 215

WASHING 11, 55, 85, 149, 153, 275, 293, 294

WASHOUT 305

WASTE DISPOSAL 176, 205, 207, 213, 215, 229, 239, 405, 406, 407, 412, 416, 418, 420, 422, 424

WASTE MANAGEMENT 421

WASTE REPOSITORIES 424

WASTE TREATMENT 176, 224, 405, 406, 408, 410, 413, 414, 415, 424, 425, 427

WASTE WATER 224, 369

WASTES, ORGANIC 303, 318

WASTES, RADIOACTIVE 139, 176, 179, 205, 213, 215, 216, 224, 228, 229, 239, 274, 318, 324, 331, 338, 364, 365, 381, 387, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 421, 422, 423, 424, 425, 426

WATER 122, 139, 189, 191, 193, 205, 206, 216, 217, 227, 229, 329, 349, 351, 353, 355, 363, 387, 409, 419, 424

WATER CURRENTS 182

WEAPONS, NUCLEAR 218, 226, 299, 328, 394, 404

WEIGHT 28, 87, 88, 124, 128, 137, 159

WHEAT 160

WHOLE BODY COUNTERS 125, 248, 309

WHOLE BODY COUNTING 124, 287, 309, 319, 330

WHOLE BODY IRRADIATION 86, 137, 151, 264

WHOLE BODY IRRADITION 32

WIND 163, 198, 231, 234, 240, 241, 242, 243, 245, 335, 356, 377, 395, 396

WINTER FAT 109, 209

WORKING LEVEL MONTH 390

WOUNDS 11, 131, 267, 276, 277, 278, 286, 294, 397

WOUNDS, PUNCTURE 283, 291, 292, 307

XENON 372

XENON 133 281

XENON 135 281

YEASTS 86, 151

YTTERBIUM 169 66

YTTRIUM 26, 92, 135, 320

YTTRIUM CITRATES 106

YTTRIUM 90 123, 150, 156

KEYWORD INDEX

YTTRIUM 91 74, 106, 123, 127, 144, 150, 281, 422

ZINC 65 281, 320, 330

ZIRCONIUM 1, 146, 152, 244, 397

ZIRCONIUM CITRATES 52, 92

ZIRCONIUM OXIDES 215, 293

ZIRCONIUM 93 381

ZIRCONIUM 95 74, 220, 332, 352

TAXON INDEX

ALECTORIS GRAECA 207
ANACYSTIS NIDULAUS 215
ARTEMISIA SPINESCENS 209
ARTEMISIA TRIDENTATA 201
ASPERGILLUS NIGER 161
ATRIPLEX CANESCENS 192, 209
ATRIPLEX CONFERTIFOLIA 201, 209
BROMUS TECTORUM 175
CANDIDA BRUSEI 151
CANDIDA UTILIS 151
CANNA INDICA 151
CARASSIUS AURATUS 26
CHASMICHTYOS GLUOSUS 26
CHIRONOMUS sp. 135
CHLORELLA PSENOIDOSA 215
CHRYSOTHAMNUS VICIDIFLOURS 209
CLADONIA sp. 204
CLOSTRIDIUM PERFRINGENS 151
COLEOGYNE SP. 201
COLEUS 86
CYPRINODONTIDAE 26
DESCURAINIA PINNATA 175
EPHEDRA NEVADINSIS 209
EQUUS ASINUS 154
ESCHERICHIA COLI 86, 215
EUROTIA LANATA 134, 192
EUROTIO LANATA 209
FESTUCA ARUNDINACEA 172
FULICA AMERICANA 175
GAMBUSIA AFFINIS 135
GIGANTINA HARVEYANA 151
GIGARTINA CORYMBIFERA 151
GLYCINE sp. 174
GRAVIA-LYCIUM ANDERSONII 201
GRAYIA SPINOSA 209
HAEMOPHILUS INFLUEZAE 215
HETEROPNEUSTES 26
HILARIA JAMESII 192
HORDEUM VULGARE 175
HYLOCOMIUM sp. 204
HYMENOCLEA SALSOLA 209
LARREA TRIDENTATA 201, 209
LYCIUM ANDERSONII 209
LYCIUM PALLIDUM 201
LYCIUM SHOCKLEYI 201
MACACA MULATTA 151, 152, 215

TAXON INDEX

MACROCYSTIS PYRIFERA 164

MYCOPLASMA 151

MYCOPLASMA ARTHRITIDIS: RATTUS NATALENSIS 86

MYCOPLASMA PNEUMONIAE 86

MYCOPLASMA PULMONIS 86

NEUROSPORA CRASSA 151

NICOTIANA TOBACUM 151

ORHYZOPSIS HYMENOIDES 192

ORYZOPSIS HYMENOIDES 134

PASTEURELLA 151

PHAESEOLUS VULGARIS 163

PHASEOLUS VULGARIS 172

PHASEOLUS VULGARIS L. 162

PHYSA HETEROSTROPHA 135

PISUM SATIVA 175

PLATYMONAS VIRIDIS 165

PSEUDOMONAS AERUGINOSA 151

RATTUS NATALENSIS 86

SALSOLA IBERICA 200

SALSOLA PANISENII 192

SALSOLA PAULSENII 200

SALSOLA PESTIFER 200

SHIGELLA 151

SITANION JUBATUM 134

SOMATERIA sp 207

STAPHYLOCOCCUS EPIDERMIDIS 151

TETRADYMIA GLABRATA 209

TRITICUM AESTIVUM 160

ZEA MAYS 86

TITLE INDEX

Aberrations
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans* (283)

Absolute
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)

Absorbed
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)

Absorption
Absorption from the Gut of Suspension of Plutonium Sodium Aerosol* (8)
Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle* (114)
Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239* (265)

Accelerate
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)

Accelerated
Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes* (75)

Accident
A Preliminary Report on the B-52 Accident in Greenland on January 21, 1968* (206)
Fractional Airborne Release of Plutonium Under Shipping Accident Conditions* (383)

Accidental
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)

Accidents
Nuclear Accidents and their Management* (271)

Accumulation
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)

Actinide
Bibliography of Properties Data on Actinide Carbides and Nitrides* (380)

Actinomycetes
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)

Activities
Report of Health Activities for Month of August, 1945* (136)
Report of Health Activities for Month of October, 1945* (147)
Report of Health Activities for Month of June, 1945* (148)
Report of Health Activities for Month of November, 1945* (158)
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974* (324)

Activity
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting* (247)
Total Alpha Activity Determination in Foodstuffs* (325)

Actual
Actual Problems of the Distribution of Radioisotopes and the Kinetics of their Excretion* (74)

Acute
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)

Addendum
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)

Administered
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Distribution and Excretion of Plutonium Administered Intravenously to Man* (270)

Administration
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)

Administrative
Administrative Procedures and Controls in Plutonium Production Areas* (197)

Adult
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
The Long-Term Effects of Plutonium 239 in Adult Beagles* (49)
Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs* (98)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)

Advanced
Advanced Methods for Management and Disposal of Radioactive Wastes* (407)

Aeration
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)

Aerosol
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
Absorption from the Gut of Suspension of Plutonium Sodium Aerosol* (8)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)

TITLE INDEX

Aerosol
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Aerosols
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51* (184)
Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols* (305)
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
Affection
The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection* (64)
Afterwards
Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination* (269)
Aged
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
Air
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine* (322)
Plutonium Sensitive Alpha Air Monitor* (346)
Airborne
Airborne Dust Size Distributions as a Function of Wind Speed* (240)
Plutonium in Airborne Particles, July-September 1972* (347)
The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System* (359)
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Fractional Airborne Release of Plutonium Under Shipping Accident Conditions* (383)
Airstream
Project Airstream* (337)
Alamos
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility* (408)
Alaska
Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska* (368)
Algal
Plutonium Observed on Algal Surfaces in the Ocean* (164)
Alkanes
Solvent Extraction of Neptuminum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)
Alpha
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone* (122)
Evapoation Of Alpha Bearing Aqueous Wastes On a Laboratory Scale* (176)
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
The Alpha Radioactivity of Marine Organisms* (194)
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
The Effect of Skeletally Deposited Alpha-Ray Emitters in Man* (260)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239* (265)
Bone Sarcoma Incidence vs. Alpha Particle Dose* (296)
Total Alpha Activity Determination in Foodstuffs* (325)
Liquid Scintillation Counting of Alpha Emitters* (338)
Plutonium Sensitive Alpha Air Monitor* (346)
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)
Pyrolysis-Incineration of Combustible Alpha Wastes* (416)
Alteration
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Altitude
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
Alveolar
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Homeostasis of the Alveolar Macrophage Population* (65)
Ambient
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
Americium
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)
Metabolic and Therapeutic Studies of Plutonium and Americium* (57)

TITLE INDEX

Americium
Americium Metabolism in Beagles* (59)
Americium 241 Retention in Beagles* (60)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Kinetics of Exchange and Biological Action of Americium 241 in Dogs* (79)
Cortisol Metabolism in Skin of Beagles Bearing Americium 241* (83)
Somatic Effects in the Action of Americium 241 on Animals* (97)
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Uptake of Plutonium and Americium by Plants from Soils* (171)
Americium Uptake by Plants from Soil* (173)
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
Studies of the Behavior of Plutonium and Americium in the Lithosphere* (229)
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
The Use of Americium Dioxide as a Primary Standard for the Determination of Americium 241* (246)
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Semiquantitative Determination of Uranium, Plutonium, and Americium in Seawater* (250)
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Medical Uses: Americium 241, Californium 252* (287)
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)

Amines
Solvent Extraction of Plutonium with Primary Amines* (178)

AmO2
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)

Analysis
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
An Analysis of the Retention of Plutonium by the Tissues of the Rat* (38)
Electrophoretic Analysis of Blood Plasma* (81)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung* (157)
Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report* (189)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)
Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples* (344)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)

Analytical
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
Analytical Support* (319)

Animal
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)

Animals
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Somatic Effects in the Action of Americium 241 on Animals* (97)
Early Changes in Certain Immunological Indices in the Case of Plutonium 239 Lesion of Experimental Animals* (108)
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)

Annexes
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)

Annual
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Division of Biological and Medical Research, Annual Report, 1973* (86)
Biological and Medical Research Division, Annual Report, 1967* (137)
Fission Product Inhalation Program Annual Report, 1971-1972* (150)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report* (363)

TITLE INDEX

Anomalous
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Apparatus
An Apparatus for Maintaining a Slow and Constant Rate of Injection* (113)
Appendix
Fallout Program Quarterly Summary Report, Appendix* (349)
April
Reported Nuclear Detonations, April 1973* (225)
Aquatic
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Aqueous
Evapoation Cf Alpha Bearing Aqueous Wastes On a Laboratory Scale* (176)
Colloidal Properties of Plutonium in Dilute Aqueous Solution* (190)
The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems* (237)
The Determination of Plutonium 238 and Curium 242 in Aqueous Soil Extracts* (374)
Area
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report* (189)
Resuspension from a Uniform Area Source* (230)
A Different Look at Area 13 FIDLER Survey Data* (317)
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Areas
Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada* (109)
Administrative Procedures and Controls in Plutonium Production Areas* (197)
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Arginase
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
Articles
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
ASPERGILLUS
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
Assay
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
The Problems and Methods of Sample Assay* (308)
Assembly
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Assessing
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
Assessment
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
An Assessment of the Long-Term Exposure Due to Resuspension, Part 2* (232)
The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes* (278)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Assessment of Potential Health Consequences of Transuranium Elements* (310)
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Assimilablity
Assimilablity of Plutonium, Ruthenium, and Technetium by Phytoplankton* (165)
Associated
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Atmosphere
Transuranium Elements in the Atmosphere* (218)
Atmospheres
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
Atmospheric
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Scales of Atmospheric Motion and their Impact on the Fallout Problem* (335)
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska* (368)
Atoll
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Atomic
The Atomic Energy Industry's Approach to Environmental Protection* (254)

TITLE INDEX

Atomic
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Atoms
Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection* (121)
Attack
Radiological Factors Affecting Decision-Making in a Nuclear Attack* (404)
August
Report of Health Activities for Month of August, 1945* (136)
Automated
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
Autopsies
United States Transuranium Registry Study of Thirty Autopsies* (277)
Autopsy
Plutonium in Autopsy Tissue* (257)
Autoradiographic
Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones* (17)
Autoradiographic and Histopathologic Studies in Radiation Carcinogenesis of the Lung* (58)
The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting* (247)
Autoradiographs
Fission Track Autoradiographs* (285)
Autoradiography
An Improved Technique for Neutron-Induced Autoradiography of Bone Containing Plutonium* (249)
Availability
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
A413
Transuranic-Contaminated Solid Waste Treatment Development Facility, A413* (414)
B
A Preliminary Report on the B-52 Accident in Greenland on January 21, 1968* (206)
Barrow
Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska* (368)
Basal
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Basin
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Beagle
Transmission of Radiation-Induced Tumors in Beagle Dogs* (29)
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)
Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs* (98)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs* (116)
Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239* (117)
Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle* (120)
Beagles
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Plutonium-Induced Popliteal Lymphadenitis in Beagles* (15)
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)
Microscopic Distribution of Plutonium 239 and Thorium 228 in Beagles* (46)
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
The Long-Term Effects of Plutonium 239 in Adult Beagles* (49)
Americium Metabolism in Beagles* (59)
Americium 241 Retention in Beagles* (60)
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Cortisol Metabolism in Skin of Beagles Bearing Americium 241* (83)
Environmental and Radiation Effects on the Dental Health of Beagles* (89)
Bearing
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Cortisol Metabolism in Skin of Beagles Bearing Americium 241* (83)
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Evapoation Of Alpha Bearing Aqueous Wastes On a Laboratory Scale* (176)
Bedded
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Behavior
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism* (127)
Curium Behavior in Plants and Soil* (172)
The Behavior of Tritium in Soil* (217)
Studies of the Behavior of Plutonium and Americium in the Lithosphere* (229)
Bibliographies
Bibliographies in Nuclear Science and Technology* (199)
Bibliography
Uranium (III), A Bibliography 1965 to 1973* (181)
Bibliography of Properties Data on Actinide Carbides and Nitrides* (380)

Bikini
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Biological
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes* (75)
Kinetics of Exchange and Biological Action of Americium 241 in Dogs* (79)
Biological Action of Californium 252* (80)
Division of Biological and Medical Research, Annual Report, 1973* (86)
Biological and Medical Research Division, Annual Report, 1967* (137)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Biomedical
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Tritium in Biomedical Research and Clinical Medicine* (261)
Biota
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Birds
Ionizing Radiation and Wild Birds: A Review* (207)
Bis
Solvent Extraction of Neptuminum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)
Black
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
Blood
The Terminal Blood Chemistry of Radioisotope Injected Dogs* (31)
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)
Oxygenation of Rat Blood Following Inhalation of Plutonium 239* (50)
Electrophoretic Analysis of Blood Plasma* (81)
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
In Vivo Studies on the Interactions of Plutonium(+4) with Blood Constituents* (118)
In Vitro Studies of the Interactions of Plutonium(+4) with Blood Proteins* (119)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Distribution of Plutonium Observed in Human Blood* (292)
Board
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Body
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
The Use of Zirconium and Other Carriers in the Removal of Radioelements from the Body. Comments on the Use of Complexing Agents* (92)
Whole Body Counting of Plutonium in Dogs* (124)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body* (268)
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
The Estimation of a Body Burden of Plutonium for Urinalysis Data* (288)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements* (386)
Bone
A Case of a Bone Tumor Arising from the Temporal Bone* (41)
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Bone Tumors in Dogs Given Plutonium 239* (56)
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone* (122)
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
Radionuclides and Bone Strength* (155)
Bone Disease Induced by Radiation* (156)
An Improved Technique for Neutron-Induced Autoradiography of Bone Containing Plutonium* (249)
Bone Sarcoma Incidence vs. Alpha Particle Dose* (296)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Bones
Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones* (17)
Bovine
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)
Box
Different Type Glove Box Filters Used for Plutonium 238 Work* (313)
Boxes
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)

TITLE INDEX

Bronchopulmonary
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Building
Removal of Plutonium from 234-5 Building Waste* (427)
Burden
The Estimation of a Body Burden of Plutonium for Urinalysis Data* (288)
Plutonium Inhalation: The Burden of Negligible Consequence* (402)
Burdened
Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs* (116)
Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239* (117)
Burdens
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)
Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements* (386)
Buried
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
Burning
Resuspension of Radioactivity Induced by Burning Crop Stubble* (244)
Calcium
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Californium
Biological Action of Californium 252* (80)
Dosimetry of Californium 252 Intracavity Applications Based on the Revised Manchester System* (251)
Medical Uses: Americium 241, Californium 252* (287)
The Dosimetry of the Radiation from Californium 252* (327)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Cancer
Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975* (284)
Carbides
Bibliography of Properties Data on Actinide Carbides and Nitrides* (380)
Carcinogenesis
Autoradiographic and Histopathologic Studies in Radiation Carcinogenesis of the Lung* (58)
Carcinogenic
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Cardiac
Design and Fabrication of Plutonium Sources for Cardiac Pacemakers* (340)
Carriers
The Use of Zirconium and Other Carriers in the Removal of Radioelements from the Body. Comments on the Use of Complexing Agents* (92)
Cases
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Cataneous
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Cattle
Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle* (114)
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
CBA
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Cells
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226* (272)
Center
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Centra
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
Cerium
Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route* (4)
Combined Effect of Strontium 90, Cerium 144 and Plutonium 239 on the Rat Organism (Report 1)* (76)
Combined Effect of Strontium 90, Cerium 144, and Plutonium 239 on the Rat Organism (Report 2)* (77)
Cesium
Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water* (370)
Cessation
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
CF
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Chain
Dose Estimates for the Marine Food Chain* (196)
Characterization
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)

TITLE INDEX

Chelating
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
Chelation
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Chemical
The Disposition of Inhaled Plutonium. Part 1. Comparison of Chemical Forms* (16)
Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle* (120)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body* (268)
Decontamination of a Highly Radioactive Chemical Processing Facility* (391)
Chemical Coagulation of Radioactive Wastes at High pH* (415)
Chemistry
The Terminal Blood Chemistry of Radioisotope Injected Dogs* (31)
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Chemistry of Plutonium Incorporated in Humans* (301)
Chest
Estimation of Chest Wall Thickness in Lung Counting for Plutonium* (259)
Chinese
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Chop
Decontamination and Densification of Chop-Leach Cladding Residues* (412)
Chromium
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51* (184)
Chromosomal
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Chromosome
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans* (283)
Chronic
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Comparative Morphology of Chronic Radioisotope Injury* (123)
Radiation Doses and Possible Radiation Effects of Low-Level, Chronic Radiation in Vegetation* (357)
Citrate
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Cladding
Decontamination and Densification of Chop-Leach Cladding Residues* (412)
Clearance
Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung* (157)
Climates
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Clinical
Tritium in Biomedical Research and Clinical Medicine* (261)
Coagulation
Chemical Coagulation of Radioactive Wastes at High pH* (415)
Coaster
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Collected
Data on Environmental Radioactivity Collected in Italy, January-December, 1970* (352)
Colloidal
Colloidal Properties of Plutonium in Dilute Aqueous Solution* (190)
Colorado
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Combinations
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
Combustible
Pyrolysis-Incineration of Combustible Alpha Wastes* (416)
Commission
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Committee
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Comparative
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)

TITLE INDEX

Comparative
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
Comparative Morphology of Chronic Radioisotope Injury* (123)
Complex
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Complexing
The Use of Zirconium and Other Carriers in the Removal of Radioelements from the Body. Comments on the Use of Complexing Agents* (92)
Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism* (127)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
Composite
Studies on the Improvement of a Composite Dust Sampler and Its Utilization in Environmental Research* (332)
Composition
Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone* (122)
Compounds
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)
Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung* (157)
Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds* (163)
The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body* (268)
Concentration
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles* (336)
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Concentrations
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements* (386)
Conditioner
Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops* (303)
Conference
Proceedings of the Third Environmental Protection Conference* (224)
Consequence
Plutonium Inhalation: The Burden of Negligible Consequence* (402)
Constant
An Apparatus for Maintaining a Slow and Constant Rate of Injection* (113)
Constituents
In Vivo Studies on the Interactions of Plutonium(+4) with Blood Constituents* (118)
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)
Containment
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Contaminants
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Contaminated
Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada* (109)
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site* (192)
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
Report About a Plutonium 239 Contaminated, Lacerated and Incised Wound* (282)
Medical Management of Radioactively Contaminated Wounds* (294)
Details of the Disposal of Radioactive Wastes Contaminated with Plutonium 239* (410)
Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF"* (413)
Transuranic-Contaminated Solid Waste Treatment Development Facility, A413* (414)
Contamination
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
The Interpretation Of Data Relating to Plutonium Contamination* (266)
Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination* (269)
Risk of Radioactive Contamination. Current and Prospective Problems* (274)
The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes* (278)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Studies of the Significance of Surface Contamination* (388)
Contaminations
Pulmonary Lavage, Therapy of Pulmonary Contaminations* (55)
Contemporaneous
Uranium of the Contemporaneous Sedimentary Cycle of the Sea* (193)
Contents
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Continental
Frequency and Diurnal Variation of Dust in the Continental United States* (234)

TITLE INDEX

Control
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
A Control Design for Plutonium Counting Systems* (179)
Controls
Administrative Procedures and Controls in Plutonium Production Areas* (197)
Correlation
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Cortex
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Cortical
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)
Corticosterone
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Cortisol
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Cortisol Metabolism in Skin of Beagles Bearing Americium 241* (83)
Cost
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Costs
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Counting
Whole Body Counting of Plutonium in Dogs* (124)
A Control Design for Plutonium Counting Systems* (179)
The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting* (247)
Estimation of Chest Wall Thickness in Lung Counting for Plutonium* (259)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Some Observations Obtained from a Nation-Wide In Vivo Counting Service* (330)
Liquid Scintillation Counting of Alpha Emitters* (338)
Coupling
Medium Properties and Total Energy Coupling in Underground Explosions* (227)
Cow
The Transfer of Plutonium 239 from the Diet of a Cow to Its Milk* (104)
Cratering
Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions* (367)
Crop
Resuspension of Radioactivity Induced by Burning Crop Stubble* (244)
Crops
Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops* (303)
Curium
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Curium Behavior in Plants and Soil* (172)
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
The Determination of Plutonium 238 and Curium 242 in Aqueous Soil Extracts* (374)
Current
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Risk of Radioactive Contamination. Current and Prospective Problems* (274)
C57
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
C57BL
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)
Dairy
Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle* (114)
Damage
Damage* (208)
Daughter
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
Daughters
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Days
Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection* (312)
December
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)

TITLE INDEX

December
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Data on Environmental Radioactivity Collected in Italy, January-December, 1970* (352)
Mound Laboratory@@Laboratory, January-December, 1972* (353)
Mound Laboratory, July-December, 1970* (354)
Decision
Radiological Factors Affecting Decision-Making in a Nuclear Attack* (404)
Decontamination
Decontamination of a Highly Radioactive Chemical Processing Facility* (391)
Decontamination and Densification of Chop-Leach Cladding Residues* (412)
Deep
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Dehydrogenase
Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs* (98)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
Delivered
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
Densification
Decontamination and Densification of Chop-Leach Cladding Residues* (412)
Densities
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Dental
Environmental and Radiation Effects on the Dental Health of Beagles* (89)
Deposit
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Deposited
Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route* (4)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
The Effect of Skeletally Deposited Alpha-Ray Emitters in Man* (260)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Deposition
A Study of the Deposition and Retention of Plutonium Dioxide in Rats* (7)
Rat Mammary Neoplasia Following Deposition of Plutonium* (103)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds* (163)
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols* (305)
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
Desert
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
The Radioecology of Plutonium and Other Transuranics in Desert Environments* (221)
Design
A Control Design for Plutonium Counting Systems* (179)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Design and Fabrication of Plutonium Sources for Cardiac Pacemakers* (340)
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Designate
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Designs
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Destination
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Detector
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
Determinations
Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones* (17)
Determinaton
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
Determine
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Detonation
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Detonations
Reported Nuclear Detonations, April 1973* (225)

TITLE INDEX

Developing
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Device
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Diagnosis
Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination* (269)
Diagnosis and Treatment of Radioactive Poisoning* (300)
Diet
The Transfer of Plutonium 239 from the Diet of a Cow to Its Milk* (104)
Plutonium 239 in Total Diet and Milk* (333)
Differing
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Diffusion
The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems* (237)
Dilute
Colloidal Properties of Plutonium in Dilute Aqueous Solution* (190)
Dioxide
A Study of the Deposition and Retention of Plutonium Dioxide in Rats* (7)
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51* (184)
A Study of the in vitro Solubility of Plutonium 239 Dioxide* (185)
The Use of Americium Dioxide as a Primary Standard for the Determination of Americium 241* (246)
On the "Dissolution" of Respirable Plutonium Dioxide Particles* (262)
Diphosphonate
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)
Directed
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Disease
Bone Disease Induced by Radiation* (156)
Displacement
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Disposal
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources* (216)
Advanced Methods for Management and Disposal of Radioactive Wastes* (407)
Details of the Disposal of Radioactive Wastes Contaminated with Plutonium 239* (410)
Disposition
The Disposition of Inhaled Plutonium. Part 1. Comparison of Chemical Forms* (16)
Dissolution
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
On the "Dissolution" of Respirable Plutonium Dioxide Particles* (262)
Distribution
Metabolism and Distribution of Inhaled Plutonium in Rats* (2)
Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route* (4)
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Microscopic Distribution of Plutonium 239 and Thorium 228 in Beagles* (46)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Actual Problems of the Distribution of Radioisotopes and the Kinetics of their Excretion* (74)
Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes* (75)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)
Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle* (114)
Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle* (120)
Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection* (121)
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body* (268)
Distribution and Excretion of Plutonium Administered Intravenously to Man* (270)

TITLE INDEX

Distribution
Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226* (272)
Distribution of Plutonium Observed in Human Blood* (292)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Plutonium Distribution in the Environs of the Nevada Test Site--Status Report* (314)
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions* (367)
Distributions
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Airborne Dust Size Distributions as a Function of Wind Speed* (240)
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Diuretics
Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism* (127)
Diurnal
Frequency and Diurnal Variation of Dust in the Continental United States* (234)
Diversified
Integration of Environmental Programs at a Diversified Nuclear Production Site* (365)
Division
Division of Biological and Medical Research, Annual Report, 1973* (86)
Biological and Medical Research Division, Annual Report, 1967* (137)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Dog
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Dogs
Hematopoiesis in Dogs Submitted to Subacute Plutonium 239 Intoxication* (5)
Transmission of Radiation-Induced Tumors in Beagle Dogs* (29)
The Terminal Blood Chemistry of Radioisotope Injected Dogs* (31)
Bone Tumors in Dogs Given Plutonium 239* (56)
Kinetics of Exchange and Biological Action of Americium 241 in Dogs* (79)
Effect of Plutonium on Dogs* (87)
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)
Removal of Polymeric Plutonium from Dogs with DTPA and Glucan* (95)
Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs* (98)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
Effects of Product Upon Dogs* (100)
Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs* (116)
Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239* (117)
Whole Body Counting of Plutonium in Dogs* (124)
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
Dose
Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones* (17)
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
Dose Estimates for the Marine Food Chain* (196)
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239* (265)
Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226* (272)
Plutonium Transport and Dose Estimation Model* (273)
Bone Sarcoma Incidence vs. Alpha Particle Dose* (296)
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols* (305)
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Doses
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
Radiation Doses and Possible Radiation Effects of Low-Level, Chronic Radiation in Vegetation* (357)
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Dosimeter
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Dosimetry
Dosimetry of Californium 252 Intracavity Applications Based on the Revised Manchester System* (251)
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Internal Dosimetry of Spontaneously Fissioning Nuclides* (321)
The Dosimetry of the Radiation from Californium 252* (327)
Downstream
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Drifted
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)

TITLE INDEX

Drinking
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
DTPA
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
Removal of Plutonium from Mouse Liver by Glucan and DTPA* (93)
Removal of Polymeric Plutonium from Dogs with DTPA and Glucan* (95)
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Effectiveness of DTPA in Removing Plutonium from the Pig* (111)
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Dust
Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust* (107)
Frequency and Diurnal Variation of Dust in the Continental United States* (234)
Airborne Dust Size Distributions as a Function of Wind Speed* (240)
Studies on the Improvement of a Composite Dust Sampler and Its Utilization in Environmental Research* (332)
Dynamics
Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy* (376)
E
Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection* (312)
Early
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Early Changes in Certain Immunological Indices in the Case of Plutonium 239 Lesion of Experimental Animals* (108)
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)
Ecological
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Ecology
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974* (324)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)
Effective
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Effectiveness
Relative Biclogical Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Effectiveness of DTPA in Removing Plutonium from the Pig* (111)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Effluent
Radioactive Effluent Monitoring at the Rocky Flats Plant* (331)
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
Savannah River Plant Effluent Reduction Program* (426)
Effluents
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Electrical
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Electrolytes
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
Electrophoretic
Electrophoretic Analysis of Blood Plasma* (81)
Elimination
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
Emergencies
Weapon Effects Tests--Planned Emergencies* (394)
Emitters
Relative Biclogical Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism* (127)
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
The Effect of Skeletally Deposited Alpha-Ray Emitters in Man* (260)
Liquid Scintillation Counting of Alpha Emitters* (338)
Emitting
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)

TITLE INDEX

Emitting
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Emphasis
Toxicity of the Transuranium Elements with Special Emphasis on Plutonium* (115)
Encapsulation
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Endosteal
Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226* (272)
Energy
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Medium Properties and Total Energy Coupling in Underground Explosions* (227)
The Atomic Energy Industry's Approach to Environmental Protection* (254)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy* (376)
Enewetak
Radioactivity Levels in Enewetak Soil* (328)
Engineering
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
Environment
Radionuclides in the Environment* (175)
Nuclear Power and the Environment* (213)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Environmental
Environmental and Radiation Effects on the Dental Health of Beagles* (89)
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report* (189)
Environmental Tritium Studies at a PWR Power Plant* (191)
Environmental Studies Group (H-8)* (205)
Environmental Sciences Information Storage and Retrieval System* (212)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Proceedings of the Third Environmental Protection Conference* (224)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
The Atomic Energy Industry's Approach to Environmental Protection* (254)
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Reactor and Fuel Production Facilities, 1972 Environmental Release Report* (318)
Studies on the Improvement of a Composite Dust Sampler and Its Utilization in Environmental Research* (332)
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples* (344)
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Data on Environmental Radioactivity Collected in Italy, January-December, 1970* (352)
Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report* (363)
Integration of Environmental Programs at a Diversified Nuclear Production Site* (365)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Environments
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
The Radioecology of Plutonium and Other Transuranics in Desert Environments* (221)
Plutonium 238 Release in Simulated Natural Environments* (236)
Environs
Plutonium Distribution in the Environs of the Nevada Test Site--Status Report* (314)
Equivalent
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Estimate
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Estimated
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
Estimates
Dose Estimates for the Marine Food Chain* (196)
Quantitative Health Estimates of Transuranic Releases* (256)
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Estimating
Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions* (367)

TITLE INDEX

Estimation
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
*Estimation of Chest Wall Thickness in Lung Counting for Plutonium** (259)
Plutonium Transport and Dose Estimation Model* (273)
The Estimation of a Body Burden of Plutonium for Urinalysis Data* (288)
Evapoation
Evapoation Of Alpha Bearing Aqueous Wastes On a Laboratory Scale* (176)
Excitation
*Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy** (376)
Excreta
Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection* (312)
Excretion
Retention and Excretion* (3)
Actual Problems of the Distribution of Radioisotopes and the Kinetics of their Excretion* (74)
Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes* (75)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle* (114)
Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle* (120)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
Distribution and Excretion of Plutonium Administered Intravenously to Man* (270)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Experience
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
Experiences
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Explosion
Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles* (336)
Explosions
Medium Properties and Total Energy Coupling in Underground Explosions* (227)
Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions* (367)
Exposed
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Exposure
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
*Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide** (71)
An Assessment of the Long-Term Exposure Due to Resuspension. Part 2* (232)
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)
*Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements** (297)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Exposures
Population Exposures* (329)
Extraction
Solvent Extraction of Plutonium with Primary Amines* (178)
Solvent Extraction of Neptuminum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)
Extracts
The Determination of Plutonium 238 and Curium 242 in Aqueous Soil Extracts* (374)
Fabrication
Design and Fabrication of Plutonium Sources for Cardiac Pacemakers* (340)
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Facilities
Reactor and Fuel Production Facilities, 1972 Environmental Release Report* (318)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)
Facility
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
Decontamination of a Highly Radioactive Chemical Processing Facility* (391)
The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility* (408)
Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF"* (413)
Transuranic-Contaminated Solid Waste Treatment Development Facility, A413* (414)
Failure
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Fallout
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, *240: A New Approach to the Chemistry of Environmental Radionuclides** (182)
Records of Plutonium Fallout in Marine and Terrestrial Samples* (198)

TITLE INDEX

Fallout
Fallout Plutonium in Swedish Reindeer Lichens* (204)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Scales of Atmospheric Motion and their Impact on the Fallout Problem* (335)
Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles* (336)
Fallout Program Quarterly Summary Report, Appendix* (349)
Methods of Fallout Measurements Used in India* (355)
Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska* (368)
Fasting
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Fauna
Effect of Soil Pollution with Plutonium 239 on Field Fauna* (54)
February
Report for Month Ending February 29, 1944* (159)
Feces
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
Determination of Plutonium in Human Feces* (183)
Fed
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Female
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Fibroplastic
Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust* (107)
FIDLER
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
A Different Look at Area 13 FIDLER Survey Data* (317)
Field
Effect of Soil Pollution with Plutonium 239 on Field Fauna* (54)
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
Filters
Different Type Glove Box Filters Used for Plutonium 238 Work* (313)
Fish
Effect of Internal Irradiation on Fish* (26)
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
Fission
Fission Product Inhalation Program Annual Report, 1971-1972* (150)
Fission Track Autoradiographs* (285)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy* (376)
Safety Principles In the Storage Of Fission Products* (420)
Fissioning
Internal Dosimetry of Spontaneously Fissioning Nuclides* (321)
Fixation
Polymeric Media for Tritium Fixation* (424)
Flash
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Flats
Resuspension of Plutonium at Rocky Flats* (243)
Radioactive Effluent Monitoring at the Rocky Flats Plant* (331)
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Resuspension of Plutonium at Rocky Flats* (396)
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)
Fluids
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Fluorescent
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)
Foliarly
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Foliary
Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds* (163)
Food
Dose Estimates for the Marine Food Chain* (196)
Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops* (303)
Foodstuffs
Total Alpha Activity Determination in Foodstuffs* (325)
Form
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Formation
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)
Forms
The Disposition of Inhaled Plutonium. Part 1. Comparison of Chemical Forms* (16)
Fraction
Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine* (322)

TITLE INDEX

Fractional
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Fractional Airborne Release of Plutonium Under Shipping Accident Conditions* (383)
Frequency
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Frequency and Diurnal Variation of Dust in the Continental United States* (234)
Fuel
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Reactor and Fuel Production Facilities, 1972 Environmental Release Report* (318)
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Fuels
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Function
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Airborne Dust Size Distributions as a Function of Wind Speed* (240)
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Fundamentals
An Overview of Fundamentals for Radiation Measurements* (379)
Fungi
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)
Future
Future Considerations in the Shipment of Plutonium* (223)
Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes* (421)
Gastrointestinal
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Gaussian
The Resuspension Ratio for a Gaussian Plume* (231)
Ge
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Generalized
Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination* (269)
Generator
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Geologic
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Germanium
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Global
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
Glove
Different Type Glove Box Filters Used for Plutonium 238 Work* (313)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Glucan
Removal of Plutonium from Mouse Liver by Glucan and DTPA* (93)
Removal of Polymeric Plutonium from Dogs with DTPA and Glucan* (95)
Grand
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Grazing
Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada* (109)
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site* (192)
Greenland
A Preliminary Report on the B-52 Accident in Greenland on January 21, 1968* (206)
Groundwaters
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)
Guide
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Guides
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)

TITLE INDEX

Gut
Absorption from the Gut of Suspension of Plutonium Sodium Aerosol* (8)

H
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Mammalian Radiobiology Group (H-4)* (152)
Environmental Studies Group (H-8)* (205)

Hamster
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)

Hamsters
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)

Hands
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)

Hanford
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967* (419)

Harm
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)

Harmful
Is All Nuclear Radiation Harmful?* (401)

Hazards
Uranium Mining Hazards* (389)

Health
Monthly Health Report on Problems Relating to Product* (11)
Monthly Health Report on Problems Related to Product* (12)
Health Information Meeting, January 16, 1945* (84)
Environmental and Radiation Effects on the Dental Health of Beagles* (89)
Report of Health Activities for Month of August, 1945* (136)
Monthly Health Report on Problems Relating to Product for Month of May 1945* (143)
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Medical and Health Physics Section, Progress Report for May 1947* (146)
Report of Health Activities for Month of October, 1945* (147)
Report of Health Activities for Month of June, 1945* (148)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Report of Health Activities for Month of November, 1945* (158)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources* (216)
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Quantitative Health Estimates of Transuranic Releases* (256)
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Assessment of Potential Health Consequences of Transuranium Elements* (310)
Reference Levels in Health Physics* (387)
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)
Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners* (399)
Monthly Health Report on Problems Relating to Product for Period Ending October 31, 1944* (403)

Heat
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)

Heavy
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)

Height
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)

Hematological
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)

Hematopoiesis
Hematopoiesis in Dogs Submitted to Subacute Plutonium 239 Intoxication* (5)
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)

Hexylphosphinyl
Solvent Extraction of Neptuninum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)

Histological
Histological Effects of Product on Mice* (91)

Histopathologic
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Autoradiographic and Histopathologic Studies in Radiation Carcinogenesis of the Lung* (58)

Holland
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)

Homeostasis
Homeostasis of the Alveolar Macrophage Population* (65)

Hot
Radiation Standards for Hot Particles* (307)
Hot Spots or Hot Lungs* (311)
Hot Spot Mechanisms* (334)

Human
Determination of Plutonium in Human Feces* (183)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
Distribution of Plutonium Observed in Human Blood* (292)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range* (371)
Humans
Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans* (283)
Chemistry of Plutonium Incorporated in Humans* (301)
Humid
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Idaho
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
Immunological
Early Changes in Certain Immunological Indices in the Case of Plutonium 239 Lesion of Experimental Animals* (108)
Impact
Scales of Atmospheric Motion and their Impact on the Fallout Problem* (335)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Implications
Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources* (216)
The Implications of Sampling from a Log-Normal Population* (369)
Incidence
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
Bone Sarcoma Incidence vs. Alpha Particle Dose* (296)
Incineration
Pyrolysis-Incineration of Combustible Alpha Wastes* (416)
Incised
Report About a Plutonium 239 Contaminated, Lacerated and Incised Wound* (282)
Index
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
India
Methods of Fallout Measurements Used in India* (355)
Indices
Early Changes in Certain Immunological Indices in the Case of Plutonium 239 Lesion of Experimental Animals* (108)
Industrial
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
Industry
International Safeguards and Nuclear Industry* (226)
The Atomic Energy Industry's Approach to Environmental Protection* (254)
Information
Health Information Meeting, January 16, 1945* (84)
Environmental Sciences Information Storage and Retrieval System* (212)
Information and Research: An Essential Partnership* (214)
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Ingestion
Ingestion of Plutonium Oxide Particles by Swine* (112)
Inhalation
Inhalation of Plutonium* (1)
Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route* (4)
Oxygenation of Rat Blood Following Inhalation of Plutonium 239* (50)
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection* (64)
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Inhalation of Plutonium by Rats* (126)
Fission Product Inhalation Program Annual Report, 1971-1972* (150)
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range* (371)
Plutonium Inhalation: The Burden of Negligible Consequence* (402)
Inhaled
Metabolism and Distribution of Inhaled Plutonium in Rats* (2)
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
The Disposition of Inhaled Plutonium. Part 1. Comparison of Chemical Forms* (16)
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)
Toxicology of Inhaled Plutonium* (141)
Inhaled Radioelements* (295)

TITLE INDEX

Initial
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Initiation
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Injected
The Terminal Blood Chemistry of Radioisotope Injected Dogs* (31)
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
Injection
Injection Tables* (24)
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Injection Tables* (43)
An Apparatus for Maintaining a Slow and Constant Rate of Injection* (113)
Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection* (121)
Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection* (312)
Injured
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
Injury
Comparative Morphology of Chronic Radioisotope Injury* (123)
The Problem of Liver Pathochemistry After Injury with Plutonium 239* (133)
Insoluble
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung* (157)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Installations
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Intake
Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans* (283)
Integration
Integration of Environmental Programs at a Diversified Nuclear Production Site* (365)
Intensity
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Interactions
In Vivo Studies on the Interactions of Plutonium(+4) with Blood Constituents* (118)
In Vitro Studies of the Interactions of Plutonium(+4) with Blood Proteins* (119)
Internal
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)
Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program* (21)
Effect of Internal Irradiation on Fish* (26)
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes* (278)
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Internal Dosimetry of Spontaneously Fissioning Nuclides* (321)
Internally
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
International
International Safeguards and Nuclear Industry* (226)
Interpretation
The Interpretation Of Data Relating to Plutonium Contamination* (266)
Interpretive
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Intoxication
Hematopoiesis in Dogs Submitted to Subacute Plutonium 239 Intoxication* (5)
Intracavity
Dosimetry of Californium 252 Intracavity Applications Based on the Revised Manchester System* (251)
Intramuscularly
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
Intraperitoneal
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Intratracheal
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)

Intravenous
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection* (121)
Intravenously
Distribution and Excretion of Plutonium Administered Intravenously to Man* (270)
Inventory
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Ionizing
Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust* (107)
Ionizing Radiation and Wild Birds: A Review* (207)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Iron
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Irradiation
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)
Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program* (21)
Effect of Internal Irradiation on Fish* (26)
Influence of Irradiation on the Incorporation of Radionuclides* (40)
Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone* (122)
Isotope
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Isotopes
Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes* (75)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
Italy
Data on Environmental Radioactivity Collected in Italy, January-December, 1970* (352)
January
Health Information Meeting, January 16, 1945* (84)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
A Preliminary Report on the B-52 Accident in Greenland on January 21, 1968* (206)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Data on Environmental Radioactivity Collected in Italy, January-December, 1970* (352)
Mound Laboratory@@Laboratory, January-December, 1972* (353)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Joint
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
July
Plutonium in Airborne Particles, July-September 1972* (347)
Mound Laboratory, July-December, 1970* (354)
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
Junction
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
June
Report of Health Activities for Month of June, 1945* (148)
Karlsruhe
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Kinetics
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Actual Problems of the Distribution of Radioisotopes and the Kinetics of their Excretion* (74)
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Kinetics of Exchange and Biological Action of Americium 241 in Dogs* (79)
Labeled
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)
Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51* (184)
Labelled
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range* (371)
Laboratory
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Evapoation Of Alpha Bearing Aqueous Wastes On a Laboratory Scale* (176)
Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report* (189)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)

TITLE INDEX

Laboratory
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine* (322)
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples* (344)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Mound Laboratory@@Laboratory, January-December, 1972* (353)
Mound Laboratory, July-December, 1970* (354)
Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report* (363)
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility* (408)
Lacerated
Report About a Plutonium 239 Contaminated, Lacerated and Incised Wound* (282)
Lactic
Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs* (98)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
Lagoon
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Lake
Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water* (370)
Land
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Lavage
Pulmonary Lavage, Therapy of Pulmonary Contaminations* (55)
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide* (149)
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Lawrence
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report* (363)
Layer
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Leach
Decontamination and Densification of Chop-Leach Cladding Residues* (412)
Leachability
Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds* (163)
Lesion
Early Changes in Certain Immunological Indices in the Case of Plutonium 239 Lesion of Experimental Animals* (108)
Lethal
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)
Li
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Lichens
Fallout Plutonium in Swedish Reindeer Lichens* (204)
Light
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Lightning
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Limitations
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Linear
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Liposome
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Liquid
Liquid Scintillation Counting of Alpha Emitters* (338)
Literature
Plutonium Metabolism. A Literature Review* (52)
Lithium
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Lithosphere
Studies of the Behavior of Plutonium and Americium in the Lithosphere* (229)
Liver
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Removal of Plutonium from Mouse Liver by Glucan and DTPA* (93)
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
The Problem of Liver Pathochemistry After Injury with Plutonium 239* (133)

TITLE INDEX

Livermore
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report* (363)
Local
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination* (269)
Localized
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
Log
The Implications of Sampling from a Log-Normal Population* (369)
Logistics
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Look
A Different Look at Area 13 FIDLER Survey Data* (317)
Los
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility* (408)
Low
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
Nuclear Track Technique for Low Level Plutonium in Urine* (186)
The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting* (247)
Radiation Doses and Possible Radiation Effects of Low-Level, Chronic Radiation in Vegetation* (357)
Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy* (376)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Lumbar
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
Luminous
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Lung
Autoradiographic and Histopathologic Studies in Radiation Carcinogenesis of the Lung* (58)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung* (157)
Estimation of Chest Wall Thickness in Lung Counting for Plutonium* (259)
Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239* (265)
Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975* (284)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Lungs
Hot Spots or Hot Lungs* (311)
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
LWR
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Lydase
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)
Lymph
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Effects of Transuranics on Pulmonary Lymph Nodes of Rodents* (101)
Lymphadenitis
Plutonium-Induced Popliteal Lymphadenitis in Beagles* (15)
Lymphocytes
Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans* (283)
Macrophage
Homeostasis of the Alveolar Macrophage Population* (65)
Macrophages
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Maintaining
An Apparatus for Maintaining a Slow and Constant Rate of Injection* (113)
Male
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Mammalian
Mammalian Radiobiology Group (H-4)* (152)
Mammary
Rat Mammary Neoplasia Following Deposition of Plutonium* (103)
Man
The Effect of Skeletally Deposited Alpha-Ray Emitters in Man* (260)
Radiation Sickness in Man* (264)
Distribution and Excretion of Plutonium Administered Intravenously to Man* (270)
Removal of Plutonium and Other Transuranic Elements from Man* (276)
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)

TITLE INDEX

Man
Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols* (305)
Management
Nuclear Accidents and their Management* (271)
Medical Management of Radioactively Contaminated Wounds* (294)
Nuclear Materials Management and Safeguards* (400)
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Advanced Methods for Management and Disposal of Radioactive Wastes* (407)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
Manchester
Dosimetry of Californium 252 Intracavity Applications Based on the Revised Manchester System* (251)
Manual
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
March
Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975* (284)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Marine
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
The Alpha Radioactivity of Marine Organisms* (194)
Dose Estimates for the Marine Food Chain* (196)
Records of Plutonium Fallout in Marine and Terrestrial Samples* (198)
Mass
Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles* (336)
Materials
The Metabolic Properties of Various Materials. Tracer Studies, Versene Studies with Plutonium* (36)
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Nuclear Materials Management and Safeguards* (400)
Mathematical
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Maximum
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (261)
Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements* (386)
Measure
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Measured
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
Measurement
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine* (322)
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
Measurements
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239* (265)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)
Methods of Fallout Measurements Used in India* (355)
An Overview of Fundamentals for Radiation Measurements* (379)
Measuring
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
Mechanism
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
Mechanisms
Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust* (107)
Mechanisms of Development of Plutonium Pneumosclerosis* (128)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)
Hot Spot Mechanisms* (334)
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Media
Polymeric Media for Tritium Fixation* (424)
Medical
Division of Biological and Medical Research, Annual Report, 1973* (86)
Biological and Medical Research Division, Annual Report, 1967* (137)
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Medical and Health Physics Section, Progress Report for May 1947* (146)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Medical Uses: Americium 241, Californium 252* (287)
Medical Management of Radioactively Contaminated Wounds* (294)
Medicine
Tritium in Biomedical Research and Clinical Medicine* (261)
Medium
Medium Properties and Total Energy Coupling in Underground Explosions* (227)
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)

TITLE INDEX

Meeting
Health Information Meeting, January 16, 1945* (84)
Mesothorium
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Metabolic
Technical Progress Report on the Metabolic Studies of Product* (34)
Technical Progress Report on the Metabolic Studies of Product* (35)
The Metabolic Properties of Various Materials. Tracer Studies, Versene Studies with Plutonium* (36)
Technical Progress Report on the Metabolic Studies of Product* (37)
Metabolic and Therapeutic Studies of Plutonium and Americium* (57)
Metabolism
Metabolism and Distribution of Inhaled Plutonium in Rats* (2)
Metabolism of Product for Period Ending October 15, 1944* (33)
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Plutonium Metabolism. A Literature Review* (52)
Americium Metabolism in Beagles* (59)
Cortisol Metabolism in Skin of Beagles Bearing Americium 241* (83)
Metals
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)
Meteorological
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
MeV
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Mexico
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Mice
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Some Further Notes on the Mice Treated with Plutonium Before Weaning* (28)
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
Histological Effects of Product on Mice* (91)
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)
Michigan
Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water* (370)
Microscopic
Microscopic Distribution of Plutonium 239 and Thorium 228 in Beagles* (46)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Milk
The Transfer of Plutonium 239 from the Diet of a Cow to Its Milk* (104)
Plutonium 239 in Total Diet and Milk* (333)
Mine
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine* (322)
Miner
Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975* (284)
Mineralized
Determination of Localized Dose II From Alpha-Emitters Buried in Mineralized Bone* (67)
Miners
Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners* (399)
Mining
Uranium Mining Hazards* (389)
Mixed
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
Model
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Plutonium Transport and Dose Estimation Model* (273)
Models
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Mojave
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Monitor
Plutonium Sensitive Alpha Air Monitor* (346)
Monitoring
Radioactive Effluent Monitoring at the Rocky Flats Plant* (331)
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System* (359)
Environmental Monitoring at the Lawrence Livermore Laboratory, 1974 Annual Report* (363)
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
Monodisperse
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51* (184)
Monomeric
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)

TITLE INDEX

Month
Report of Health Activities for Month of August, 1945* (136)
Monthly Health Report on Problems Relating to Product for Month of May 1945* (143)
Report of Health Activities for Month of October, 1945* (147)
Report of Health Activities for Month of June, 1945* (148)
Report of Health Activities for Month of November, 1945* (158)
Report for Month Ending February 29, 1944* (159)
Monthly
Monthly Health Report on Problems Relating to Product* (11)
Monthly Health Report on Problems Related to Product* (12)
Monthly Health Report on Problems Relating to Product for Month of May 1945* (143)
Monthly Health Report on Problems Relating to Product for Period Ending October 31, 1944* (403)
Morphology
Comparative Morphology of Chronic Radioisotope Injury* (123)
Motion
Scales of Atmospheric Motion and their Impact on the Fallout Problem* (335)
Mound
Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report* (189)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Mound Plutonium Study* (351)
Mound Laboratory@@Laboratory, January-December, 1972* (353)
Mound Laboratory, July-December, 1970* (354)
Mouse
Removal of Plutonium from Mouse Liver by Glucan and DTPA* (93)
N
Solvent Extraction of Neptuninum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)
NaI
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
Nation
Some Observations Obtained from a Nation-Wide In Vivo Counting Service* (330)
National
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
Nations
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Natural
Plutonium 238 Release in Simulated Natural Environments* (236)
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Negligible
Plutonium Inhalation: The Burden of Negligible Consequence* (402)
Neoplasia
Rat Mammary Neoplasia Following Deposition of Plutonium* (103)
Neptuminum
Solvent Extraction of Neptuminum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)
Neptunium
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Neutron
An Improved Technique for Neutron-Induced Autoradiography of Bone Containing Plutonium* (249)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)
Neutrons
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Nevada
Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada* (109)
Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site* (192)
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Plutonium Distribution in the Environs of the Nevada Test Site--Status Report* (314)
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974* (324)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)

TITLE INDEX

Nevada
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
NIGER
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
Nitrate
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
Nitrides
Bibliography of Properties Data on Actinide Carbides and Nitrides* (380)
NNTRP
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
No
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Nodes
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Effects of Transuranics on Pulmonary Lymph Nodes of Rodents* (101)
Non
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Nonsense
Sense and Nonsense Over Plutonium Toxicity* (392)
Normal
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)
The Implications of Sampling from a Log-Normal Population* (369)
Notes
Some Further Notes on the Mice Treated with Plutonium Before Weaning* (28)
November
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Report of Health Activities for Month of November, 1945* (158)
NTS
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Nuclear
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Nuclear Track Technique for Low Level Plutonium in Urine* (186)
Bibliographies in Nuclear Science and Technology* (199)
Nuclear Power and the Environment* (213)
Reported Nuclear Detonations, April 1973* (225)
International Safeguards and Nuclear Industry* (226)
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Nuclear Accidents and their Management* (271)
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols* (305)
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles* (336)
Integration of Environmental Programs at a Diversified Nuclear Production Site* (365)
Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions* (367)
Radionucides from Nuclear Power Reactors* (381)
Nuclear Materials Management and Safeguards* (400)
Is All Nuclear Radiation Harmful?* (401)
Radiological Factors Affecting Decision-Making in a Nuclear Attack* (404)
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Nucleus
Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy* (376)
Nuclides
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Internal Dosimetry of Spontaneously Fissioning Nuclides* (321)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Numbers
Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples* (344)
Oak
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Occupational
Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners* (399)
Ocean
Plutonium Observed on Algal Surfaces in the Ocean* (164)
October
Metabolism of Product for Period Ending October 15, 1944* (33)
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Report of Health Activities for Month of October, 1945* (147)
Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974* (324)
Monthly Health Report on Problems Relating to Product for Period Ending October 31, 1944* (403)

TITLE INDEX

Offsite
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
Operating
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Operation
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Operations
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Organism
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Combined Effect of Strontium 90, Cerium 144 and Plutonium 239 on the Rat Organism (Report 1)* (76)
Combined Effect of Strontium 90, Cerium 144, and Plutonium 239 on the Rat Organism (Report 2)* (77)
Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism* (127)
Organisms
The Alpha Radioactivity of Marine Organisms* (194)
Organs
The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection* (64)
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Osteosarcomas
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
Outlook
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Overview
An Overview of Fundamentals for Radiation Measurements* (379)
Oxide
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Ingestion of Plutonium Oxide Particles by Swine* (112)
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide* (149)
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
Oxygenation
Oxygenation of Rat Blood Following Inhalation of Plutonium 239* (50)
O2
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Pacemakers
Design and Fabrication of Plutonium Sources for Cardiac Pacemakers* (340)
Parameters
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Parenterally
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Park
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Particle
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
Bone Sarcoma Incidence vs. Alpha Particle Dose* (296)
Particle Resuspension Rates* (395)
Particles
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Ingestion of Plutonium Oxide Particles by Swine* (112)
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide* (149)
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
On the "Dissolution" of Respirable Plutonium Dioxide Particles* (262)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Radiation Standards for Hot Particles* (307)
Calculation of the Relative Concentration and of the Mass of Nuclear Explosion Fallout Particles* (336)
Plutonium in Airborne Particles, July-September 1972* (347)
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range* (371)
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)

TITLE INDEX

Particulates
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Partnership
Information and Research: An Essential Partnership* (214)
Pathochemistry
The Problem of Liver Pathochemistry After Injury with Plutonium 239* (133)
Pathologic
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)
Pattern
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Pentacin
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)
Pentacynium
The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection* (64)
People
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Permissible
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements* (297)
Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements* (386)
pH
Chemical Coagulation of Radioactive Wastes at High pH* (415)
Phase
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Physics
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Medical and Health Physics Section, Progress Report for May 1947* (146)
Reference Levels in Health Physics* (387)
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)
Physiological
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)
Phytoplankton
Assimilablity of Plutonium, Ruthenium, and Technetium by Phytoplankton* (165)
Pig
Effectiveness of DTPA in Removing Plutonium from the Pig* (111)
Planned
Weapon Effects Tests--Planned Emergencies* (394)
Plant
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Environmental Tritium Studies at a PWR Power Plant* (191)
Radioactive Effluent Monitoring at the Rocky Flats Plant* (331)
Plutonium in Soil at the Savannah River Plant* (342)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
A Research Program on Transuranic Elements in Soil-Plant Systems* (382)
Savannah River Plant Effluent Reduction Program* (426)
Plants
Uptake of Plutonium and Americium by Plants from Soils* (171)
Curium Behavior in Plants and Soil* (172)
Americium Uptake by Plants from Soil* (173)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Plasma
Electrophoretic Analysis of Blood Plasma* (81)
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Plume
The Resuspension Ratio for a Gaussian Plume* (231)
Plutonium
Inhalation of Plutonium* (1)
Metabolism and Distribution of Inhaled Plutonium in Rats* (2)
Hematopoiesis in Dogs Submitted to Subacute Plutonium 239 Intoxication* (5)
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
A Study of the Deposition and Retention of Plutonium Dioxide in Rats* (7)
Absorption from the Gut of Suspension of Plutonium Sodium Aerosol* (8)
The Effect of Plutonium 239 Dioxide Particle Size on the Frequency of Chromosome Aberrations in the Liver Cells of the Chinese Hamster* (9)
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Plutonium-Induced Popliteal Lymphadenitis in Beagles* (15)
The Disposition of Inhaled Plutonium. Part 1. Comparison of Chemical Forms* (16)
Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones* (17)
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)
Some Further Notes on the Mice Treated with Plutonium Before Weaning* (28)
Distribution of Plutonium 239 in Male CBA Mice After Intravenous and Intraperitoneal Injection* (32)
The Metabolic Properties of Various Materials. Tracer Studies, Versene Studies with Plutonium* (36)
An Analysis of the Retention of Plutonium by the Tissues of the Rat* (38)
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)

TITLE INDEX

Plutonium
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Microscopic Distribution of Plutonium 239 and Thorium 228 in Beagles* (46)
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
The Long-Term Effects of Plutonium 239 in Adult Beagles* (49)
Oxygenation of Rat Blood Following Inhalation of Plutonium 239* (50)
Plutonium Metabolism. A Literature Review* (52)
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
Effect of Soil Pollution with Plutonium 239 on Field Fauna* (54)
Bone Tumors in Dogs Given Plutonium 239* (56)
Metabolic and Therapeutic Studies of Plutonium and Americium* (57)
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection* (64)
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Combined Effect of Strontium 90, Cerium 144 and Plutonium 239 on the Rat Organism (Report 1)* (76)
Combined Effect of Strontium 90, Cerium 144, and Plutonium 239 on the Rat Organism (Report 2)* (77)
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Effect of Plutonium on Dogs* (87)
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Removal of Plutonium from Mouse Liver by Glucan and DTPA* (93)
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
Removal of Polymeric Plutonium from Dogs with DTPA and Glucan* (95)
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Rat Mammary Neoplasia Following Deposition of Plutonium* (103)
The Transfer of Plutonium 239 from the Diet of a Cow to Its Milk* (104)
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
Early Changes in Certain Immunological Indices in the Case of Plutonium 239 Lesion of Experimental Animals* (108)
Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada* (109)
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)
Effectiveness of DTPA in Removing Plutonium from the Pig* (111)
Ingestion of Plutonium Oxide Particles by Swine* (112)
Absorption, Distribution, and Excretion of Plutonium by Dairy Cattle* (114)
Toxicity of the Transuranium Elements with Special Emphasis on Plutonium* (115)
Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs* (116)
Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239* (117)
In Vivo Studies on the Interactions of Plutonium(+4) with Blood Constituents* (118)
In Vitro Studies of the Interactions of Plutonium(+4) with Blood Proteins* (119)
Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle* (120)
Whole Body Counting of Plutonium in Dogs* (124)
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
Inhalation of Plutonium by Rats* (126)
Mechanisms of Development of Plutonium Pneumosclerosis* (128)
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
The Problem of Liver Pathochemistry After Injury with Plutonium 239* (133)
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
Toxicology of Inhaled Plutonium* (141)
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide* (149)
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Analysis of Data on the Clearance of Insoluble Compounds of Plutonium in the Lung* (157)
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds* (163)
Plutonium Observed on Algal Surfaces in the Ocean* (164)
Assimilablity of Plutonium, Ruthenium, and Technetium by Phytoplankton* (165)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)

TITLE INDEX

Plutonium
Uptake of Plutonium and Americium by Plants from Soils* (171)
Analytical Determinaton of Alpha Emitters in Feces (Plutonium, Americium, and Curium)* (177)
Solvent Extraction of Plutonium with Primary Amines* (178)
A Control Design for Plutonium Counting Systems* (179)
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Determination of Plutonium in Human Feces* (183)
Production of Monodisperse Aerosols of Plutonium 239 Dioxide Labeled with Chromium 51* (184)
A Study of the in vitro Solubility of Plutonium 239 Dioxide* (185)
Nuclear Track Technique for Low Level Plutonium in Urine* (186)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
Colloidal Properties of Plutonium in Dilute Aqueous Solution* (190)
Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site* (192)
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Administrative Procedures and Controls in Plutonium Production Areas* (197)
Records of Plutonium Fallout in Marine and Terrestrial Samples* (198)
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Fallout Plutonium in Swedish Reindeer Lichens* (204)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
The Radioecology of Plutonium and Other Transuranics in Desert Environments* (221)
Future Considerations in the Shipment of Plutonium* (223)
Studies of the Behavior of Plutonium and Americium in the Lithosphere* (229)
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
Plutonium 238 Release in Simulated Natural Environments* (236)
The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems* (237)
Resuspension of Plutonium at Rocky Flats* (243)
The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting* (247)
An Improved Technique for Neutron-Induced Autoradiography of Bone Containing Plutonium* (249)
Semiquantitative Determination of Uranium, Plutonium, and Americium in Seawater* (250)
Plutonium in Autopsy Tissue* (257)
Estimation of Chest Wall Thickness in Lung Counting for Plutonium* (259)
On the "Dissolution" of Respirable Plutonium Dioxide Particles* (262)
Alpha Absorption Measurements Applied to Lung Dose from Plutonium 239* (265)
The Interpretation Of Data Relating to Plutonium Contamination* (266)
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body* (268)
Diagnosis and Treatment of a Local and Afterwards Generalized Plutonium Contamination* (269)
Distribution and Excretion of Plutonium Administered Intravenously to Man* (270)
Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226* (272)
Plutonium Transport and Dose Estimation Model* (273)
Bronchopulmonary Lavage and DTPA Treatment of an Accidental Inhalation Plutonium 239 Exposure Case* (275)
Removal of Plutonium and Other Transuranic Elements from Man* (276)
On the Toxicity of Plutonium* (280)
Report About a Plutonium 239 Contaminated, Lacerated and Incised Wound* (282)
Chromosome Aberrations in Lymphocytes After Plutonium Intake by Humans* (283)
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
The Estimation of a Body Burden of Plutonium for Urinalysis Data* (288)
A Rapid Method for the Determination of Plutonium in Urine by Ultrafiltration* (290)
Plutonium in Puncture Wounds* (291)
Distribution of Plutonium Observed in Human Blood* (292)
Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements* (297)
Chemistry of Plutonium Incorporated in Humans* (301)
The Microscopic Distribution and Initial Deposition of Plutonium 239 in Human Bone* (302)
Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops* (303)
Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection* (312)
Different Type Glove Box Filters Used for Plutonium 238 Work* (313)
Plutonium Distribution in the Environs of the Nevada Test Site--Status Report* (314)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Plutonium 239 in Total Diet and Milk* (333)
*Design and Fabrication of Plutonium Sources for Cardiac Pacemakers** (340)
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)
Plutonium in Soil at the Savannah River Plant* (342)
Plutonium Sensitive Alpha Air Monitor* (346)
Plutonium in Airborne Particles, July-September 1972* (347)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)
Mound Plutonium Study* (351)
The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System* (359)
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water* (370)
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range* (371)
The Determination of Plutonium 238 and Curium 242 in Aqueous Soil Extracts* (374)
Experimental Study of the Fission Dynamics for the Plutonium 240 Nucleus at Low Excitation Energy* (376)
Characterization of Plutonium Aerosols from an Industrial Mixed-Oxide Fuel Fabrication Facility* (378)
Fractional Airborne Release of Plutonium Under Shipping Accident Conditions* (383)
Sense and Nonsense Over Plutonium Toxicity* (392)

TITLE INDEX

Plutonium
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Resuspension of Plutonium at Rocky Flats* (396)
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)
Plutonium Inhalation: The Burden of Negligible Consequence* (402)
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Details of the Disposal of Radioactive Wastes Contaminated with Plutonium 239* (410)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Removal of Plutonium from 234-5 Building Waste* (427)
Pneumosclerosis
Mechanisms of Development of Plutonium Pneumosclerosis* (128)
Poisoning
Diagnosis and Treatment of Radioactive Poisoning* (300)
Polluted
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)
Pollution
Effect of Soil Pollution with Plutonium 239 on Field Fauna* (54)
Polydisperse
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Polymeric
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
Removal of Polymeric Plutonium from Dogs with DTPA and Glucan* (95)
Removal of Polymeric Plutonium by DTPA Directed Into Cells by Liposome Encapsulation* (96)
Polymeric Media for Tritium Fixation* (424)
Ponies
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
Popliteal
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
Plutonium-Induced Popliteal Lymphadenitis in Beagles* (15)
Population
Homeostasis of the Alveolar Macrophage Population* (65)
Population Exposures* (329)
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
The Implications of Sampling from a Log-Normal Population* (369)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Populations
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
Potential
Considerations in Assessing the Potential Harm to Populations Exposed to Low Levels of Plutonium in Air* (142)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
Assessment of Potential Health Consequences of Transuranium Elements* (310)
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Power
Environmental Tritium Studies at a PWR Power Plant* (191)
Nuclear Power and the Environment* (213)
The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System* (359)
Radionuclides from Nuclear Power Reactors* (381)
Practicable
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Practice
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
Practices
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
Predicting
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Prediction
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Preliminary
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection* (121)
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
A Preliminary Report on the B-52 Accident in Greenland on January 21, 1968* (206)
Previously
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
Primary
Solvent Extraction of Plutonium with Primary Amines* (178)
The Use of Americium Dioxide as a Primary Standard for the Determination of Americium 241* (246)
Probabilities
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Proceedings
Proceedings of the Third Environmental Protection Conference* (224)
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)

TITLE INDEX

Products
Safety Principles In the Storage Of Fission Products* (420)
Profiles
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Programs
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Integration of Environmental Programs at a Diversified Nuclear Production Site* (365)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Progress
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program* (21)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Technical Progress Report on the Metabolic Studies of Product* (34)
Technical Progress Report on the Metabolic Studies of Product* (35)
Technical Progress Report on the Metabolic Studies of Product* (37)
Progress Report: Radioautography* (140)
Medical and Health Physics Section, Progress Report for May 1947* (146)
Analysis of Environmental Samples from the Mound Laboratory Area, Progress Report* (189)
Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975* (284)
Project
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Project Airstream* (337)
Prolonged
The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes* (278)
Proposal
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Prospective
Risk of Radioactive Contamination. Current and Prospective Problems* (274)
Prospects
Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes* (421)
Protection
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Proceedings of the Third Environmental Protection Conference* (224)
The Atomic Energy Industry's Approach to Environmental Protection* (254)
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
Proteins
In Vitro Studies of the Interactions of Plutonium(+4) with Blood Proteins* (119)
Pu
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Public
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Published
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Pulmonary
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)
Pulmonary Lavage, Therapy of Pulmonary Contaminations* (55)
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
Effects of Transuranics on Pulmonary Lymph Nodes of Rodents* (101)
Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide* (149)
Puncture
Plutonium in Puncture Wounds* (291)
Purposes
Sampling of Stores for Safeguards Purposes* (385)
PWR
Environmental Tritium Studies at a PWR Power Plant* (191)
Pyrolysis
Pyrolysis-Incineration of Combustible Alpha Wastes* (416)
Pyrophosphate
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)
Quantitative
Quantitative Autoradiographic Dose Determinations of Plutonium 239 in Bones* (17)
Quantitative Health Estimates of Transuranic Releases* (256)
Quarterly
Medical and Health Physics Quarterly Report, October, November, and December, 1950* (145)
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Fallout Program Quarterly Summary Report, Appendix* (349)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
Radiation
Transmission of Radiation-Induced Tumors in Beagle Dogs* (29)
Autoradiographic and Histopathologic Studies in Radiation Carcinogenesis of the Lung* (58)
Environmental and Radiation Effects on the Dental Health of Beagles* (89)
Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust* (107)

TITLE INDEX

Radiation
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
Bone Disease Induced by Radiation* (156)
Ionizing Radiation and Wild Birds: A Review* (207)
Radiation Sickness in Man* (264)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Radiation Standards for Hot Particles* (307)
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
The Dosimetry of the Radiation from Californium 252* (327)
Ambient Environmental Radiation Monitoring at the Lawrence Livermore Laboratory* (339)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Radiation Doses and Possible Radiation Effects of Low-Level, Chronic Radiation in Vegetation* (357)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
An Overview of Fundamentals for Radiation Measurements* (379)
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
Is All Nuclear Radiation Harmful?* (401)
Radioactive
A Device for the Contamination of Laboratory Animals by Inhalation of Radioactive Aerosols* (68)
Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes* (75)
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Analysis of the Effectiveness of Complexing Agents which Accelerate the Elimination of Radioactive Isotopes from the Body* (144)
Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources* (216)
Risk of Radioactive Contamination. Current and Prospective Problems* (274)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Diagnosis and Treatment of Radioactive Poisoning* (300)
Comparison of Excretion Analysis with Whole-Body Counting for Assessment of Internal Radioactive Contaminants* (309)
Radioactive Effluent Monitoring at the Rocky Flats Plant* (331)
Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory* (364)
Decontamination of a Highly Radioactive Chemical Processing Facility* (391)
Advanced Methods for Management and Disposal of Radioactive Wastes* (407)
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Details of the Disposal of Radioactive Wastes Contaminated with Plutonium 239* (410)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Chemical Coagulation of Radioactive Wastes at High pH* (415)
Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes* (421)
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Radioactively
Medical Management of Radioactively Contaminated Wounds* (294)
Radioactivity
The Alpha Radioactivity of Marine Organisms* (194)
Resuspension of Radioactivity Induced by Burning Crop Stubble* (244)
Radioactivity Levels in Enewetak Soil* (328)
Environmental Levels of Radioactivity at Atomic Energy Commission Installations. 1. Mound Laboratory, January-December, 1971* (348)
Data on Environmental Radioactivity Collected in Italy, January-December, 1970* (352)
Radioautographic
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)
Radioautography
Progress Report: Radioautography* (140)
Radiobiology
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program* (21)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Mammalian Radiobiology Group (H-4)* (152)
Radioecology
The Radioecology of Plutonium and Other Transuranics in Desert Environments* (221)
Radioelements
The Use of Zirconium and Other Carriers in the Removal of Radioelements from the Body. Comments on the Use of Complexing Agents* (92)
Inhaled Radioelements* (295)
Radioisotope
The Terminal Blood Chemistry of Radioisotope Injected Dogs* (31)
Comparative Morphology of Chronic Radioisotope Injury* (123)
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Radioisotopes
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)

TITLE INDEX

Radioisotopes
Actual Problems of the Distribution of Radioisotopes and the Kinetics of their Excretion* (74)
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
Radiological
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Radiological Factors Affecting Decision-Making in a Nuclear Attack* (404)
Radionucides
Radionucides from Nuclear Power Reactors* (381)
Radionuclide
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Radionuclides
Influence of Irradiation on the Incorporation of Radionuclides* (40)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
Radionuclides and Bone Strength* (155)
Radionuclides in the Environment* (175)
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Toxicology of Radionuclides* (289)
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)
Methods for Estimating the Production and Distribution of Radionuclides from Nuclear Cratering Explosions* (367)
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
Radiothorium
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Radium
Comparison of Effects of Lethal Body Burdens of Plutonium 239 and Radium 226 on Hematopoiesis in Beagles* (18)
Relative Biological Effectiveness of Radium and other Alpha Emitters in CF No. 1 Female Mice* (27)
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
Dose to Endosteal Cells and Relative Distribution Factors for Radium 224 and Plutonium 239 Compared to Radium 226* (272)
Radon
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
Effect of Metecrological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Raised
Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes* (421)
Rapid
A Rapid Method for the Determination of Plutonium in Urine by Ultrafiltration* (290)
Rat
An Analysis of the Retention of Plutonium by the Tissues of the Rat* (38)
Oxygenation of Rat Blood Following Inhalation of Plutonium 239* (50)
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Combined Effect of Strontium 90, Cerium 144 and Plutonium 239 on the Rat Organism (Report 1)* (76)
Combined Effect of Strontium 90, Cerium 144, and Plutonium 239 on the Rat Organism (Report 2)* (77)
Rat Mammary Neoplasia Following Deposition of Plutonium* (103)
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
Rate
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)
An Apparatus for Maintaining a Slow and Constant Rate of Injection* (113)
The Localized Concentration and Dose Rate Delivered by Plutonium 239 Deposited in Bone* (129)
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Rates
The Estimation of Radiation Dose Rates to Fish in Contaminated Environments, and the Assessment of the Possible Consequences* (139)
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
Particle Resuspension Rates* (395)
Rats
Metabolism and Distribution of Inhaled Plutonium in Rats* (2)
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
A Study of the Deposition and Retention of Plutonium Dioxide in Rats* (7)
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)
Effect of Pentacin and Lydase on the Rate of Americium 241 Elimination from the Body of Rats* (51)

TITLE INDEX

Rats
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
The Use of Pentacynium for the Removal of Plutonium 239 from the Organs of Rats in Inhalation Affection* (64)
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Inhalation of Plutonium by Rats* (126)
Ray
The Effect of Skeletally Deposited Alpha-Ray Emitters in Man* (260)
Reaction
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Reactor
General Characteristics of a Mathematical Model for Predicting Environmental and Human Health Effect of Developing Nuclear Reactor Programs* (258)
Reactor and Fuel Production Facilities, 1972 Environmental Release Report* (318)
The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System* (359)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Reactors
Radionucides from Nuclear Power Reactors* (381)
Readiness
Global Dose to Man from Proposed National Nuclear Test Readiness Program (NNTRP) High Altitude Nuclear Tests* (304)
Reconstruction
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Records
Records of Plutonium Fallout in Marine and Terrestrial Samples* (198)
Recurrent
The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes* (278)
Redistribution
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Reduced
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Reduction
Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements* (297)
Savannah River Plant Effluent Reduction Program* (426)
Region
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Registry
United States Transuranium Registry Study of Thirty Autopsies* (277)
Reindeer
Fallout Plutonium in Swedish Reindeer Lichens* (204)
Relationships
A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967* (419)
Release
Plutonium 238 Release in Simulated Natural Environments* (236)
Reactor and Fuel Production Facilities, 1972 Environmental Release Report* (318)
Fractional Airborne Release of Plutonium Under Shipping Accident Conditions* (383)
Releases
Dose Estimation and Prediction of Radiation Effects on Aquatic Biota Resulting from Radioactive Releases from the Nuclear Fuel Cycle* (135)
Quantitative Health Estimates of Transuranic Releases* (256)
Remedial
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Remodeling
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)
Removing
Effectiveness of DTPA in Removing Plutonium from the Pig* (111)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Repeated
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Reported
Reported Nuclear Detonations, April 1973* (225)
Repository
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Reprocessing
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
Research
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program* (21)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Division of Biological and Medical Research, Annual Report, 1973* (86)
Biological and Medical Research Division, Annual Report, 1967* (137)
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board* (153)
Information and Research: An Essential Partnership* (214)

TITLE INDEX

Research
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Tritium in Biomedical Research and Clinical Medicine* (261)
Studies on the Improvement of a Composite Dust Sampler and Its Utilization in Environmental Research* (332)
A Research Program on Transuranic Elements in Soil-Plant Systems* (382)
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Reservation
A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967* (419)
Residence
Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water* (370)
Residences
Cost Estimate for Remedial Action Program for Residences in the Grand Junction, Colorado Area* (390)
Residues
Decontamination and Densification of Chop-Leach Cladding Residues* (412)
Resistant
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)
Respirable
On the "Dissolution" of Respirable Plutonium Dioxide Particles* (262)
Respiratory
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Resuspension
Resuspension from a Uniform Area Source* (230)
The Resuspension Ratio for a Gaussian Plume* (231)
An Assessment of the Long-Term Exposure Due to Resuspension. Part 2* (232)
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Resuspension of Plutonium at Rocky Flats* (243)
Resuspension of Radioactivity Induced by Burning Crop Stubble* (244)
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
Resuspension Element Status Report* (377)
Resuspension Element Status Report* (384)
Particle Resuspension Rates* (395)
Resuspension of Plutonium at Rocky Flats* (396)
Retention
Retention and Excretion* (3)
A Study of the Deposition and Retention of Plutonium Dioxide in Rats* (7)
An Analysis of the Retention of Plutonium by the Tissues of the Rat* (38)
Americium 241 Retention in Beagles* (60)
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
The Early Retention and Distribution of Monomeric Plutonium 237(+4) and Plutonium 239(+4) in C57BL/Do Mice* (110)
Effects of Pulmonary Lavage on the Retention of Particles of Plutonium Oxide* (149)
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Retrieval
Environmental Sciences Information Storage and Retrieval System* (212)
Review
Plutonium Metabolism. A Literature Review* (52)
Ionizing Radiation and Wild Birds: A Review* (207)
A Review of Measured and Estimated Offsite Doses at Fuel Reprocessing Plants* (360)
A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967* (419)
Reynolds
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Richland
Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska* (368)
Ridge
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Risk
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Risk of Radioactive Contamination. Current and Prospective Problems* (274)
River
Plutonium in Soil at the Savannah River Plant* (342)

TITLE INDEX

River
Savannah River Plant Effluent Reduction Program* (426)
Rock
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)
Rocky
Resuspension of Plutonium at Rocky Flats* (243)
Radioactive Effluent Monitoring at the Rocky Flats Plant* (331)
A Possible Explanation of Apparent Anomalous Airborne Concentration Profiles of Plutonium at Rocky Flats* (361)
Resuspension of Plutonium at Rocky Flats* (396)
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)
Rodents
Effects of Transuranics on Pulmonary Lymph Nodes of Rodents* (101)
Roller
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Roughness
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Route
Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route* (4)
Rumen
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Russian
Russian-Thistle (SALSOLA) Species in Western United States* (200)
Ruthenium
Assimilablity of Plutonium, Ruthenium, and Technetium by Phytoplankton* (165)
s
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
The Atomic Energy Industry's Approach to Environmental Protection* (254)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Safeguards
International Safeguards and Nuclear Industry* (226)
Sampling of Stores for Safeguards Purposes* (385)
Nuclear Materials Management and Safeguards* (400)
Safety
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)
Safety Principles In the Storage Of Fission Products* (420)
Transportation Safety Studies* (423)
SALSOLA
Russian-Thistle (SALSOLA) Species in Western United States* (200)
Salt
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)
Sampler
Studies on the Improvement of a Composite Dust Sampler and Its Utilization in Environmental Research* (332)
Sampling
Discussion of Nevada Applied Ecology Group Distribution and Inventory Program Sampling Data in Preparation for Initiation of Phase 3* (315)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)
The Implications of Sampling from a Log-Normal Population* (369)
Sampling of Stores for Safeguards Purposes* (385)
Sarcoma
Bone Sarcoma Incidence vs. Alpha Particle Dose* (296)
Savannah
Plutonium in Soil at the Savannah River Plant* (342)
Savannah River Plant Effluent Reduction Program* (426)
Scale
Evapoation Of Alpha Bearing Aqueous Wastes On a Laboratory Scale* (176)
Scales
Scales of Atmospheric Motion and their Impact on the Fallout Problem* (335)
Scanner
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)
Science
Bibliographies in Nuclear Science and Technology* (199)
Sciences
Environmental Sciences Information Storage and Retrieval System* (212)
Scientific
Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972* (151)
Annual Report of the Biomedical and Environmental Research Program of the Los Alamos Scientific Laboratory Health Division, January-December 1973* (215)
Proposal to Designate Land Areas of the Los Alamos Scientific Laboratory as a National Environmental Research Park* (253)
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility* (408)
Scintillation
The Determination of Low-Level Plutonium Activity, Autoradiographic Techniques vs. Scintillation Counting* (247)
Liquid Scintillation Counting of Alpha Emitters* (338)

TITLE INDEX

Sea
Uranium of the Contemporaneous Sedimentary Cycle of the Sea* (193)
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Seawater
Semiquantitative Determination of Uranium, Plutonium, and Americium in Seawater* (250)
Sedimentary
Uranium of the Contemporaneous Sedimentary Cycle of the Sea* (193)
Sediments
Comparison of the Distributions in Marine Sediments of the Fallout Derived Nuclides Iron 55 and Plutonium 239, 240: A New Approach to the Chemistry of Environmental Radionuclides* (182)
Concentrations and Redistribution of Plutonium, Americium, and Other Radionuclides on Sediments at Bikini Atoll Lagoon* (195)
Selected
Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada* (109)
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Selective
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
Semi
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Semiannual
Research in Radiobiology, Semiannual Report of Progress in the Internal Irradiation Program* (21)
Semiquantitative
Semiquantitative Determination of Uranium, Plutonium, and Americium in Seawater* (250)
Sense
Sense and Nonsense Over Plutonium Toxicity* (392)
Sensitive
Plutonium Sensitive Alpha Air Monitor* (346)
September
Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974* (324)
Plutonium in Airborne Particles, July-September 1972* (347)
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
Sequence
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Serum
Serum Lactic Dehydrogenase Levels In Adult Beagle Dogs* (98)
Serum Lactic Dehydrogenase Levels in Adult Beagle Dogs with Internally Deposited Radionuclides* (99)
Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs* (116)
Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239* (117)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Service
Some Observations Obtained from a Nation-Wide In Vivo Counting Service* (330)
Setting
Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners* (399)
Shipment
Future Considerations in the Shipment of Plutonium* (223)
Shipping
Fractional Airborne Release of Plutonium Under Shipping Accident Conditions* (383)
Sickness
Radiation Sickness in Man* (264)
Simulant
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Simulated
Plutonium 238 Release in Simulated Natural Environments* (236)
Simultaneous
Mechanisms of the Simultaneous Effects of Ionizing Radiation and Fibroplastic Dust* (107)
Single
Behavior of Plutonium 239 in the Rat Organism Following Single and Repeated Intraperitoneal Administration* (63)
Site
Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site* (192)
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
Plutonium Distribution in the Environs of the Nevada Test Site--Status Report* (314)
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Integration of Environmental Programs at a Diversified Nuclear Production Site* (365)
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
Sites
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
Situ
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Situation
Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes* (421)
Sized
Analysis of Plutonium 239 and Americium 241 in Nevada Applied Ecology Group Large-Sized Bovine Samples* (341)

TITLE INDEX

Skeletally
The Effect of Skeletally Deposited Alpha-Ray Emitters in Man* (260)
Skeleton
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
Skin
Cortisol Metabolism in Skin of Beagles Bearing Americium 241* (83)
Dose Equivalent Rate in the Basal Layer of the Skin from Americium 241 Alpha Particles* (255)
Sludge
Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops* (303)
Sodium
Absorption from the Gut of Suspension of Plutonium Sodium Aerosol* (8)
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Soil
Effect of Soil Pollution with Plutonium 239 on Field Fauna* (54)
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (166)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 2. Alteration of Plutonium Form* (167)
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)
Curium Behavior in Plants and Soil* (172)
Americium Uptake by Plants from Soil* (173)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
The Behavior of Tritium in Soil* (217)
The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems* (237)
Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops* (303)
Determination of Americium 241 in Soil Using an Automated Nuclear Radiation Measurement Laboratory* (323)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada *Applied Ecology Group Study Sites* (326)*
Radioactivity Levels in Enewetak Soil* (328)
Plutonium in Soil at the Savannah River Plant* (342)
Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil* (350)
The Determination of Plutonium 238 and Curium 242 in Aqueous Soil Extracts* (374)
A Research Program on Transuranic Elements in Soil-Plant Systems* (382)
A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967* (419)
Soils
Uptake of Plutonium and Americium by Plants from Soils* (171)
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
Nevada Applied Ecology Group Soils Element Activities for the Period October, 1973 through September, 1974* (324)
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
Solid
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF"* (413)
Transuranic-Contaminated Solid Waste Treatment Development Facility, A413* (414)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Solubility
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
A Study of the in vitro Solubility of Plutonium 239 Dioxide* (185)
Soluble
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)
Solution
Colloidal Properties of Plutonium in Dilute Aqueous Solution* (190)
Solutions
The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems* (237)
Solvent
Solvent Extraction of Plutonium with Primary Amines* (178)
Solvent Extraction of Neptuminum(+6) Using Bis-(Di-N-Hexylphosphinyl) Alkanes* (180)
Somatic
*Somatic Effects in the Action of Americium 241 on Animals** (97)
Sorption
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Source
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Resuspension from a Uniform Area Source* (230)
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)
Physiological Effects of Plutonium and Health Physics. Plutonium as a Source of Alpha-Particles* (397)
Sources
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources* (216)
Design and Fabrication of Plutonium Sources for Cardiac Pacemakers* (340)

TITLE INDEX

Sources
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Southern
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Species
Distribution and Excretion of Three Chemical Species of Plutonium 239(+4) in the Beagle* (120)
Russian-Thistle (SALSOLA) Species in Western United States* (200)
Spectra
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Spectrometer
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Speed
Airborne Dust Size Distributions as a Function of Wind Speed* (240)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Spontaneously
Internal Dosimetry of Spontaneously Fissioning Nuclides* (321)
Spores
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
Spot
Hot Spot Mechanisms* (334)
Spots
Hot Spots or Hot Lungs* (311)
Stability
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Standard
The Use of Americium Dioxide as a Primary Standard for the Determination of Americium 241* (246)
Standards
Radiation Standards for Hot Particles* (307)
Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners* (399)
Statistical
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Status
Recent Status of Practical Application of Transuranic Elements* (211)
Plutonium Distribution in the Environs of the Nevada Test Site--Status Report* (314)
Resuspension Element Status Report* (377)
Resuspension Element Status Report* (384)
Sterilization
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
Storage
Environmental Sciences Information Storage and Retrieval System* (212)
Safety Principles In the Storage Of Fission Products* (420)
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)
Stores
Sampling of Stores for Safeguards Purposes* (385)
Strength
Radionuclides and Bone Strength* (155)
Strike
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Strontium
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
Combined Effect of Strontium 90, Cerium 144 and Plutonium 239 on the Rat Organism (Report 1)* (76)
Combined Effect of Strontium 90, Cerium 144, and Plutonium 239 on the Rat Organism (Report 2)* (77)
Structure
Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone* (122)
Stubble
Resuspension of Radioactivity Induced by Burning Crop Stubble* (244)
Subacute
Hematopoiesis in Dogs Submitted to Subacute Plutonium 239 Intoxication* (5)
Subjects
Plutonium in the Excreta of Three Subjects 10(E+4) Days After Injection* (312)
Submicron
The Production and Human Inhalation of Plutonium Labelled Particles in the Submicron Range* (371)
Subsoils
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Substances
Combined Effect of Complexing Substances Diuretics on the Behavior of Emitters in the Organism* (127)
Suggested
Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements* (297)
Summary
Index of Interpretive Articles Published in the Health and Safety Laboratory Fallout Program Quarterly Summary Reports--from 1958 through January 1, 1975* (220)
Fallout Program Quarterly Summary Report, Appendix* (349)

TITLE INDEX

Support
Information Support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory* (219)
Reynolds Electrical and Engineering Company Activities and Sample Logistics in Support of the Nevada Applied Ecology Group* (222)
Analytical Support* (319)
Surface
Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height* (241)
Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site* (366)
Studies of the Significance of Surface Contamination* (388)
Surfaces
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Plutonium Observed on Algal Surfaces in the Ocean* (164)
Survey
A Different Look at Area 13 FIDLER Survey Data* (317)
Suspended
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Suspension
Absorption from the Gut of Suspension of Plutonium Sodium Aerosol* (8)
Swedish
Fallout Plutonium in Swedish Reindeer Lichens* (204)
Swine
Ingestion of Plutonium Oxide Particles by Swine* (112)
Symposium
Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities* (405)
Synthesis
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
Syrian
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Exposure of Syrian Hamsters to Chromium 51 Labeled Aerosols of Plutonium 239 Dioxide* (71)
System
The Effect of Chemical Form on the Distribution and Excretion of Plutonium 239 Following Its Deposition in the Respiratory System of the Rat* (138)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Environmental Sciences Information Storage and Retrieval System* (212)
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Dosimetry of Californium 252 Intracavity Applications Based on the Revised Manchester System* (251)
Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples* (344)
The Zero Power Reactor Number 9 Airborne Plutonium Monitoring System* (359)
Systems
A Control Design for Plutonium Counting Systems* (179)
The Diffusion of Plutonium 238 in Aqueous Solutions and Soil Systems* (237)
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
A Research Program on Transuranic Elements in Soil-Plant Systems* (382)
General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants* (393)
Tables
Injection Tables* (24)
Injection Tables* (43)
Taranto
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
TDF
Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF"* (413)
Technetium
Comparative Animal Experiments Concerning the Distribution of Technetium 99m Pyrophosphate, Technetium 99m Diphosphonate and Strontium 85* (10)
Assimilablity of Plutonium, Ruthenium, and Technetium by Phytoplankton* (165)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
Effect of Selective Dissolution, Electrolytes, Aeration and Sterilization on Technetium 99 Sorption by Soils* (233)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Technical
Technical Progress Report on the Metabolic Studies of Product* (34)
Technical Progress Report on the Metabolic Studies of Product* (35)
Technical Progress Report on the Metabolic Studies of Product* (37)
Technology
Bibliographies in Nuclear Science and Technology* (199)
Teeth
Radioisotopes in Dog Teeth. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium* (44)
Temperatures
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Temporal
A Case of a Bone Tumor Arising from the Temporal Bone* (41)
term
Long-term Effects of Inhaled DTPA in Rats Previously Exposed to Plutonium 239 Nitrate Aerosol* (6)
The Long-Term Effects of Plutonium 239 in Adult Beagles* (49)
Some Effects of Long-Term Alpha Irradiation on the Composition and Structure of Bone* (122)
An Assessment of the Long-Term Exposure Due to Resuspension. Part 2* (232)
Population Exposure Estimates as Derived from an Environmental Assessment Of LWR Fuel Cycle Facilities, Part 2: Long-Term Population Doses Following Cessation Of Plant Operations* (373)
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)

TITLE INDEX

Terminal
The Terminal Blood Chemistry of Radioisotope Injected Dogs* (31)
Terrestrial
Records of Plutonium Fallout in Marine and Terrestrial Samples* (198)
A Comparison of the In-Situ Measurement of Terrestrial Americium with a Ge(Li) Spectrometer and a FIDLER* (252)
Therapeutic
Metabolic and Therapeutic Studies of Plutonium and Americium* (57)
The Efficiency of Bronchopulmonary Lavage as a Therapeutic Procedure for Removing Insoluble Radioactive Particles from the Lung* (293)
Therapy
Pulmonary Lavage, Therapy of Pulmonary Contaminations* (55)
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Thereof
Behavior of a Citrate Complex of Plutonium 239 in the Rat Organism Following Inhalation Thereof* (62)
Thermoelectric
Cost-Effective Radioisotope Thermoelectric Generator Designs Involving Curium 244 and Plutonium 239 Heat Sources* (210)
Thickness
Thickness of the Deposit of Plutonium and Radium at Bone Surfaces in the Beagle* (105)
Estimation of Chest Wall Thickness in Lung Counting for Plutonium* (259)
Thin
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
Third
Proceedings of the Third Environmental Protection Conference* (224)
Thirty
United States Transuranium Registry Study of Thirty Autopsies* (277)
Thistle
Russian-Thistle (SALSOLA) Species in Western United States* (200)
Thorium
Microscopic Distribution of Plutonium 239 and Thorium 228 in Beagles* (46)
Preliminary Report on the Effect of Number of Atoms on Thorium Distribution Following Intravenous Injection* (121)
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
Thoron
Effect of Meteorological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Thymidine
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
Thyroid
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)
Tissue
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue: Addendum* (30)
Lung Retention and Tissue Distribution of Inhaled Plutonium 239 Aerosols Produced at Different Temperatures* (72)
Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice* (94)
Effects of DTPA on Excretion and Tissue Distribution of Injected Plutonium 238 in Fed and Fasting Rats* (102)
Plutonium in Autopsy Tissue* (257)
An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue* (263)
Tissues
An Analysis of the Retention of Plutonium by the Tissues of the Rat* (38)
Kinetics of Curium 244 Accumulation in Organs and Tissues of Rats in Chronic Introduction of the Isotope Into the Body* (78)
Tl
Plutonium in Human Lungs: Assessment with Thin NaI(Tl) Detector Systems* (362)
Tonopah
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Toxic
Studies of the Metabolism and Toxic Action of Injected Radium. Part 2. The Hematological Effects of Parenterally Administered Radium, A Comparison of Plutonium and Radium Effects* (39)
Toxicity
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Comparative Toxicity of Radium 226, Plutonium 239, and Strontium 90 in Adult Beagles* (47)
Toxicity of Inhaled Polydisperse or Monodisperse Aerosols of Plutonium 238 Pu O2 in Syrian Hamsters* (69)
Toxicity of Inhaled Polydisperse on Monodisperse Aerosols of Americium 241 AmO2 in Syrian Hamsters* (70)
Acute Toxicity of Inhaled Plutonium 238 Dioxide in Beagle Dogs* (88)
Toxicity of the Transuranium Elements with Special Emphasis on Plutonium* (115)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (169)
Plutonium-Resistant Fungi and Actinomycetes in Soil. 1. Mechanisms of Plutonium Toxicity* (170)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
On the Toxicity of Plutonium* (280)
Sense and Nonsense Over Plutonium Toxicity* (392)
Toxicology
Toxicology of Inhaled Plutonium* (141)
Toxicology of Radionuclides* (289)
Trace
Heavy Metals as Trace Constituents in Natural and Polluted Groundwaters* (306)
Tracer
The Metabolic Properties of Various Materials. Tracer Studies, Versene Studies with Plutonium* (36)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)

TITLE INDEX

Tracer
Initial Particle Resuspension Rates--A Field Experiment Using Tracer Particles* (245)
Track
Nuclear Track Technique for Low Level Plutonium in Urine* (186)
Fission Track Autoradiographs* (285)
The Performance of a Fission Track Dosimeter for Monitoring the Neutron Radiation from Californium 252 Sources on Hands Inside Glove Boxes* (343)
Tract
Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract* (279)
Transaminase
Serum Transaminase Levels in Plutonium 239 Burdened Beagle Dogs* (116)
Serum Transaminase Levels in Beagle Dogs Burdened with Plutonium 239* (117)
Transfer
The Transfer of Plutonium 239 from the Diet of a Cow to Its Milk* (104)
Energy Spectra and Fractional Absorbed Dose Distributions in Linear Energy Transfer 14-MeV Neutrons* (375)
Transition
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Translocation
Translocation Kinetics of Plutonium Oxide from the Popliteal Lymph Nodes of Beagles* (14)
The Effect of Combinations of Chelating Agents on the Translocation of Intramuscularly Deposited Plutonium 239 Nitrate in the Rat* (131)
Transmission
Transmission of Radiation-Induced Tumors in Beagle Dogs* (29)
Transplutonic
Maximum Permissible Concentrations and Maximum Permissible Body Burdens for Transplutonic Elements* (386)
Transport
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Deposition, Leachability, and Transport of Foliary-Applied Plutonium Compounds* (163)
The Reaction of Plutonium(+4) with the Iron Transport System in Human Blood Serum* (187)
Plutonium Transport and Dose Estimation Model* (273)
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
Transportation
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
Transportation Safety Studies* (423)
Transuranic
Distribution and Removal of Transuranic Elements and Cerium Deposited by the Inhalation Route* (4)
Recent Status of Practical Application of Transuranic Elements* (211)
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Quantitative Health Estimates of Transuranic Releases* (256)
Removal of Plutonium and Other Transuranic Elements from Man* (276)
A Research Program on Transuranic Elements in Soil-Plant Systems* (382)
The Los Alamos Scientific Laboratory Transuranic Treatment Development Facility* (408)
Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF"* (413)
Transuranic-Contaminated Solid Waste Treatment Development Facility, A413* (414)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Transuranics
Effects of Transuranics on Pulmonary Lymph Nodes of Rodents* (101)
The Radioecology of Plutonium and Other Transuranics in Desert Environments* (221)
Transuranium
Toxicity of the Transuranium Elements with Special Emphasis on Plutonium* (115)
Transuranium Elements in the Atmosphere* (218)
United States Transuranium Registry Study of Thirty Autopsies* (277)
Suggested Reduction of Permissible Exposure to Plutonium and other Transuranium Elements* (297)
Assessment of Potential Health Consequences of Transuranium Elements* (310)
Radiation Protection Practices for Transuranium Radionuclides, A Manual of Good Practice* (398)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Trinity
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
Tritiated
Chromosomal Changes in Chinese Hamster Cells Following Cataneous Exposure to Tritiated Luminous Compounds* (13)
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
Tritium
Environmental Tritium Studies at a PWR Power Plant* (191)
The Behavior of Tritium in Soil* (217)
Tritium in Biomedical Research and Clinical Medicine* (261)
Laboratory System for Tritium Analysis of Large Numbers of Environmental Samples* (344)
Polymeric Media for Tritium Fixation* (424)
Tumor
A Case of a Bone Tumor Arising from the Temporal Bone* (41)
Tumor Incidence in C57 Black/6 Mice Treated with Tritiated Thymidine* (73)
Tumors
Pulmonary Tumors in Rats Following Intratracheal Introduction of Soluble Plutonium 239 Compounds* (25)
Transmission of Radiation-Induced Tumors in Beagle Dogs* (29)
Bone Tumors in Dogs Given Plutonium 239* (56)
Twenty
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
U
Assessment of Public Radiation Exposure in the Vicinity of U.S. Atomic Energy Commission Sites* (372)
UK
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Ultrafiltration
A Rapid Method for the Determination of Plutonium in Urine by Ultrafiltration* (290)

TITLE INDEX

Ultrastructural
Contribution to the Study of Pulmonary Retention and Disposal of Plutonium Oxide. Ultrastructural Study of Alveolar Macrophages* (61)
um
Early Distribution and Retention of 0.3 um Monodisperse Plutonium 239 Dioxide Particles in the Chinese Hamster* (90)
Underground
Medium Properties and Total Energy Coupling in Underground Explosions* (227)
Uniform
Resuspension from a Uniform Area Source* (230)
United
Russian-Thistle (SALSOLA) Species in Western United States* (200)
Frequency and Diurnal Variation of Dust in the Continental United States* (234)
United States Transuranium Registry Study of Thirty Autopsies* (277)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Uptake
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Biological Availability of Foliarly-Applied Plutonium 238 Aerosols: Factors Affecting Plant Uptake and Transport* (162)
Plant Uptake of Plutonium 239, 240 and Americium 241 from Soil Containing Aged Source Materials* (168)
Uptake of Plutonium and Americium by Plants from Soils* (171)
Americium Uptake by Plants from Soil* (173)
Accumulation of Technetium from Soil by Plants--A Potential Mechanism for Uptake and Toxicity* (174)
Uptakes
The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes* (278)
Uranium
Uranium (III), A Bibliography 1965 to 1973* (181)
Procedure for Measuring Uranium, Thorium, Radium, Plutonium, and Americium in Soil Samples* (188)
Uranium of the Contemporaneous Sedimentary Cycle of the Sea* (193)
Size Distribution of Radon Daughter Particles in Uranium Mine Atmospheres* (203)
Semiquantitative Determination of Uranium, Plutonium, and Americium in Seawater* (250)
Uranium Miner Lung Cancer Study, Progress Report, March 15, 1974-March 15, 1975* (284)
Measurement of the Free Fraction Present in the Air of a Laboratory Uranium Mine* (322)
Uranium Mining Hazards* (389)
Evaluation of Methods for Setting Occupational Health Standards for Uranium Miners* (399)
Urea
Urea Synthesis and Arginase Activity in Plutonium Injured Rats* (53)
Urinalysis
The Estimation of a Body Burden of Plutonium for Urinalysis Data* (288)
Urine
Nuclear Track Technique for Low Level Plutonium in Urine* (186)
A Rapid Method for the Determination of Plutonium in Urine by Ultrafiltration* (290)
US
A Preliminary Evaluation of the Biological Measurements on Operation Roller Coaster (Joint US/UK Experiments)* (154)
Valency
The Effect of Valency and Type of Plutonium 239 Chemical Compounds on Its Distribution in the Body* (268)
Values
Plasma Cortisol and Corticosterone Levels in Beagles. 1. Preliminary Values for Control and Radionuclide Bearing Animals* (82)
Variables
Influence of Selected Variables on Transport of Plutonium to Spores of ASPERGILLUS NIGER* (161)
Effect of Metecrological Variables on Atmospheric Suspended Particulates and Associated Natural Radon and Thoron Daughters* (356)
Vascularity
The Influence of Reduced Local Vascularity on the Rate of Internal Reconstruction in Adult Long Bone Cortex* (48)
Vegetation
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
Climates and Vegetation Pattern Across the Mojave/Great Basin Desert Transition of Southern Nevada* (201)
Plutonium 239-240 and Americium 241 Contamination of Vegetation in Aged Plutonium Fallout Areas* (209)
Statistical Analysis of Plutonium 239-240 and Americium 241 Contamination of Soil and Vegetation on Nevada Applied Ecology Group Study Sites* (326)
Radiation Doses and Possible Radiation Effects of Low-Level, Chronic Radiation in Vegetation* (357)
Velocities
The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses* (345)
Ventilation
*General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants** (393)
Versene
The Metabolic Properties of Various Materials. Tracer Studies, Versene Studies with Plutonium* (36)
Vertebral
The Localized Distribution of Plutonium 239 in the Lumbar Vertebral Centra of 5-Level Dogs* (130)
Vertebrates
Ecological Studies of Small Vertebrates in Plutonium-Contaminated Study Areas of Nevada Test Site and Tonopah Test Range* (202)
Vertical
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Vessels
The Effect of Internally Deposited Radioisotopes Upon the Blood Vessels Of Cortical Bone* (45)
Visualized
Pathologic and Normal Bone Remodeling as Visualized by Radioautographic Distribution of Plutonium* (42)

TITLE INDEX

Vitro
In Vitro Studies of the Interactions of Plutonium(+4) with Blood Proteins* (119)
The Solubility of Plutonium from Rumen Contents of Cattle Grazing on Plutonium-Contaminated Desert Vegetation in In Vitro Bovine Gastrointestinal Fluids* (134)
A Study of the in vitro Solubility of Plutonium 239 Dioxide* (185)
Vivo
Elimination by Pulmonary Lavage, In Vivo, of Inhaled Plutonium Oxide Particles--Description of Techniques Used* (85)
In Vivo Studies on the Interactions of Plutonium(+4) with Blood Constituents* (118)
In Vivo Solubility of Intramuscularly Injected Chromium 51-Plutonium 239 Oxide Particles* (125)
Operating Parameters and Limitations of a Germanium-Lithium Drifted Detector System for the In Vivo Measurement of Americium 241* (248)
Some Observations Obtained from a Nation-Wide In Vivo Counting Service* (330)
Volume
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes Volume 2: Effects* (298)
Ionizing Radiation: Levels and Effects. A Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly with Annexes. Volume 1: Levels* (299)
Vulnerable
Lightning Flash Densities and Calculation of Strike Probabilities to Certain Vulnerable Installations at the Nevada Test Site (NTS)* (316)
Wall
Estimation of Chest Wall Thickness in Lung Counting for Plutonium* (259)
Warm
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Washington
Atmospheric Fallout During 1974 at Richland, Washington and Point Barrow, Alaska* (368)
Waste
Potential Containment Failure Mechanisms and their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico* (409)
Transuranium Nuclides in the Environment from Management of Solid Radioactive Waste* (411)
Transuranic Contaminated Solid Waste Treatment Development Facility - "TDF"* (413)
Transuranic-Contaminated Solid Waste Treatment Development Facility, A413* (414)
Transuranic Solid Waste Management Research Programs, Quarterly Report, January-March, 1974* (417)
Nuclear Waste Management and Transportation Quarterly Report for July through September, 1975* (418)
A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967* (419)
Storage of Long and Medium-Term Radioactive Waste in a Rock Salt Formation in Holland* (422)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Removal of Plutonium from 234-5 Building Waste* (427)
Wastes
Evapoation Of Alpha Bearing Agueous Wastes On a Laboratory Scale* (176)
Health Implications of the Disposal of Radioactive Wastes and Wastes from Other Sources* (216)
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
Experiences in the Management of Plutonium-Containing Solid Wastes at the Nuclear Research Center, Karlsruhe* (406)
Advanced Methods for Management and Disposal of Radioactive Wastes* (407)
Details of the Disposal of Radioactive Wastes Contaminated with Plutonium 239* (410)
Chemical Coagulation of Radioactive Wastes at High pH* (415)
Pyrolysis-Incineration of Combustible Alpha Wastes* (416)
Present Situation and Future Prospects Regarding the Problems Raised by Radioactive Wastes* (421)
Water
Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water* (281)
A Study of Selected Parameters Affecting the Radiation Dose from Radionuclides in Drinking Water Downstream of the Hanford Project* (320)
Residence Times For Plutonium 239 and Cesium 137 in Lake Michigan Water* (370)
Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low As Practicable" Guides--Fabrication of Light-Water Reactor Fuels Containing Plutonium* (425)
Weaning
Some Further Notes on the Mice Treated with Plutonium Before Weaning* (28)
Weapon
Plutonium Uptake by Animals Exposed to a Non-Nuclear Detonation of a Plutonium-Bearing Weapon Simulant. Part 1. Field Operations* (132)
Weapon Effects Tests--Planned Emergencies* (394)
Weathering
Sorption of Neptunium 237 and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas as a Function of Sodium and Calcium Concentration* (238)
Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas* (239)
Western
Russian-Thistle (SALSOLA) Species in Western United States* (200)
Wet
Investigations of the Dose to Man from the Wet Deposition of Nuclear Aerosols* (305)
Wheat
A Field Study to Determine Plutonium Contents in Wheat and Soil in a Warm Humid Area* (160)
Wild
Ionizing Radiation and Wild Birds: A Review* (207)
Wind
Airborne Dust Size Distributions as a Function of Wind Speed* (240)
Experimental Design for Determining Tracer Resuspension Rates as a Function of Wind Speed and Atmospheric Stability* (242)
Work
Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program* (19)

TITLE INDEX

Work
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (20)
Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program* (22)
Research in Radiobiology, Semi annual Report of Work in Progress on the Chronic Toxicity Program* (23)
Different Type Glove Box Filters Used for Plutonium 238 Work* (313)
Wound
Plutonium Contaminated Wound Experience and Assay Techniques at the Los Alamos Scientific Laboratory* (267)
Report About a Plutonium 239 Contaminated, Lacerated and Incised Wound* (282)
Wounds
A Measure of the Effectiveness of DTPA Chelation Therapy in Cases of Plutonium Inhalation and Plutonium Wounds* (286)
Plutonium in Puncture Wounds* (291)
Medical Management of Radioactively Contaminated Wounds* (294)
Years
Maximum Vertical Displacement of Sea Level of the Taranto Region During the Last 125,000 Years and the Outlook for the Geologic Destination of Wastes Containing Transuranic Elements* (228)
The Distribution of Plutonium in Trinity Site Soils After Twenty-Eight Years* (235)
Yield
Absolute Neutron Yield of a Fluorescent Thyroid Scanner Source* (358)
Ytterbium
Inhalation Exposure of Ponies to Aerosols of Ytterbium 169 Labeled Plutonium 238 Dioxide* (66)
Yttrium
Plutonium and Yttrium Content of the Blood, Liver, and Skeleton of the Rat at Different Times After Intravenous Administration* (106)
Zirconium
The Use of Zirconium and Other Carriers in the Removal of Radioelements from the Body. Comments on the Use of Complexing Agents* (92)

PUBLICATION DESCRIPTION INDEX

A Report on the Inadequacy of Existing Radiation Protection Standards Related to Internal Exposure of Man to Insoluble Particles of Plutonium and other Alpha-Emitting Hot Particles 307

AAEC-LIB/BIB-362 400

AAEC-LIB/BIB-4071 181

AEC-tr-6944 76, 77

AEC-tr-7169 126, 127

AEC-tr-7387 128

AEC-tr-7401 264

AEC-tr-7430 108

AEC-tr-7512 123

AEC-tr-7571 79, 80

AEC-tr-7590 5, 50, 56, 62, 63, 75

AECD-2024-H 28

AECD-2372 39

AECD-2651 106

AECD-3200 145

AED-C-25-03 199

AFWL-tr-69-75 88

American Industrial Hygiene Association Journal, 36(6), 484-490 203

American Industrial Hygiene Association Journal, 36(8), 567-575 297

American Midland Naturalist, 93(1), 53-70 201

Analytical Chemistry, 47(11), 1866-1868 250

ANL-4625 140

ANL-5584 92

ANL-6637 288

ANL-7409 94, 137

ANL-75-3 (Part 2) 105, 272, 302, 312

ANL-8060 (Part 2) 285

ANL-8060 (Part 3) 370

ANL-8069 229

ANL-8070 57, 86

ANL/CEN/AF-100 380

Annual Review of Pharmacology, 13, 325-357 289

Archives des Maladies Professionnelles de Medicine du Travail et de Securite Sociale, 31(4-5), 185-196 61

Archives des Maladies Professionnelles de Medicine du Travail et de Securite Sociale, 31, 513-516 149

Atomic Energy in Australia, 16(2), 2-5 254

Atomic Energy Review, 12(1), 3-45 194

Atoomenergie en Haar Toepassingen, 16(2), 139-141 392

Atoomenergie en Haar Toepassingen, 16(7-8), 166-174 422

AWRE-O-29/65 154

BARC-748 362

BNL-17433 390

BNWL-B-430 424

BNWL-SA-11 124

BNWL-SA-3075 398

BNWL-SA-5056 101

BNWL-SA-5085 396

BNWL-SA-5119 15

BNWL-SA-5124 395

BNWL-SA-5393 174

BNWL-tr-127 338

BNWL-tr-96 85

BNWL-1221 16

BNWL-1464 419

BNWL-1847 223

BNWL-1850 (Part 1) 6, 29

BNWL-1881 218

BNWL-1889 239

BNWL-1950 (Part 2) 162, 166, 169, 175, 188

BNWL-1950 (Part 3) 230, 231, 232, 234, 240, 242, 243, 244, 245, 361, 368, 381

BNWL-1950 (Part 3), Part of Annual Report for 1974, (p. 209-212), 287 p. 241

BNWL-1952 407, 412, 418, 423

BNWL-280 112

BP-97 146

British Journal of Radiology, 39(468), 881-895 260

British Veterinary Journal, 120, 158-161 104

BWNL-1952 416

CEA-CONF-2368 65

CEA-CONF-2417 410

CEA-CONF-2970 376

CEA-N-1667 177

CEA-N-1722 68

CH-1459 159

CH-3313 147

CH-3655 2

CH-3884 39

Chemosphere, 4(5), 283-288 322

CN-1990 37

CN-2312 35, 403

CN-2383 33

CN-2653 12

CN-2740 91

CN-2786 81, 100

PUBLICATION DESCRIPTION INDEX

CN-2905 11, 87

CN-2992 1, 34, 143

CN-3076 148

CN-3130 136

CN-3358 158

CN-3542 113

Comptes Rendus Academy of Science, Series D, 276(2), 225-228 85

CONF-448 266, 309

CONF-555 388

CONF-651008 247

CONF-660341 355

CONF-680507 206

CONF-690103 313, 330, 346, 394

CONF-691234 271

CONF-700541 179

CONF-700816 (Vol. 2) 141

CONF-710401 197, 405

CONF-710809 13, 73, 191, 217, 261, 344

CONF-710919 257

CONF-720453 216, 421

CONF-720503 40

CONF-720519 340

CONF-721107 360, 420

CONF-730570 65

CONF-730667 410

CONF-730811 210

CONF-730907 (Part 2) 362

CONF-731110 332, 356

CONF-731112 252

CONF-740406 342, 391, 426

CONF-740529 139, 142, 310

CONF-740702 277

CONF-740901 (Part 2) 383

CONF-7409106 376

CONF-740921 236, 395, 396

CONF-740930 101

CONF-741017 411

CONF-741018 329, 345, 372, 373

CONF-741026 406

CONF-741208 379

CONF-750662 135

CONF-750847 160, 163, 167, 168, 170, 171, 173, 174, 233, 235, 237, 238, 382

CONF-750967 (Vol. 1) 219, 365, 369

CONF-750967 (Vol. 2) 331, 408, 415

CONF-750967 (Vols. 1-2) 224

CONF-751043 110

CONF-751105 182, 192, 273, 303

CONF-751116 359

CONF-790967 (Vol. 2) 364

COO-119-229 17, 117

COO-119-231 22, 98

COO-119-233 21

COO-119-234 180

COO-119-236 19, 59

COO-119-241 60

COO-119-246 82

COO-119-249 43

COO-1826-32 284

COO-220 18, 31, 41, 44, 45, 46, 67, 89, 121, 129, 130

COO-223 20

COO-225 42, 47, 49

COO-226 23, 178

COO-227 48, 116

COO-228 24

COO-2379-6 182

COO-3563-37 182

COS-4A 385

CRC Critical Reviews in Environmental Control, 5(3), 397-413 207

CS-1907 84

Deutsche Lebensmittel-Rundschau, 69(10), 364-368 325

Doklady Akademii Nauk SSSR, 215(1), 214-217 165

DP-MS-75-40 160

DPSPU-74-30-14 342

DPSPU-74-30-15 426

DUN-8133 318

Environment, 12(4), 15 208

ERDA-92 219, 224, 331, 364, 365, 369, 408, 415

EUR-5041-e 343

Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, 120(4), 481-488 10

FTD-tt-63-559 53

Genshiryoku Kogyo, 20(4), 15-26 211

Geokhimiya, 9, 1362-1372 193

Geologie en Mijnbouu, 53(4), 149-155 306

Gigiena i Sanitariya, 4, 46-50 97

Gigiena i Sanitariya, 5, 38-42 268

Gigiena i Sanitariya, 6, 41-43 78

Gigiena i Sanitariya, 6, 47-51 51

PUBLICATION DESCRIPTION INDEX

Gigiena Truda i Professional'nye Zabolevaniya, 13(5), 61-63 25

HASL-224 337

HASL-273 349

HASL-291 115, 218, 256, 411

HASL-292 220

Health Physics, 12, 173-207 279

Health Physics, 24(4), 439-441 259

Health Physics, 24, 317-327 286

Health Physics, 25, 405-411 102

Health Physics, 27, 55-59 267

Health Physics, 27, 592-593 103

Health Physics, 28(2), 156-158 8

Health Physics, 28, 139-144 320

Health Physics, 28, 205-207 358

Health Physics, 28, 387-394 120

Health Physics, 28, 395-398 14

Health Physics, 28, 443-449 375

Health Physics, 28, 61-67 265

Health Physics, 28, 669-675 277

Health Physics, 28, 816-818 255

Health Physics, 29(5), 798-795 32

Health Physics, 29, 111-123 321

Health Physics, 29, 17-25 328

Health Physics, 29, 43-51 204

Health Physics, 29, 61-68 131

Health Physics, 29, 69-73 262

Health Physics, 29, 97-101 249

Health Physics, 9, 267-275 122

HEDL-TME-74-57 246

HW-21868 52

HW-44341 292

HW-66172 291

HW-70806-RD 427

IAEA-SM-181/14 332

IAEA-SM-181/26 356

IAEA-SM-184/11 139

IAEA-SM-184/14 142

IAEA-SM-184/16 310

IAEA-SM-198 135

IAEA-SM-199/115 182

IAEA-SM-199/42 303

IAEA-SM-199/73 192

IAEA-SM-199/78 273

ICRP Publication 10A 278

International Journal of Applied Radiation and Isotopes, 16, 545-554 190

Johns Hopkins University Press, Baltimore, Maryland 226

Journal of Biological Chemistry, 172, 185-190 183

Journal of Geophysical Research, 80(30), 4153-4162 198

Journal of Range Management, 26(3), 225-226 200

Journal of Spacecraft and Rockets, 11(10), 704-709 210

JPRS-19995 133

K-1470 401

KFK-2006 282

KFK-2089 406

LA-DC-7483 247

LA-UR-74-1590 236

LA-UR-74-1596 253

LA-UR-74-1953 316

LA-1151 270

LA-4875 257

LA-5227-PR 3, 151

LA-5337-PR 319

LA-5614-PR 414

LA-5633-PR 152, 205, 215

LA-5666-PR 417

LA-5762-PR 413

Laboratory Investigation, 8, 162-170 58

Laboro Umano, 25(2), 34-50 274

Lancet, 2(7891), 1238-1239 311

LF-tr-46 61

LF-tr-53 149

LF-tr-71 55

LF-45 9, 71, 90, 125, 150, 184, 185, 275

LF-49 66, 69, 70, 72, 258, 378

Marine Science Communications, 1(1), 39-49 164

Maritime Radiology, Section 25 199

MDDC-270 113

Medical Radiology, 10(1), 45-49 64

Ms. Thesis, University of Rochester 7

National Bureau of Standards Handbook No. 52 281

NCRP Report No. 42 404

Nevada Applied Ecology Group Progress Report for 1974 221

NIOSH-72-2 399

NRPB-R-31 283

NRPB-R31 138, 153, 157, 290, 293, 301

Nuclear News, 14(6), 69-73 402

PUBLICATION DESCRIPTION INDEX

NVO-140 (Vol. 1) 196

NVO-153 109, 114, 134, 161, 202, 209, 212, 214, 221, 222, 314, 315, 317, 323, 324, 326, 341, 357, 366, 377

ORNL-TM-4639 409

ORNL-TM-4904 425

ORNL-tr-2907 165

Part of Annual Report for 1973, (p. 74-75), 162 p. 29

Part of Annual Report for 1974, (p. 52-56), 238 p. 162

Part of Annual Report for 1974, (p. 28-30), 238 p. 166

Part of Annual Report for 1974, (p. 25-28), 238 p. 169

Part of Annual Report for 1974, (p. 240-242), 287 p. 231

Part of Annual Report for 1974, (p. 237-239), 287 p. 232

Part of Annual Report for 1974, (p. 226-231), 287 p. 234

Part of Annual Report for 1974, (p. 213-215), 287 p. 240

Part of Annual Report for 1974, (p. 207-208), 287 p. 242

Part of Annual Report for 1974, (p. 216-221), 287 p. 243

Part of Annual Report for 1974, (p. 223-225), 287 p. 244

Part of Annual Report for 1974, (p. 203-207), 287 p. 245

Part of Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972, (p. 4-5), 144 p. 3

Part of Annual Report of the Biological and Medical Research Group (H-4) of the Los Alamos Scientific Laboratory Health Division, January through December, 1972, (p. 76-78), 144 p. 319

Part of Annual Report, July 1972-June 1973, (p. 163-168) 285

Part of Bair, W.G., Plutonium Inhalation Studies, A series of Lectures Given in Japan in 1969 at the Invitation of the Japanese Atomic Energy Commission, (p. 2.1-2.44), 277 p. 16

Part of Balabukha, V.S. and Barnes, J.H. (Eds.), Chemical Protection of the Body Against Ionizing Radiation, The MacMillan Company, New York, New York, (p. 147-162), 168 p. 144

Part of Barron, E.S.G., et al, Monthly Health Report on Problems Relating to Product for Month of May, 1945, (p. 12-15), 47 p. 1

Part of Barron, E.S.G., et al, Health Problems Relating to Product for Month of March, 1945, (p. 20-24), 34 p. 81

Part of Barron, E.S.G., et al, Health Problems Relating to Product for Month of March, 1945, (p. 18-20), 34 p. 100

Part of Barron, E.S.G, et al, Monthly Health Report on Problems Relating to Product for Month of May, 1945, (p. 32-35), 47 p. 34

Part of Biological and Medical Research Division Annual Report, 1967, (p. 180), 300 p. 94

Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 43-47), 384 p. 66

Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 145-149), 384 p. 69

Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 156-159), 384 p. 70

Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 40-42), 384 p. 72

Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 80-84), 384 p. 258

Part of Boecker, B.B. and Rupprecht, F.C. (Eds.), Annual Report of the Inhalation Toxicology Research Institute, October 1, 1973 through September 30, 1974, (p. 24-28), 384 p. 378

Part of Brues, A.M. (Ed.), Division of Biological and Medical Research Quarterly Report, February, March, April, 1951, (p. 72-84), 229 p. 140

Part of Bujdoso, E. (Ed.), Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972. Akademiai Kiado, Budapest, Hungary, (p. 303-306), 655 p. 40

Part of Chemistry Division Annual Report, July 1972 through June 1973, (p. 10-12), 176 p. 229

Part of Cole, K.S., et al, Monthly Report on Problems Relating to Product for Period Ending July 31, 1944, (p. 4-6), 6 p. 37

Part of Division of Biological and Medical Research Annual Report, 1973, (p. 137-143), 242 p. 57

Part of Dougherty, T.F., et al (Eds.), Proceedings of a Symposium on Some Aspects of Internal Irradiation held at The Homestead, Heber, Utah, May 8-11, 1961. Pergamon Press, New York, New York, (p. 145-162), 529 p. 155

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 127-132), 209 p. 17

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 221), 225 p. 18

Part of Dougherty, T.F., Research in Radiobiology, Semiannual Report of Work in Progress on the Chronic Toxicity Program, (p. 3-55), 185 p. 24

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 75-77), 225 p. 31

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 166), 225 p. 41

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 129), 136 p. 42

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 99-143), 225 p. 44

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p, 150-165), 225 p. 45

PUBLICATION DESCRIPTION INDEX

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 144-148), 225 p. 46

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 133-135), 136 p. 47

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 120-142), 231 p. 48

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 132), 135 p. 49

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 197-206), 268 p. 59

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 200-207), 225 p. 67

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 365-371), 380 p. 82

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 43-72), 225 p. 89

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 85-98), 172 p. 98

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 221), 231 p. 116

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 93-110), 209 p. 117

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 215-220), 225 p. 121

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 224-225), 225 p. 129

Part of Dougherty, T.F., Research in Radiobiology, An Annual Report of Work in Progress on the Chronic Toxicity Program, (p. 168-196), 225 p. 130

Part of Dougherty, T.F., Research in Radiobiology, Semiannual Report of Work in Progress on the Chronic Toxicity Program, (p. 58-65), 135 p. 178

Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Progress in the Internal Irradiation Program, (p. 277-296), 326 p. 180

Part of Egami, N. (Ed.), Radioactivity and Fishes. Contamination, Injuries, and Utilization, (p. 298-315) 26

Part of Enewetak Radiological Survey, (p. 526-541), 736 p. 196

Part of Engelmann, R.J. and Sehmel, G.A. (Coords.), Proceedings of a Symposium on Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants (1974) held in Richland, Washington, September 4-6, 1974, (p. 780-790), 988 p. 236

Part of Engelmann, R.J. and Sehmel, G.A. (Coords.), Proceedings of the Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants Symposium held in Richland, Washington, September 4-6, 1974, (p. 846-858), 988 p. 395

Part of Engelmann, R.J. and Sehmel, G.A. (Coords.), Proceedings of the Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants held in Richland, Washington, September 4-6, 1974, (p. 757-779), 988 p. 396

Part of Fieuw, G. (Ed.), Proceedings of the Tripartite Symposium on Safety Measurements on Nuclear Research held in Brussels, Belgium, April 19, 1971, (A.3.1-A.3.7) 387

Part of First, M.W. and Morgan, J.M., Jr. (Eds.), Proceedings of the 11th AEC Air Cleaning Conference held in Richland, Washington August 31-September 3, 1970 (p. 697-720) 869 p. 141

Part of Fish, B.R. (Ed.), Proceedings of a Symposium on Surface Contamination held in Gatlinburg, Tennessee, June, 1964, Pergamon Press, New York, New York, (p. 169-178), 423 p. 388

Part of Haney, W.A. (Ed.), Chemical Effluents Technology Waste Disposal Investigations, January-June, 1961, (p. 7), 17 p. 427

Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-19 - I-37), 227 p. 115

Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-127 - I-144), 227 p. 189

Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-80 - I-103), 227 p. 218

Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-5 - I-18), 227 p. 256

Part of Hardy, E.P., Jr., Environmental Quarterly, December 1, 1974 through March 1, 1975, (p. I-110 - I-126), 227 p. 411

Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, December 1, 1969 through March 1, 1970, (p. II-9 - II-19), 144 p. 337

Part of Hart, J.C., et al (Eds.), Proceedings of the 8th Health Physics Society Midyear Topical Symposium on Population Exposures held in Knoxville, Tennessee, October 21-24, 1974, (p. 283-288), 434 p. 345

Part of Hart, J.C., et al (Eds.), Proceedings of the 8th Midyear Topical Symposium of the Health Physics Society on Population Exposures held in Knoxville, Tennessee, October, 21-24, 1974, (p. 421-428), 434 p. 372

Part of Hart, J.C., et al (Eds.), Proceedings of the 8th Midyear Topical Symposium of the Health Physics Society on Population Exposures held in Knoxville, Tennessee, October 21-24, 1974, (p. 199-205), 434 p. 373

Part of Hodge, H.C., et al (Eds.), Uranium, Plutonium, Transplutonic Elements, Chapter 21. Springer-Verlag, New York, New York, (p. 929-940), 995 p. 287

Part of Hodge, H.C., et al (Eds.), Uranium, Plutonium, Transplutonic Elements, Chapter 19. Springer-Verlag, New York, New York, (p. 897-908), 995 p. 386

Part of Hodge, H.C., et al (Eds.), Uranium, Plutonium, Transplutonic Elements, Chapter 7. Springer-Verlag, New York, New York, (p. 295-306), 995 p. 389

Part of Hunt, S.E., Fission, Fusion and the Energy Crisis, Chapter 10. Pergamon Press, Oxford, England, (p. 109-118), 164 p. 213

PUBLICATION DESCRIPTION INDEX

Part of Jee, W.S.S. (Ed.), The Health Effects of Plutonium and Radium, Proceedings of a Symposium held in Sun Valley, Idaho, October 6-9, 1975. J.W. Press, Salt Lake City, Utah, (p. 7-20), 802 p. 110

Part of Jee, W.S.S., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 9-119), 330 p. 43

Part of Knox, J.B., et al, Radioactivity Released from Underground Nuclear Detonations: Source, Transport, Diffusion, and Deposition, Chapter 9, (p. 99-104), 113 p. 334

Part of Knox, J.B., et al, Radioactivity Released from Underground Nuclear Detonations: Source, Transport, Diffusion, and Deposition, Chapter 3, (p. 18-23), 113 p. 335

Part of Knox, J.B., et al, Radioactivity Released from Underground Nuclear Detonations: Source, Transport, Diffusion, and Deposition, Chapter 2, (p. 8-17), 113 p. 367

Part of Lebedinskii, A.V. and Moskalev, Yu.I. (Eds.), Plutonium 239: Its Distribution, Biological Effects and Accelerated Elimination, (p. 88-91), 267 p., (Translated Edition) 53

Part of Lebedinskii, A.V. and Moskalev, Yu.I. (Eds.), Distribution, Biological Effects, and Migration of Radioactive Isotopes, (p. 317-331), 408 p. 123

Part of Lloyd, R.D. (Ed.), Retention and Dosimetry of Some Injected Radionuclides in Beagles, (p. 123-143), 162 p. 60

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 234-240), 355 p. 9

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 50-54), 355 p. 71

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission PRoduct Inhalation Program, October 1, 1971 through September 30, 1972, (p. 61-64), 355 p. 90

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 55-60), 355 p. 125

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October, 1, 1971 through September 30, 1972, (p. 21-28), 355 p. 184

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 29-36), 355 p. 185

Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Annual Report of the Fission Product Inhalation Program, October 1, 1971 through September 30, 1972, (p. 287-294), 355 p. 275

Part of Medical and Health Physics Quarterly Report, July, August, and September, 1952, (p. 84-87), 134 p. 36

Part of Metabolism of Radioisotopes in the Animal Organism, (p. 124-136) 126

Part of Metabolism of Radioisotopes in the Animal Organism, (p. 205-209) 127

Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 281-284), 807 p. 13

Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 252-267), 807 p. 73

Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 623-639), 807 p. 191

Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 462-470), 807 p. 217

Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 647-659), 807 p. 261

Part of Moghissi, A.A. and Carter, M.W. (Eds.), Proceedings of a Symposium on Tritium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, (p. 512-516), 807 p. 344

Part of Monthly Health Report on Problems Relating to Product for Month of April, 1945, (p. 10), 29 p. 87

Part of Monthly Health Report on Problems Relating to Product for Period Ending February 15, 1945, (p. 7), 16 p. 91

Part of Moskalev, Yu. I. (Ed.), Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 238-242), 405 p. 5

Part of Moskalev, Yu.I. (Ed.), Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 243-250), 405 p. 50

Part of Moskalev, Yu.I. (Ed.), Distribution Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 257-265), 405 p. 56

Part of Moskalev, Yu.I. (Ed.), Distribution, Biological Effects and Accelerated Excretion of Radioactive Isotopes, (p. 34-41), 405 p. 62

Part of Moskalev, Yu.I. (Ed.), Distribution, Biological Effects, and Accelerated Excretion of Radioactive Isotopes, (p. 124-130), 405 p. 63

Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 371-380), 574 p. 128

Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 441-452), 718 p. 76

Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 453-462), 718 p. 77

Part of Nickson, J.J., et al, Monthly Health Report on Problems Relating to Product for Period Ending October 31, 1944, (p. 1-12), 13 p. 35

Part of Platt, A.M. (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 1-17), 51 p. 407

Part of Platt, A.M. (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 43-51), 51 p. 423

Part of Platt, A.M., (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 19-29), 51 p. 412

PUBLICATION DESCRIPTION INDEX

Part of Platt, A.M., (Comp.), Nuclear Waste Management and Transportation Quarterly Progress Report for July through September, 1975, (p. 31-34), 51 p. 416

Part of Plutonium, Chapter 3. Pergamon Press, New York, New York, (p. 85-102), 262 p. 397

Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 319-344), 450 p. 4

Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 287-306), 450 p. 74

Part of Proceedings of a Symposium on the Radiological Impacts of Releases from Nuclear Facilities into Aquatic Environments held in Otaniemi, Finland, June 30-July 4, 1975, (18 p.) 524 p. 135

Part of Proceedings of a Symposium on Population Dose Evaluation and Standards for Man and His Environment held in Portoroz, Yugoslavia, May 20-24, 1974, (p. 555-575), 646 p. 139

Part of Proceedings of a Symposium on Population Dose Evaluation and Standards for Man and His Environment held in Portoroz, Yugoslavia, May 20-24, 1974, (p. 435-449), 646 p. 142

Part of Proceedings of a Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p. 121-137), 724 p. 182

Part of Proceedings of a Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p. 325-336), 724 p. 192

Part of Proceedings of a Symposium on Radiological Protection of the Public in a Nuclear Mass Disaster held in Interlaken, Switzerland, May 26-June 1, 1968, (p. 39-45), 688 p. 206

Part of Proceedings of a Symposium on the Disposal of Radioactive Wastes held in Paris, France, April 12-14, 1972, (p. 205-223), 290 p. 216

Part of Proceedings of a Symposium on the Assessment of Radioactive Body Burdens in Man held in Heidelberg, Germany, May 11-16, 1964, Vol. 2, (p. 617-628), 1043 p. 266

Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 381-386), 450 p. 269

Part of Proceedings of a Symposium on Biological Effects of thX held in Alta, Utah, July 22-24, 1974, (2 p.) 272

Part of Proceedings of a Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p. 385-400), 724 p. 273

Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 307-318), 450 p. 276

Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 387-417) 450 p. 294

Part of Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962, (p. 23-44), 450 p. 308

Part of Proceedings of a Symposium on the Assessment of Radioactive Body Burdens in Man held in Heidelberg, Germany, May 11-16, 1964, Vol. 1, (p. 217-229), 1043 p. 309

Part of Proceedings of a Symposium on Population Dose Evaluation and Standards for Man and his Environment held in Protoroz, Yugoslavia, May 20-24, 1974, (p. 451-462), 646 p. 310

Part of Proceedings of a Symposium on Physical Behavior of Radioactive Contaminants in the Atmosphere held in Vienna, Austria, November 12-16, 1973, (p. 181-187 332

Part of Proceedings of a Symposium on the Physical Behavior of Radioactive Contaminants in the Atmosphere held in Vienna, Austria, November 12-16, 1973, (p. 189-210). 356

Part of Proceedings of a Symposium on the Management of Radioactive Wastes from Fuel Reprocessing held in Paris, France, November 27-December 1, 1972, (p. 99-130), 1266 p. 360

Part of Proceedings of a Symposium on the Management of Plutonium-Contaminated Solid Wastes held in Marcoule, France, October 14-16, 1974, (14 p.) 406

Part of Proceedings of a Symposium on the Management of Radioactive Wastes from Fuel Reprocessing held in Paris, France, November 27-December 1, 1972, (p. 181-198), 1266 p. 420

Part of Proceedings of the All India Symposium on Radioactivity and Meteorology of Radionuclides held in Bombay, India, March 14-18, 1966, (p. 287-300) 355

Part of Proceedings of the American Nuclear Society Symposium held in Washington, D.C., October 27-November 1, 1974, (16 p.) 411

Part of Proceedings of the Annual Bioassay Symposium held in Albuquerque, New Mexico, October 7-8, 1965, (p. 184-186) 247

Part of Proceedings of the Congress on Alveolar Macrophages held in Lille, France, May 28-29, 1973, (7 p.) 65

Part of Proceedings of the Health Physics Society 9th Midyear Topical Symposium on Operational Health Physics held in Denver, Colorado, February 9-12, 1976, (6 p.) 339

Part of Proceedings of the IEEE Nuclear Science Symposium held in San Francisco, California, November 14-16, 1973, (13 p.) 252

Part of Proceedings of the Information Symposium on Disposal of Radioactive Waste held in Paris, France, April 12-14, 1972, (p. 193-203), 290 p. 421

Part of Proceedings of the International Symposium on Neutron Induced Reactions held in Smolenice, Czechoslovakia, September 1-7, 1974, (8 p.) 376

Part of Proceedings of the National Environmental Research Park Symposium held in Idaho Falls, Idaho, October 22, 1974, (18 p.) 253

Part of Proceedings of the Nuclear Science Symposium held in San Francisco, California, November 17-21, 1975, (4 p.) 359

Part of Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities held in Golden, Colorado, April 13-16, 1971, (p. 293-296), 457 p. 197

Part of Proceedings of the Symposium on Transuranium Nuclides in the Environment held in San Francisco, California, November 17-21, 1975, (p 311-327), 724 p. 303

PUBLICATION DESCRIPTION INDEX

Part of Proceedings of the 1st Annual Health Physics Society Symposium held in Ann Arbor, Michigan, June 25-27, 1956, (p. 53-60) 186

Part of Proceedings of the 11th Annual Symposium of the Institute of Nuclear Materials Management held in Gatlinburg, Tennessee, May 25-27, 1970, (20 p.) 179

Part of Proceedings of the 11th Hanford Symposium on the Biological Implications of the Transuranium Elements held in Richland, Washington, September 27-29, 1971. Published in Health Physics, 22(6), 931 257

Part of Proceedings of the 15th Symposium of the Committee on Hot Laboratories of Euratom held it Goesthacht, Germany, June 14-15, 1973, (p. 721-743) 410

Part of Proceedings of the 19th Annual Symposium of the Health Physics Society held in Houston, Texas, July 7-11, 1974, (7 p.) 277

Part of Proceedings of the 2nd International Symposium on Power from Radioisotopes held in Madrid, Spain, May 29-June 1, 1972, (p. 8 93-905), 986 p. 340

Part of Proceedings of the 2nd AEC Environmental Protection Symposium held in Albuquerque, New Mexico, April 16-19, 1974, Vol. 1, (p. 495-510), 1151 p. 342

Part of Proceedings of the 2nd AEC Environmental Protection Symposium held in Albuquerque, New Mexico, April 16-19, 1974, Vol. 2, (p. 715-725), 1151 p. 391

Part of Proceedings of the 2nd AEC Environmental Protection Symposium held in Albuquerque, New Mexico, April 16-19, 1974, (p. 47-62), 1151 p. 426

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 442-488), 1015 p. 219

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 607-621), 1015 p. 331

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 584-606), 1015 p. 364

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 204-219), 1015 p. 365

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 144-167), 1015 p. 369

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 889-905), 1015 p. 408

Part of Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975, (p. 810-824), 1015 p. 415

Part of Proceedings of the 4th Measurement Science Symposium held in San Luis Obispo, California, December 6-7, 1974, (15 p.) 379

Part of Proceedings of the 4th International Symposium on Packaging and Transportation of Radioactive Materials held in Miami Beach, Florida, September 22-27, 1974, (p. 1148-1161), 1195 p. 383

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 122) 160

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 123) 163

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124) 167

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124-125) 168

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 125) 170, 171

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 126) 173, 174

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 124) 233, 235, 237

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 125) 238

Part of Proceedings of the 67th Annual Symposium of the American Society of Agronomy held in Knoxville, Tennessee, August 24-29, 1975, (p. 123) 382

Part of Proceedings of the 7th Annual Symposium on Bioassay and Analytical Chemistry held in Argonne, Illinois, October 12-13, 1961, (p. 13-21) 288

Part of Proceedings of the 8th Intersociety Energy Conversion Engineering Symposium held in Philadelphia, Pennsylvania, August 13-16, 1973 (6 p.) 210

Part of Radiation and the Lymphatic System, Proceedings of the 14th Annual Hanford Biology Symposium held in Richland, Washington, September 30-October 2, 1974, (p. 225-229), 258 p. 101

Part of Radiobiology, (p. 131-137), 214 p. 79

Part of Radiobiology, (p. 138-143), 214 p. 80

Part of Radiobiology, (p. 161-166) 108

Part of Radiological and Environmental Research Division Annual Report, July 1973 through June 1974, (p. 73-81), 231 p. 105

Part of Radiological and Environmental Research Division Annual Report, July 1973 through June 1974, (p. 71-72), 231 p. 272

Part of Radiological and Environmental Research Division Annual Report, July 1973 through June 1974, (p. 82-89), 231 p. 302

Part of Radiological and Environmental Research Division Annual Report, July 1973 thrugh June 1974, (p. 136-141), 231 p. 312

Part of Radiological and Environmental Research Division Annual Report, January through December, 1973, (p. 85-89), 187 p. 370

Part of Richmond, C.R. and Sullivan, E.M. (Comps.), Annual Report of the Biomedical and Environmental Research Program of the LASL Health Division, January-December 1973, (p. 1-19), 165 p. 152

PUBLICATION DESCRIPTION INDEX

Part of Richmond, C.R. and Sullivan, E.M. (Comps.), Annual Report of the Biomedical and Environmental Research Program of the LASL Health Division, January through December, 1973, (p. 34-41), 165 p. 205

Part of Richter, G.W. and Epstein, M.A. (Eds.), International Review of Experimental Pathology, Vol. 1. Academic Press, New York, New York, (p. 243-369), 453 p. 156

Part of Rosenthal, M.W. (Ed.), Therapy of Radioelement Poisoning, Transcription of a Meeting on Experimental and Clinical Approaches to the Treatment of Poisoning by Radioactive Substances held in Lemont, Illinois, October 20-21, 1955, (p. 100-113), 175 p. 92

Part of Simpson, C.L., et al, Annual Report for 1974, (p. 243-246), 287 p. 230

Part of Simpson, C.L., et al, Annual Report for 1974, (p. 221-223), 287 p. 361

Part of Simpson, C.L., et al, Annual Report for 1974, (p. 20-21), 287 p. 368

Part of Simpson, C.L., et al, Annual Report for 1974, (p. 22-24), 287 p. 381

Part of Snyder, W.S. (Ed.), Proceedings of the 3rd International Congress of the IRPA held in Washington, D.C., September 9-14, 1973, (p. 979-984) 362

Part of Spitzer, S. (Ed.), Proceedings of the 21st Hahnemann Symposium on Emergency Medical Management held in Philadelphia, Pennsylvania, December 8, 1969. Grune and Stratton, Inc., New York, New York, (p. 281-292) 271

Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 4-35), 127 p. 138

Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 103-115), 127 p. 157

Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 116-127), 127 p. 283

Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 65-73), 127 p. 290

Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protectin Board, (p. 74-88), 127 p. 293

Part of Stather, J.W., et al, The Radiological Protection of People Exposed to Plutonium: Current Research at the National Radiological Protection Board, (p. 49-64), 127 p. 301

Part of Stover, B.J. and Jee, W.S.S. (Eds.), Radiobiology of Plutonium. J.W. Press, Salt Lake City, Utah, (p. 409-430), 552 p. 296

Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1965, (p. 40-43), 139 p. 112

Part of Thompson, R.C., et al, Annual Report for 1973, (p. 121), 162 p. 6

Part of Transuranic Solid Waste Management Research Programs, Quarterly Report, April-June, 1974, (p. 6), 18 p. 413

Part of Transuranic Solid Waste Management Research Programs Quarterly Report, October-December, 1973, (p. 15-17), 55 p. 414

Part of Vaughan, B.E., et al, Annual Report for 1974, (p. 192-202), 238 p. 175

Part of Vaughan, B.E., et al, Annual Report for 1974, (p. 153-154), 238 p. 188

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 125-135), 504 p. 109

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 97-124), 504 p. 114

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 137-149), 504 p. 134

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 187-195), 504 p. 161

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 151-185), 504 p. 202

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 43-87), 504 p. 209

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 471-472), 504 p. 212

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 491-497), 504 p. 214

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 465-469), 504 p. 222

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for January, 1975, (p. 237-250), 504 p. 314

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 217-230), 504 p. 315

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 231-235), 504 p. 317

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress for 1974, (p. 473-490), 504 p. 323

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 1-25), 504 p. 324

PUBLICATION DESCRIPTION INDEX

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 339-448), 504 p. 326

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 449-463), 504 p. 341

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 89-95), 504 p. 357

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group, Progress Report for 1974, (p. 27-41), 504 p. 366

Part of White, M.G. and Dunaway, P.B. (Eds.), The Radioecology of Plutonium and Other Transuranics in Desert Environments, Nevada Applied Ecology Group Progress Report for 1974, (p. 197-205), 504 p. 377

Part of Willis, C.A. and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1969, Vol. 2. Gordon and Breach, Science Publishers, New York, New York, (p. 1235-1255), 1848 p. 330

Part of Willis, C.A. and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1969, Vol. 2. Gordon and Breach, Science Publishers, New York, New York, (p. 1117-1125), 1848 p. 346

Part of Willis, C.A. and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the 3rd Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1966, Vol. 3. Gordon and Breach, Science Publishers, Inc., New York, New York, (p. 1573-1580) 394

Part of Willis, C.A., and Handloser, J.S. (Eds.), Health Physics Operational Monitoring, Proceedings of the Health Physics Society Midyear Topical Symposium held in Los Angeles, California, January 29-31, 1969, Vol. 2. Gordon and Breach, Science Publishers, New York, New York, (p. 981-993), 1848 p. 313

PB-237-744 399

Ph.D. Thesis, Oklahoma State University 371

Ph.D. Thesis, University of Washington 195

Physics in Medicine and Biology, 19(4), 448-459 327

Poumon et le Cour, 26, 1029-1038 55

Pracovni Lekarstvi, 21(2), 49-55 107

Presentation given to the Joint Committee on Atomic Energy in Washington, D.C., October 2, 1974 351

Proceedings of a Symposium on the Diagnosis and Treatment of Radioactive Poisoning held in Vienna, Austria, October 15-18, 1962 300

Proceedings of the Rocky Flats Symposium on Safety in Plutonium Handling Facilities held in Golden, Colorado, April 13-16, 1971 405

Proceedings of the Society for Experimental Biology and Medicine, 83, 494-498 27

Proceedings of the Society for Experimental Biology and Medicine, 107, 120-123 111

Proceedings of the 3rd Environmental Protection Symposium held in Chicago, Illinois, September 23-26, 1975 224

Proceedings of the 8th Health Physics Society Midyear Topical Symposium on Population Exposures held in Knoxville, Tennessee, October 21-24, 1974, 434 p. 329

PROT-SAN-11-71 352

Przeglad Geofizyczny, 16, 197-208 336

Radiation Data and Reports, 14(5), 331 225

Radiation Data and Reports, 14(3), 208 347

Radiation Data and Reports, 14(3), 216-219 354

Radiation Data and Reports, 15(3), 134-147 348

Radiation Data and Reports, 15(12), 834-841 353

Radiation Research, 12, 431 18

Radiation Research, 12, 480-481 129

Radiation Research, 26, 114-123 119

Radiation Research, 26, 287-294 99

Radiation Research, 33, 381-394 187

Radiation Research, 33, 490-500 118

Radiation Research, 53, 102-114 93

Radiation Research, 61, 239-250 15

Radiation Research, 61, 468-477 38

Radiation Research, 61, 513-518 83

Radiation Research, 63(2), 253-261 95

Radiation Research, 63(2), 262-274 96

Radiobiologiya, 13(1), 119-123 108

Radiobiologiya, 14(2), 261-265 79

Radiobiologiya, 14(2), 266-270 80

Radiochemical and Radioanalytical Letters, 18(2), 51-59 176

Radiochemical and Radioanalytical Letters, 17(3), 197-205 338

Radiological Health Data and Reports, 8(4), 191-194 333

Radiological Protection Bulletin No. 9 280

Radioprotection, 9(1), 15-25 295

REG/G-3.12 (8-73) 393

Regulatory Guide No. 4.5 350

RFP-1528 179

RFP-2328 248

RT/PROT-73-24 228

Soil Science, 108(4), 305-307 172

STI/PUB/354 332, 356

STI/PUB/375 139, 142, 310

STI/PUB/406 135

STI/PUB/410 182, 192, 273

PUBLICATION DESCRIPTION INDEX

STI/PUB/65 4, 74, 269, 276, 294, 300, 308

STI/PUB/84 266, 309

Strahlentherapie, 146(6), 675-684 282

Strahlentherapie, 148(6), 564-570 251

TID-15685 7

Transactions on Nuclear Science, 23(1), 690-692 359

UCID-16790 304

UCLA-12-1047 374

UCLA-12-986 209

UCRL-1143 145

UCRL-2001 36

UCRL-50027-74 363

UCRL-50230 (Rev. 1) 334, 335, 367

UCRL-50387 263

UCRL-50387 (Add.) 30

UCRL-51975 227

UCRL-75204 252

UCRL-75371 (Rev. 1) 328

UCRL-76109 305

UCRL-76141 379

UCRL-76536 377

UCRL-76823 384

UCRL-77106 339

UCRL-77318 303

United Nations, New York, New York 298, 299

UR-3490-182 289

UR-3490-552 375

UR-665 132

Voprosy Meditsinskoi Khimii, 9(2), 154-160 133

WASH-1332 342, 391

WASH-1332 (74) 426

Zoologicheskii Zhurnal, 52(4), 601-603 54

ORNL/EIS-91/V8
(NVO/AEIC-77/1)

INTERNAL DISTRIBUTION

1-3. S. I. Auerbach
4. M. F. Baldauf
5. E. A. Bondietti
6. J. R. Buchanan
7. M. V. Cone
8. F. L. Culler
9. J. T. Ensminger
10. L. D. Eyman
11. R. A. Faust
12. C. S. Fore
13. C. W. Francis
14. W. Fulkerson
15. S. V. Kaye
16. F. M. Martin
17. H. F. McDuffie
18. H. A. Pfuderer
19. H. Postma
20. D. E. Reichle
21. C. R. Richmond
22. P. S. Rohwer
23. M. H. Shanks
24. T. Tamura
25. J. E. Till
26. J. R. Trabalka
27-28. G. U. Ulrikson
29. D. J. Wilkes
30. Biology Library
31-32. Central Research Library
33-34. Laboratory Records Department
35. Laboratory Records Department, RC
36-135. Nevada Applied Ecology Information Center
136. ORNL Patent Office
137. Y-12 Document Reference Section

EXTERNAL DISTRIBUTION

138-139. Albuquerque Operations Office

J. F. Burke
W. B. Johnston

140. Allied Chemical Corporation

C. E. Nichols

141. American Nuclear Society

E. Ronne

142-146. Argonne National Laboratory

C. S. Abrams
J. S. Marshall
M. W. Rosenthal
J. Rundo
R. A. Schlenker

147. Atlantic-Richfield Hanford Company

K. Price

148-150. Battelle Columbus Laboratories

V. Q. Hale
W. Martin
A. Rudolph

151-161. Battelle-Northwest Laboratories

W. J. Bair
F. T. Cross
P. J. Dionne
L. L. Eberhardt
R. O. Gilbert
P. O. Jackson
I. C. Nelson
C. L. Sanders
M. R. Sikov
B. O. Stuart
R. C. Thompson

162-163. Brookhaven National Laboratory

P. J. Bottino
A. H. Sparrow

164-166. Colorado State University

J. Johnson
W. Whicker
T. F. Winsor

167. Comitato Nazionale per l'Energia Nucleare, Italy

A. Antonelli

168. Commissariat a l'Energie Atomique, France

A. Grauby

169. Comparative Animal Research Laboratory

G. R. Eisele

170. Desert Research Institute

T. P. O'Farrell

171. DRI, Reno

G. B. Maxey

172-176. EG&G, Inc.

K. C. Humphreys
W. M. Quam
W. A. Rhoads
P. Stuart
T. P. Stuart

177. Electrical Power Research Institute

C. L. Comar

178-180. Euratom Joint Nuclear Research Center, Italy

P. de Bortoli
P. Gaglione
F. Girardi

181-183. Georgia Institute of Technology

M. W. Carter
A. A. Moghissi
K. Z. Morgan

184-187. Health and Safety Laboratory

E. P. Hardy, Jr.
J. H. Harley
J. Rivera
H. L. Volchok

188-190. Idaho Operations Office

O. D. Markham
C. W. Sill
C. E. Williams

191. Institute of Biology of South Seas, USSR

G. G. Polikarpov

192-193. Institute of Biophysics, USSR

Yu. I. Moskalev
D. P. Osanov

194. Institute of Cancer Research, England

D. M. Taylor

195. International Atomic Energy Agency

H. J. Otway

196. Kerr-McGee Corporation

A. Valentine

197. Lawrence Berkeley Laboratory

P. W. Durbin

198-209. Lawrence Livermore Laboratory

L. R. Anspaugh
P. N. Dean
L. S. Germain
M. L. Mendelsohn
W. T. Nervik
Y. C. Ng
V. E. Noshkin
J. L. Olsen
P. L. Phelps
B. W. Shore
J. T. Tinney
G. Tompkins

210-211. LFE/Environmental Analysis Laboratory

L. Leventhal
R. Wessman

212-227. Los Alamos Scientific Laboratory

J. E. Dummer
E. H. Essington
E. B. Fowler
L. Gomez
T. E. Hakonson
W. C. Hanson
J. W. Healy
L. J. Johnson
H. S. Jordon
J. H. McQueen
W. D. Moss
J. Nyhan
J. H. Patterson
W. D. Purtymun
D. Rohrer
R. G. Thomas

228. Lovelace Foundation for Medical Education and Research

R. O. McClellan

229. McClellan Air Force Base

A. W. Myers

230. Mound Laboratory

H. F. Anderson

231. National Library of Medicine

H. Kissman

232. National Oceanographic and Atmospheric Administration, Air Resources Laboratory

N. C. Kennedy

233-274. Nevada Operations Office

R. C. Amick
E. D. Campbell
B. W. Church
E. M. Douthett
P. B. Dunaway (5)
M. E. Gates
D. G. Jackson
R. L. Kinnaman
R. R. Loux
R. W. Newman
R. Ray
R. Silverstrom
J. D. Stewart
M. G. White (25)

275. Northeastern Radiological Health Laboratory

B. Shleien

276. Oak Ridge Associated Universities

P. L. Johnson

277. Pantex Plant, Texas

D. L. Dufek

278-280. Reynolds Electrical and Engineering Company

E. R. Sorom
A. W. Western
D. Wireman

281-286. Rockwell-International/Rocky Flats Plant

E. W. Bean
R. W. Bistline
F. J. Miner
J. R. Seed
M. A. Thompson
G. J. Werkema

287. Royal Free Hospital School of Medicine, England

A. C. James

288-289. Sandia Laboratories

R. Luna
M. L. Merritt

290. Southeastern Radiological Health Laboratory

R. Lieberman

291-292. Technical Information Center, Oak Ridge

293-297. United Kingdom Atomic Energy Authority

G. W. Dolphin
D. C. Fraser
D. Ramsden
H. Smith
B. T. Taylor

298-322. U. S. Energy Research and Development Administration, Headquarters

T. M. Albert
R. E. Allen
N. F. Barr
M. B. Biles
F. E. Coffman
G. W. Cunningham
R. C. Dahlman
G. H. Daly
L. J. Deal
G. C. Facer
R. Franklin
J. S. Kane
A. F. Kluk
J. L. Liverman
T. F. McCraw
R. D. Maxwell
W. S. Osburn, Jr.
A. F. Perge
H. G. Richover
R. C. Seamans, Jr.
H. F. Soule
J. Swinebroad
C. D. W. Thornton
R. L. Watters
J. H. Wilson, Jr.

323-324. U. S. Energy Research and Development Administration, Research and Technical Support Division, Oak Ridge

W. R. Bibb
J. A. Lenhard

325. U. S. Environmental Protection Agency, Denver

P. Smith

326-345. U. S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory

F. Au
D. S. Barth
J. Barth
W. Bliss
C. F. Costa
R. L. Douglas
D. E. Hendricks
F. M. Jakubowski
R. Kinnison
V. D. Leavitt
J. McBride
A. A. Mullen
R. G. Patzer
J. C. Payne, Jr.
G. D. Potter
D. Smith
R. E. Stanley
W. W. Sutton
D. Wickman
D. T. Wruble

346. U. S. Geological Survey, Denver

W. S. Twenhofel

347-349. U. S. Nuclear Regulatory Commission

J. J. Davis
G. Hamada
J. A. Harris

350. University of California, Davis

O. Raabe

351-354. University of California, Los Angeles

J. E. Kinnear
A. Morrow
E. M. Romney
A. Wallace

355. University of Hawaii

L. J. Casarett

356-358. University of Nevada, Las Vegas

W. G. Bradley
K. Moor
W. E. Niles

359-361. University of Nevada, Reno

V. Bowman
P. Fenske
P. T. Tueller

362. University of North Carolina, Chapel Hill

B. J. Stover

363. University of Rochester

P. E. Morrow

364-369. University of Utah

D. R. Atherton
J. H. Dougherty
T. F. Dougherty
W. S. S. Jee
C. W. Mays
G. N. Taylor

370. University of Washington

W. R. Schell

371. Washington State University

V. Schultz

372-373. Westinghouse Environmental Systems

J. Tower
H. C. Woodson

374-376. Woods Hole Oceanographic Institution

V. T. Bowen
J. C. Burke
G. Thompson

☆ U.S. GOVERNMENT PRINTING OFFICE: 1977-748-189/165