ORNL-EIS-75-21-No. 5
NVO-AEIC-75-1

Environmental Aspects of the Transuranics

A Selected, Annotated Bibliography

sponsored by
Nevada Applied Ecology Group
Nevada Operations Office

OAK RIDGE NATIONAL LABORATORY
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ENVIRONMENTAL ASPECTS OF THE TRANSURANICS
A SELECTED, ANNOTATED BIBLIOGRAPHY

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Nevada Applied Ecology Group
Nevada Operations Office
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ABSTRACT

This fifth published bibliography of 594 references is from the computer file built to provide information support to the Nevada Applied Ecology Group (NAEG) of ERDA's Nevada Operations Office. The general scope is environmental aspects of uranium and the transuranic elements, with a preponderance of material on plutonium. In addition, supporting materials involving basic ecology or general reviews on other nuclides are entered at the request of the NAEG. Tables containing significant numeric data are referred to in the comment field. The references are arranged by subject category with first authors arranged alphabetically within the category. Indexes are given for author, keywords, geographic location, permuted title, taxons, and publication description.

PREFACE

This publication of 594 references is the fifth in a series of published bibliographies from the Applied Ecology Information Center of ERDA's Nevada Operations Office. The identifying report numbers in this series of bibliographies, ORNL-EIS-21 (Suppls. 1-3), have been changed to add NVO-AEIC.

The scope is centered on the environmental aspects of plutonium, but 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, technetium, and reviews and bibliographies on other radionuclides have been added to scope at the Nevada Applied Ecology Group (NAEG) request. The current domestic and foreign literature is actively sought. As an example, WASH-1359, "Plutonium and Other Transuranium Elements; Sources, Environmental Distribution and Biomedical Effects" from the December 10, 1974 U. S. Environmental Protection Agency hearings is included in this bibliography. Because of the interest in energy from nuclear power and the concern about safety aspects, 25 references cited in the report, WASH-1259, "Environmental Monitoring at Major U. S. Atomic Energy Commission Contractor Sites," are also included.

All the published literature references are contained in a dynamic computerized information file that is available for search upon submission of specific requests.

Citation Form

The references are arranged by subject category, with authors listed 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, feet, etc., X3 means X^3.

Indexes

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

ACKNOWLEDGEMENTS

P. B. Dunaway, Manager of the Nevada Applied Ecology Group, Nevada Operations Office, has closely guided this NAEG Information Center in selection of material for this project.

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Dr. G. R. Eisele of the Comparative Animal Research Laboratory has contributed documents on the biomedical aspects of plutonium, and the Nevada Operations Office Technical Library staff have been helpful in alerting us to relevant materials.

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

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8 - *Abstract*
9 - *Abstractor's Initials*
10 - *Comments (Pertinent Numerical Data)*

1 CHEMICAL ASPECTS

2 (260)
3 Clanet, F., J. Ballada, J. Lucas, and C. Gil,
4 Faculte de Pharmacie, Laboratoire de Chimie Mineral et d'Hydrologie, 37-Tours, France; Commissariat a l'Energie Atomique, Department de Protection, Fontenay-aux-Roses, France. 5 1973, July; 1972

6 Determination of Urinary Plutonium by
7 Radiochemical Analysis on Ion Exchange Filters. LA-tr-73-39; 6 p.; Health Physics, 23, 245-247

8 A new method for determination of urinary plutonium is described. Known amounts of Pu 239(+4) were added to human urine collected in concentrated hydrochloric acid. The plutonium was purified and fixed on Amberlite SB-2 filters. Following elution and evaporation the radioactivity of the residue was measured. The detection limit was 1 pCi Pu 239/l of urine. The average recovery yield was 80%. This method reduced analysis time by one-half when compared to the classic method using columns of ion exchange resins. 9 (ST)

10 Translated by Kanner Associates, Redwood City, California for Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

BIOLOGICAL ASPECTS

<1>
Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1974, January

Influence of Plutonium on the Soil Microflora. BNWL-1950 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1973, (p. 19-21), 200 p.

The effect of soil plutonium concentration on the soil microflora was measured as a function of changes in [illegible] types and numbers and soil respiration rate. A noncalcareous Pitzville silt loam of pH 7.0 was amended with Pu 239 as the soluble (valence 4) nitrate, at levels of 0.05, 0.5 and 10 uCi/g and with starch, nitrogen and water to provide optimal microbial activity. Subsamples of soil were periodically removed to determine the changes in types and numbers of soil microflora and Pu water solubility with time. Soil respiration rate was monitored by continuous collection of soil-evolved carbon dioxide. Plutonium did not generally affect the rate of growth but decreased the total number of all classes of microorganisms. The fungi were the exception, differing from the controls only at a Pu concentration of 10 uCi/g or 180 ug/g. The accumulative carbon dioxide curve generally corresponded to the growth curve of the fungi. In the case of the other classes of organism, the maximum logarithmic growth occurred before the rate of carbon dioxide evolution reached minimum levels. Soil respiration rate and cumulative carbon dioxide over the incubation period were significantly reduced only at the 10 uCi/g level of Pu amendment, although numbers of all classes or organisms except the fungi were depressed below this level. (Auth) (RAF)

<2>
Adee, R.R., and J.J. Laidler, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA; Hanford Engineering Development Laboratory, Applied Research Department, Richland, WA. 1973, November

Subcellular Identification of Exogenous Particles by High-Voltage Electron Microscopy. American Industrial Hygiene Association Journal, 34(11), 507-511

Hamsters were exposed to particles of asbestos, Cr 203, NiO, and rats to Pu 239 PuO2 by either aerosol inhalation or injection. High-voltage electron microscopy was used to obtain diffraction images, and stereopairs of electron micrographs were used to identify and localize specific particles in cells. Pu 239 PuO2 particles were suspended in saline and injected intraperitoneally into rats where they were phagocytized by macrophages. Lung tissue or macrophage pellets from washings of the peritoneal cavity were doubly fixed in 2% glutaraldehyde and 1% OsO4, dehydrated through a graded series of alcohol and propylene oxide, and embedded in a low viscosity resin. Some tissues were stained en bloc in 2% uranyl acetate after osmium fixation. Plutonium in sections 1 um thick was too dense to get a clear diffraction pattern, but acceptable patterns could be obtained in 0.3 um sections. The sections were doubly stained with uranyl acetate and lead citrate and examined in a JEOL 1000-kv electron microscope. Electron micrographs were taken at initial magnifications of 5000 to 20,000 X using an 8 degrees tilt in obtaining stereopairs. Diffraction patterns were obtained from the particulate materials by selected area diffraction. (RAF)

Figure 4 shows a high-voltage electron micrograph of a Pu 239 PuO2 particle phagocytized by a rat peritoneal macrophage. Figure 5 shows high-voltage electron micrographs of a stereopair showing a Pu 239 PuO2 particle within a peritoneal macrophage.

<3>
Albert, R.E., New York University Medical Center, Institute of Environmental Medicine, New York, NY. 1974, December; 1974, March 25
[illegible]
WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 311-326), 327 p.

Largely on the basis of rat skin tumor experiments, Tamplin and Cochran propose that a single radioactive particle in the lung which delivers a local dose of more than 1000 rem per year will produce focal tissue damage and that this focal damage per se confers a risk of lung cancer of one in two thousand. The Tamplin-Cochran approach to the risk assessment from hot particles is based on the Geesaman Hypothesis which is described as follows: When a critical architectural unit of a tissue (e.g., a hair follicle) is irradiated at a sufficiently high dosage, the chance of it becoming cancerous is approximately 10(E-3) to 10(E-4). This hypothesis is based almost wholly on radiation skin experiments with rats by Albert. The Tamplin Cochran proposal is evaluated here from two standpoints: 1) does tissue damage, per se, cause cancer? 2) would intense irradiation of a "critical architectural unit" cause tumors, regardless of whether damage was produced. A review of current knowledge about the relationship of tissue damage to the induction of cancer does not support the contention that tissue damage is a proximate cause of cancer; rather than tissue damage represents a parallel toxic action of carcinogens which, to some extent, may enhance the development of tumors produced by carcinogens. Since the Tamplin-Cochran proposal is based almost wholly on radiation tumor studies of the rat skin follicles, the decisive argument against this proposal is the evidence that focal alpha irradiation of localized regions on the hair follicle, in a pattern similar to that from a Pu particle, is non-tumorigenic. (RAF)

<4>
Aristov, V.P., Not given. 1972

Ultrastructure of the Alveolar-Capillary Barrier in Rats Following Single Inhalation of Plutonium 239 Citrate. AEC-tr-7457; Part of Moskalev, Yu.I. and Kalistratova, V.S. (Eds.), Biological Effects of Radiation from External and Internal Sources, (p. 381-390), 515 p.

Male Wistar rats weighing 110-130 g were used in the experiment. A citrate solution of Pu 239 was used for the inhalation (activity 292 uCi/ml, pH 6.3, concentration of sodium citrate 2%, dispersion approximately 1 micron) and exposure time was 10 minutes. The animals were sacrificed immediately after terminating the inhalation, then after 30 minutes, 6 hours, 1, 3, 7, 14 days, 1, 2, 3, and 6 months. The electron microscopic findings are described. With external irradiation, destructive changes in the

<4>

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<4> CONT.
alveolar-capillary wall are usually observed before 1 month. With inhalation of Pu 239, degenerative changes are observed at all examination times. These changes lead to an impaired exchange of gases. The greatest development of destructive processes in the alveolar-capillary barrier of rats is referable to the 14th day after inhalation. At this time, most capillaries show extremely marked vacuolization and lamination of the endothelial lining. The alveolar epithelium is markedly swollen and its cytoplasm shows diminished electron density. There are many destroyed cells, bare nuclei, as well as macrophages and erythrocytes, which are not infrequently hemolyzed in the alveolar lumen. Thirty days after inhalation the changes included focal swelling in the endothelium and epithelium. Many mitochondria, much larger than those of control animals are often seen in the cytoplasm of the alveolar epithelium. The substantial distinction of the effects of inhaled Pu is also the relatively small cumulative ionization dosage absorbed by the lungs (42 rads), with which marked destructive changes are observed in the alveolar-capillary barrier. In all probability, this is due to the large local doses created at the site of deposition of Pu. (FMM)

<5>
Atkins, H.L., R.G. Fairchild, and R.M. Drew, Brookhaven National Laboratory, Medical Department, Upton, Long Island, NY. 1973, March

Biological Properties of Californium 252. Part of Proceedings of the 54th Annual American Radium Society Symposium held in Boca Raton, Florida, May 14-19, 1972, (7 p.); American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, 117(3), 704-710

There is good biological evidence for an enhanced effect of californium 252 on tumors because of a reduced necessity for the presence of oxygen during the period of irradiation. This is the primary reason for consideration of its use in interstitial and intracavitary cancer therapy. Balanced against this is the complexity of dosage calculation and the variability of RBE depending on dose rate. A table of RBE values of Cf 252 in various biological systems is given. In a study on spleen colony-forming ability in mice the RBE for Cf neutrons was 2.44 compared to gamma irradiation. Experiments with Chinese hamster cells were performed to measure RBE and OER for Cf 252. Survival curves for various dose rates of Cf 252 and Cs 137 are given, and the RBE of Cf 252 was calculated to be 3.94. Measurement of the OER of Cf 252 are also reported in tabular form for several biological systems including VICIA FABA and HELA cells. The measurements show good agreement, with values generally ranging from 1.4 to 1.75. The difficulties in storage and handling of Cf 252 due to special hazards must also be considered. Because of these problems a careful evaluation of californium 252 must be carried out prior to its routine clinical use. (FMM)

<6>
Atkins, H.L., R.G. Fairchild, and J.S. Robertson, Brookhaven National Laboratory, Medical Research Center, Upton, Long Island, NY. 1972, May

Dose-Rate Effects on RBE of Californium and Radium Reactions of Pig Skin. Radiology, 103(2), 439-442

Experiments on the skin of pigs showed a marked dose rate dependence of the biological effect of Cs 137 or Ra 226 gamma rays over the clinically useful range. The slope of a line relating duration of exposure to dose was 0.296 in a series of experiments. On the other hand, exposure to mixed neutron and gamma ray Cf 252 radiation resulted in effects which were much less dependent on dose reate. The relative biological effect varied markedly with dose rate from about 5 at acute exposures to over 7 at prolonged low dose rate exposures. It is suggested to base the radiation dose of Cf 252 on a given dose of neutrons with a slight correction for the additional gamma dose obtained with the Cf. (Auth) (RAF)

<7>
Bair, W.J., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

The Biological Effects of Transuranium Elements in Experimental Animals. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 171-229), 327 p.

A review is presented of the absorption of the transuranic elements into the body, and the distribution within the organism following ingestion, deposition on skin and inhalation. Experiments show that most transuranic element compounds are notreadily absorbed from the gastrointestinal tract. In rats, Np nitrate was most readily absorbed, nearly 1%. The least absorbed was PuO2, 0.0001%. The effect of the physical properties of the inhaled particles on retention of Pu in the lung is discussed and retention half-lives of several Pu compounds are summarized for various animal species. The translocation from lung to other tissues is described. All of the transuranics tend to translocate from lung to bone and liver and to a lesser extent to spleen and kidney, however, the rate depends mostly on the in vivo solubility of the compound inhaled. The biological effects which occur depend on the radiation exposure and the relative radiation sensitivity of the tissue into which the radionuclide is deposited. Animal experiments have identified neoplasia as the most sensitive response to the long-term effects of transuranic elements deposited in the body. The most consistent hematologic response seen after injection and inhalation of the transuranics is lymphopenia, while osteogenic sarcomas appear to be the most sensitive effect following the skeletal deposition of Pu, Am Cm and Es in mice, rats and dogs. Lung cancer has been observed in laboratory animals following inhalation of relatively soluble Pu compounds and the relationship between cancer incidence and radiation dose has been described mathematically. The hot particle issue is discussed at length and it is believed from the results of some experiments that particulate alpha emitting transuranics in the lung do not represent a higher risk of lung cancer than the equivalent quantity of relatively non-particulate transuranium elements distributed throughout the lung. The dose levels at which major biological effects have been observed in experimental animals are shown relative to the maximum

<7> CONT.
permissible lung burden of 0.016 uCi for occupational exposures. Lung cancer has been observed at dose levels equivalent to about 100 times the maximum lung burden. Research is in progress to examine the late effects of low levels of transuranic elements and to develop a better understanding of the mechanism by which alpha emitters induce cancer. (PMM)

Figure 1 shows retention of Pu in pulmonary region of lungs for various animal species. Figure 3 shows retention of transuranium elements in rat lungs (Pu 238, Pu 239, Am 241, Cm 242, Es 253). Figures 11-12 show distribution of Pu in dogs after inhalation of Pu 239(NO3)4 and Pu 239 PuO2. Figure 17 shows Pu-induced lung cancer in experimental animals. Figure 24 shows observed biological effects of inhaled Pu.

<8>
Bair, W.J., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1974

Toxicology of Plutonium. Part of Lett, J.T., et al (Eds.), Advances in Radiation Biology, Vol. 4. Academic Press, Inc., New York, New York, (p. 255-315), 435 p.

This review describes the current status of our knowledge of the toxicology of plutonium. The subject is considered in respect to the 3 most common routes by which plutonium might enter the body: The gastrointestinal tract, the respiratory tract and wounds in the skin. The physical-chemical properties of Pu compounds which influence its toxicological properties in addition to the route of entry, are given. Absorption, retention and translocation of Pu in the 3 routes as well as the fate of systemic Pu in liver, bone and other tissues and its excretion are discussed. Other subjects reviewed are: The biological effects of Pu on blood, bone, liver, lungs, and lymph nodes with a brief discussion of counter measures of Pu contamination. (Auth) (RAF)

<9>
Bair, W.J., and D.H. Willard, General Electric Company, Hanford Laboratories, Biology Laboratory, Richland, WA. 1963

Plutonium Inhalation Studies. 3. Effect of Particle Size on Total Dose Deposition, Retention and Translocation. Health Physics, 9, 253-266

Forty-eight beagle dogs were exposed to plutonium dioxide aerosols of three particle size distributions. The aerosol concentrations ranged from 10(E-7) to 10(E-3) uc per cm3 air and the total amount of plutonium deposited in the dogs varied form 0.01 to 100 uc during exposure periods that ranged from 10 to 30 min. Total deposition in dogs exposed to aerosols with Count Median Diameters of 0.086, 0.43, and 0.60 u averaged 4, 30, and 60 per cent, respectively, of the total amount of plutonium inhaled. For all particle sizes the percentage of plutonium apparently deposited in the alveoli of the lung increased with decreasing microcuries of deposited plutonium. For a given amount of plutonium deposited, the percentage deposited in the alveoli was greatest for the aerosol with particles of the largest median diameter. The rates of pulmonary clearance, translocation and excretion in both urine and feces were greatest for the aerosol with particles of the smallest median diameters. In comparing the three aerosols it was concluded that all processes favored pulmonary deposition and retention of Pu 239 PuO2 inhaled as an aerosol with the largest Count Median Diamter, 0.60 u. (Auth)

<10>
Bair, W.J., D.H. Willard, and J.E. West, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1961, January 10

Plutonium Inhalation Studies. HW-69500; Part of Hungate, F.P. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1960, (p. 67-76), 195 p.

Immediately following a single exposure of beagle dogs to Pu 239 PuO2, 40 to 85 per cent of the total Pu 239 deposited was recovered from lungs. Deposition and retention of plutonium in lungs was less for particles with a geometric mean diameter by weight of 1.7 microns than for 4.3 micron particles, but a larger percentage was excreted in the urine. Retention was also less when the amount deposited was increased. For 4.3 micron particles the half-time for pulmonary retention was about 2,000 days. There was marked accumulation of plutonium in bronchial lymph nodes but only trace amounts were translocated to other tissues. In other dogs death occurred at times up to more than one year following deposition of more than 0.1 uCi/g of lung. Histopathologic effects were confined to lungs and bronchial lymph nodes. (Auth)

Table 1 shows the distribution of Pu 239 in dogs immediately after exposure.

<11>
Balabukha, V.S., A.T. Ivannikov, and L.M. Razbitnaya, Not given. 1972, September

The Effect of Aminoalkylphosphonic Acids on the Elimination of Uranium from the Organism. Gigiena Truda i Professional'nye Zaboleraniya, 9, 29-32

Data on the study of complex-forming properties of aminoalkylphosphonic acids with respect to uranyl and their effectiveness in eliminating uranium from the organism of rats are presented. Seven different aminoalkylphosphonic acids were studied. All of them fix uranium quite well and accelerate its elimination from the organism. As regards their efficacy they are superior to aminocarboxylic acids. Uranyl complexes with aminoalkylphosphonic acids are shown to be characterized by a considerable strength and a comparatively low solubility. Some features peculiar to their effect depending upon the number of functional groups and the presence of the hetero-atom N,S and O in the carbon ring were revealed. Aminoalkylphosphonic acids hold out promise in accelerating elimination of uranium. (Auth)

<12>
Ballou, J.E., Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1962, January 15

Removal of Internally Deposited Plutonium. HW-77500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1961, (p. 77-80), 180 p.

Evaluation of the effectiveness of chelating agents showing promise in plutonium therapeutics was continued in rats burdened

<12>

BIOLOGICAL ASPECTS

<12> CONT.
with plutonium. Preliminary tests indicate the complexing agent triethylenetetraminehexaacetic acid (TTHA) is as effective as diethylenetriaminepentaacetic acid (DTPA) when given intraperitoneally and more effective than DTPA when administered orally. The range of toxicity and therapeutic effectiveness of TTHA has not yet been clearly defined. (Auth)

<13>
Ballou, J.E., Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1961, January 10

Effects of Combined Plutonium and X-Irradiation in the Rat. HW-69500; Part of Hungate, F.P. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1960, (p. 134-137), 195 p.

Rats administered 32 uCi Pu/kg and 400 R total-body x ray were not protected by delaying the x ray exposure 1/4 or 28 days. Plutonium administered with diethylenetriaminepentaacetate (DTPA) was less toxic in combination with x irradiation than equivalent plutonium citrate solutions. Approximately 90 per cent of the plutonium administered with a 12 times molar excess of DTPA was excreted in two days. (Auth)

Table 1 shows effect of DTPA/Pu ratio on Pu distribution in liver, carcass, femur, urine and feces 48 hours after injection.

<14>
Ballou, J.E., Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Adrenal Distribution of Neptunium 237 and Plutonium 239. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 70-72), 242 p.

Neptunium 237, following intravenous administration to rats, is retained for long periods of time in the adrenal cortex associated primarily with cells in the reticular and glomerular zones. The distribution pattern of Pu 239 in the adrenal cortex is similar to that of Np 237. Equally prolonged retention was observed in the adrenal and femur. Plutonium and Np deposited in the outer cortex of the adrenal appear to be uniformly spread throughout the cells of the zona glomerulosa. Within the zona reticularis, deposition is primarily in cells of the reticuloendothelial system. Plutonium does not appear to be associated with the extractable lipid fraction or with cell nuclei. The fraction of Pu deposited in the adrenal and femur is markedly influenced by the mass of radionuclide injected. (Auth) (FMM)

<15>
Ballou, J.E., Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1961, January 10

Wound Decontamination with EDTA. HW-69500; Part of Hungate, F.P. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1960, (p. 111-113), 195 p.

Experiments on rats were done in which wounds contaminated with plutonium were decontaminated with three different agents. The plutonium was placed in the wound as 10 ul of a pH 1, plutonium(+4) nitrate solution, and allowed to dry 15 minutes before decontamination procedures were commenced. About $0.^5$ uCi of plutonium was employed. Decontaminants employed were: water, a 10 percent solution of household detergent, and a 10 percent solution of household detergent with 17 g of the tetrasodium salt of EDTA added per 100 ml. The results suggest that chelating agents such as EDTA, when applied to plutonium contaminated wounds, offer little advantage in removal of the plutonium and may significantly increase its absorption into the body. (Auth) (FMM)

<16>
Ballou, J.E., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1965, January

Effect of Splenectomy on Acute Plutonium Toxicity. BNWL-122; Part of Thompson, R.C. and Woods, S.W. (Eds.), Hanford Biology and Research Annual Report for 1964, (p. 83-84), 216 p.

Studies have indicated that the greater toxicity of Pu 239 was probably related to the greater mass of Pu 239 involved (1 uCi of Pu 239 weighs about 270 times as much as 1 uCi of Pu 238), but probably did not involve any factor of direct chemical toxicity. It seemed most likely that the different toxicities were explainable in terms of different distributions of the two isotopes among body organs, the distribution being influenced by the mass of material involved. It was observed that initial deposition of Pu 239 in the spleen was several times greater than that of Pu 238 (as percent of injected dose) and that histopathologic damage to the spleen was greater in the case of Pu 239. Experiments were done on rats splenectomized three weeks prior to intravenous injection of Pu 238 or Pu 239 as citrate solutions. It was shown that the survival time of rats injected with either Pu 238 or Pu 239 was not altered by prior splenectomy. This would seem to eliminate spleen damage as a critical factor in explaining the greater acute toxicity of Pu 239. (Auth) (FMM)

<17>
Ballou, J.E., R.H. Busch, and G.E. Dagle, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Physics and Instrumentation Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1974, August

Histopathologic Effect of Intratracheally Instilled Einsteinium 253 Chloride in Rats. BNWL-1850 (Part 1); Part of Thompson, R.C., et al, Annual Report for 1973, (p. 70-71), 162 p.

Male rats were administered Es 253 EsCl3 intratracheal instillation. The biological effects were followed for 880 days as part of studies in progress on long-term biological effects in these animals. The major pathologic lesions produced by intratracheally instilled Es 253 EsCl3 were: 1) radiation pneumonitis at a dose of 47.2 uCi/kg, 2) osteosarcomas at a dose of 10.7 uCi/kg, and 3) soft tissue tumors, including lung tumors, at a dose of 0.214 uCi/kg. (Auth) (RAF)

<18>
Ballou, J.E., W.J. Clarke, J.L. Palotay, and

<18> CONT.
A.S. Vogt, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Toxicity of Plutonium 239 and Plutonium 238 in the Rat. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 67-69), 242 p.

The significance of the tissue distribution of acutely toxic amounts of plutonium is considered in relation to the hematological and histopathological changes observed. Citrate solutions of Pu 239 and Pu 238 of comparable physical and chemical state were injected intravenously in rats at a dose level of approximately 75 uCi/kg. Animals were sacrificed at intervals after injection. Median survival time for the Pu 239 injected rats was 15 days; for the Pu 238 rats, 75 days. Comparison of the histopathological and hematological changes preceding death indicates damage to spleen may contribute to the earlier death with Pu 239. Death from Pu 238 was preceded by a decrease in marrow capacity due to the marked increase in trabecular bone in the marrow spaces. Peripheral blood values did not reflect the progressive decrease in marrow volume. The indications are that Pu 239 is more toxic than Pu 238 because large doses of Pu 239 more effectively irradiate both bone marrow and sensitive soft tissues. Pu 239 deposited in soft tissues tends to accumulate in cells of the reticuloendothelial system resulting in a combined radiation to both the major reticulcendothelial and hematopoietic tissues. (Auth) (FMM)

Table 1 shows distribution of Pu 238 and Pu 239 in rat tissues (liver, femur, spleen and total rat).

<19>
Ballou, J.E., and W.G. Morrow, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

The Long-Term Biological Effects of Intratracheally Instilled Einsteinium 253 Chloride in Rats. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 32-33), 103 p.

Male rats were administered 0.5 ml of Es 253 Es Cl 3 in HCl solution (pH 2) at 47.2, 10.7 and 0.214 uCi/kg dose levels. Retention curves were determined from rats administered 2.2 uCi Es 253 Es Cl3. The radiation dose to lung, kidney, liver and skeleton was calculated using parameters determined from the short-term retention curves. The long-term effects of intratracheal Es 253 EsCl 3 were characterizied by: (1) a depressed rate of growth which was dose related; (2) early death due to radiation pneumonitis in the 47.2 uCi/kg group; (3) death due to neoplastic lesions in bone and soft tissues, and leukemia in the 10.7 uCi/kg group; and (4) essentially no effect at the lowest level of 0.214 uCi/kg. (Auth) (RAF)

<20>
Ballou, J.E., and W.G. Morrow, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

In Vitro Binding of Plutonium 239 by Calcium Sodium DTPA. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 276-278), 313 p.

DTPA enhanced the ultrafilterability of Pu 239 in blood serum and in a simulated lung fluid. The DTPA effect decreased rapidly after Pu 239 addition demonstrating the importance of prompt chelate therapy. These in vitro studies demonstrated a decrease in the availability of Pu 239 for chelation by DTPA in dog blood serum at a rate of 0.45%/min between 5 and 120 min after Pu addition. In a simulated lung fluid only one third as much of the Pu 239 was available for chelation after 5 min, buth the subsequent rate of decreased availability was approximately the same as for serum during the first hour after Pu addition. It is suggested that hydrolysis may be the primary action which interferes with the formation of the Pu-DTPA chelate. (Auth) (RAF)

Table 1 shows the composition of solutions employed in Pu 239 in ultrafilterability study. Figure 1 shows time course of Pu availability for chelation in human plasma, dog serum and Gamble's Solution.

<21>
Ballou, J.E., and J.L. Palotay, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Removal of Internally Deposited Plutonium. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 113-115), 242 p.

Comparative tests indicate prompt oral treatment with triethylene tetraminehexacetic acid is more effective and less toxic than equivalent treatment with DTPA or the pentaethylester of DTPA in rats treated one hour after Pu 239 injection. Histopathological change in the liver, following oral TTHA and DTPA, was more pronounced in the DTPA animals. (Auth)

<22>
Ballou, J.E., and J.F. Park, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

The Disposition of Ingested, Injected, and Inhaled Plutonium 239 Citrate and Plutonium 239 Nitrate. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 146-152), 313 p.

Dogs administered oral, intravenous, or inhaled Pu 239 citrate or nitrate were sacrificed from 1 to 100 days after exposure to compare distribution and retention kinetics. Approximately 0.08% of the citrate and 0.005% of the nitrate oral dose was retained after 3 days, distributed mainly between skeleton (50% and 26%) and liver (25% and 26%), respectively. After intravenous administration, the Pu 239 dose was retained principally in the liver (32-46% citrate and 21-62% nitrate) and skeleton (29-44% citrate and 13-56% nitrate) during the 100-day postinjection period. Inhaled Pu 239 citrate and nitrate were cleared from the blood and excreted with kinetics similar to those described by others for dogs and humans administered intravenous Pu 239 citrate. The lung, skeleton, liver, blood, and intestines retained most of the inhaled Pu 239 1 day after exposure. After 100 days, 84-88% of the initial lung burden was retained, principally in the lung, skeleton, and liver. Plutonium was concentrated by lymphatic tissue following all methods of

<22>

BIOLOGICAL ASPECTS

<22> CONT.
administration at all time intervals. Although the concentration in specific lymph nodes (hepatic, splenic, mediastinal, and tracheobronchial) was among the highest of any tissue analyzed, the total amount deposited in a selection of 12 lymph nodes (approximately 10 grams tissue) was always less than 0.6% of the body burden. (Auth)

<23>
Ballou, J.E., and M.F. Sullivan, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Excretion of Plutonium 239 into the Intestine. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 116-119), 242 p.

Studies with gut-perfused and bile duct-cannulated rats implicate the bile as a major route of plutonium excretion into the intestine. Plutonium collected from the cannulated bile duct accounted for about half of the intestinally excreted radionuclide immediately after injection and accounted for 75 to 90%, subsequent to DTPA administration. Biliary plutonium levels increased 12-fold subsequent to DTPA treatment and remained higher than pretreatment levels for at least four days. (Auth)

<24>
Beatley, J.C., University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1970, April

Perennation in ASTRAGALUS LENTIGINOSUS and TRIDENS PULCHELLUS in Relation to Rainfall. Madrano, 20(6), 326-332

The fate of ASTRALAGUS seedlings on five sites, and TRIDENS on one site, as a contribution to the understanding of the annual-biennial-perennial habit in relation to precipitation, is recorded. Four of the sites were located on the upper bajada of eastern Jackass Flats. Vegetation was typical of the high Mojave Desert region. Soils were predominatly sand and essentially without desert pavement. The altitude was around 500 ft. The fifth site was in Mid Valley to the north of Jackass Flats. Desert pavement of the soil surface was in a disturbed condition. The sixth site was on the bajada below the Ranger Mountains with a well developed desert pavement typical of that below limestone mountain ranges of the region. Data of growth were recorded in late May or early June of consecutive years. Rainfall was recorded year-round on each site. In ASTRALAGUS LENTIGINOSUS and TRIDENS PULCHELLUS it appears the large and importantly reproducing populations in the northern Mojave Desert are biennials or annuals, which germinate following unusually heavy rainfall in the spring or autumn. Only a limited number successfully perennate where precipitation is irregular and variable from season to season. In these environments, those that do become perennial plants flower and fruit during the years between large germinations and give continuity to the presence of the species in the community. The large perennial populations of ASTRALAGUS are confined to the higher valley floors and mountains, where there is relative constancy of precipitation above a minimum necessary for the perennial habit. TRIDENS does not occur at the higher elevations in this region, and the perennial populations are those which survive the vagaries of precipitation at the lower elevations. (Auth) (RAF)

<25>
Belyaev, Yu.A., Not given. 1960

The Use of Ion-Exchange Resins After the Entrance of Plutonium into the Gastrointestinal Tract. JPRS-5124; Part of Medical Radiology, (p. 110-116), 253 p.; Medical Radiology, 5(3), 44-47

Ion exchange-resins reduced by several times the absorption of Pu from the intestine and the Pu content in the skeleton and liver of rats. The effectiveness of these resins decreased with the increase in time which had elapsed after the entrance of plutonium into the body, which is directly associated with the rate of Pu absorption from the gastrointestinal tract. The nature of distribution of plutonium in treated rats in the principal organs in which it is retained (skeleton and liver) is unchanged by this procedure. (Auth)

<26>
Belyaev, Yu.A., Not given. 1960

The Influence of the Calcium-Disodium Salt of Diaminocyclohexanetetraacetic Acid on the Plutonium Metabolism in Rats. JPRS-5078; Part of Medical Radiology, (p. 131-141), 260 p.; Medical Radiology, 5(2), 54-58

The intraperitoneal administration of Na2Ca DCTA (diaminocyclohexanetetraacetic acid) to rats (from the fourth through the 18th day) in doses of 10, 40 and 100 mg reduced the Pu 239 content in the liver which amounted respectively, to 72, 69 and 48 percent of the control. A reduction in the Pu 239 deposition in the skeleton occurred only after doses of DCTA of 40 and 100 mg and amounted to 80-82 percent of the control. A reduction in the content of Pu 239 in the liver by two times was observed even in the late administration of DCTA at 30 days. The combined intraperitoneal injection of DCTA (40 mg) and zirconium citrate (10 mg) from the fourth through the 18th day lowered the Pu 239 content in the skeleton alone to 68 percent of the control. The oral administration of DCTA (100 mg) was not very effective either with the additional administration of sodium bicarbonate or without it. The content of Pu 239 in the liver amounted to 83-79% of the control; in the skeleton it was unchanged. The combined oral administration of DCTA (40 mg) and zirconium citrate (15 mg) reduced the Pu 239 content in the liver to 66% of the control. (Auth)

<27>
Belyaev, Yu.A., Not given. 1964

Relative Efficiency of Certain Complex Compounds in the Removal of Plutonium 239 from the Organism. AEC-tr-6408; Part of Radiobiology, (p. 125-128)

The efficiency of several complex-forming agents (2,2'-diaminodiethylsulfide of tetraacetic acid (TS), triethylenetetraamine-hexaacetic acid (TTHA), tetraethylenepentaamineheptaacetic acid (TPHA), diethylenetriaminepentamethylphosphinic acid (DTPPA)) for removal of plutonium from rats was investigated. The strongest effect at early stages was shown by TTHA. This compound was several times more efficient

<27> CONT.
than DTPA which was taken as the standard for the efficiency of the other complex-forming agents. The effect of TPHA was somewhat weaker than that of TTHA but still stronger than DTPA. The least effective was TS. DTPPA was effective for the removal of Pu from soft tissues and skeleton although on the whole its efficiency was less than that of TTHA, TPHA and DTPA. When treatment with complex-forming agents was started 30 days after the injection of Pu, the efficiency of TTHA did not differ from that of TPHA and DTPA. (Auth)

Tables show Pu content in rat organs after IV or IP injection of complex-forming agents at various intervals after Pu administration.

<28>
Berlin, J.D., and D.D. Mahlum, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Neptunium-Induced Fatty Livers in Rats: Electron Microscopic and Biochemical Studies. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 43-46), 207 p.

The effects of Np 237 on the fine structure of rat hepatocytes and on protein synthesis were studied. The earliest observed morphological alterations in developing fatty livers induced by Np 237 were dilatations in the rough endoplasmic reticulum. These dilatations appeared to give rise to the lipid bodies characteristic of Np 237-induced fatty livers. Morphological and biochemical evidence suggests that protein synthesis may be less markedly inhibited after Np 237 administration than after CCl4, puromycin, or ethionine administration. (Auth)

<29>
Berliner, D.L., M.L. Berliner, and T.F. Dougherty, University of Utah, College of Medicine, Division of Radiobiology, Department of Anatomy, Salt Lake City, UT. 1962

The Effects of Chronic Irradiation by Internally Deposited Radionuclides on Corticosteroid Biosynthesis. 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, Oxford, England, (p. 179-186), 529 p.

The influences of various internal emitters (Sr 90, Th 228, Ra 226, and Pu 239) on the biosynthetic capabilities of the adrenal glands of dogs which were sacrificed from 24 hr to 6 years after injection were studied. The effect on adrenal steroidogenesis was a decrease in 11, 17, and 21 hydroxylations. The most marked effect was the reduction of 17 hydroxylation. The addition of coenzymes, glucose-6-phosphate and TPNH, corrected the inhibitory effect on 17 hydroxylation. Chronically irradiated dogs stimulated with Sr 90 24 hr prior to sacrifice responded with increased corticosterone synthesis. The site of 17 hydroxylation in the adrenal is the reticuloendothelial cells. (ST)

<30>
Blair, H.A., University of Rochester, School of Medicine and Dentistry, Department of Radiation Biology, Rochester, NY. 1964

The Shortening of Life Span by a Single Injection of Radium, Plutonium, or Polonium. Radiation Research, Supplement, 5, 216-227

It is shown that the life-span relationship for polonium poisoning in the rat can be represented by equations applied previously to data on penetrating ionizing radiation. These equations are based on the hypothesis that radiation produces injury which is reversible in part and irreversible in part and that life shortening is a measure of the total injury, unrepaired plus irreparable existing at the time of death. Semiempirical equations derived from the same hypothesis for radium and plutonium poisoning permit easy handling of data on the rat and mouse and easy comparison of these elements with polonium. The long-term toxicities of polonium and plutonium are each about 5 compared to that of radium in the rat. (Auth)

<31>
Bloom, W. (Ed.), University of Chicago, Institute of Radiobiology and Biophysics, Department of Anatomy, Chicago, IL. 1948

Histopathology of Irradiation from External Sources. National Nuclear Energy Series, Division 4, Vol. 22. 1. McGraw-Hill Book Company, Inc., New York, New York; 808 p.

The volume is one of a series which has been prepared as a record of the research work done under the Manhattan Project and the Atomic Energy Commission. A report is given of three years of intensive research, undertaken to compare the histological changes that result from various types of radiations originating externally and internally. External radiation was obtained using x rays, beta rays emitted by P 32, gamma rays released by radium and fast and slow neutrons. Internal radiation was obtained from several radionuclides, namely, alpha particles from Ra, Pu and Po; beta particles from Ba 140-La 140, Ce-Pr, Zr 93-Nb 93, Y 91, P 32, Na 24 and Ra, and gamma rays from some of the above. A few experiments were made with U. The radionuclides were administered intramuscularly, intravenously, intracardially or intraperitoneally, also by inhalation or gavage. In inhalation experiments rats inhaled aerosols of Y 91 through a tracheal tube, 28-220 uCi/rat and Pu, 1.5-31.5 uCi/rat. Plutonium nitrate or citrate was administered IV to mice (0.08 uCi/g) and to rats (0.125-0.004 uCi/g); intramuscular injections into the hind leg of mice ranged from 0.3-0.003 uCi/g. Separate chapters cover the histopathology of the cell, skin, bone, bone marrow, spleen, lymph node and intestinal lymphatic tissue, thymus, gastrointestinal tract, testes, ovary, kidney, lung, vascular system, adrenal and nervous system. A comparison is given of the several radiations and radiosenstivity and the mechanism of radiation effects are discussed. (PHM)

<32>
Boecker, B.B., Lovelace Foundation for Medical Education and Research, Inhalatio Toxicology Research Institute, Albuquerque, NM. 1973, December

Choice of the Beagle Dog as a Laboratory Animal. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 81-85), 342 p.

The advantages of using beagle dogs in studies of the long-term biological effects of internally deposited radionuclides are

<32>

BIOLOGICAL ASPECTS

<32> CONT.
reviewed. General characteristics which favor the use of the beagle dog as an experimental animal include its intermediate lifespan, medium body size, short hair coat, friendly temperament, ease of handling and good litter sizes. It has been well characterized in a number of laboratories. Fatal diseases in the beagle dog are diverse and not overshadowed by one predominant cause as is seen in some species. In inhalation toxicology studies, aerosol deposition patterns have been shown to be similar to those seen in humans. Also, particle size differences in the deep lung and subsequent retention in the lung differ from those seen in rodent species. The dog forms an important link in the extrapolation of results from laboratory animals to man. It is also large enough that possible therapeutic procedures for man such as bronchopulmonary lavage can be examined and tested in detail. (Auth)

<33>
Brooks, A.L., D.K. Mead, and R.F. Peters, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

Distribution and Retention of Monomeric Plutonium 239 Citrate in the Chinese Hamster and Its Cytogenic Effect on the Testes. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 240-243), 342 p.

Chinese hamsters were injected with Pu 239 citrate to characterize the retention and distribution of this chemical form of the isotope. These data were used to make an estimate of the radiation dose to the testes which was related to the chromosome damage recorded in mitotic metaphase cells. Injected Pu 239 citrate in the monomeric form was retained in the Chinese hamster with a long effective half-life. At day zero, the liver and bone each contained 40% of the sacrifice body burden, increased with time whereas the bone remained almost constant. This long effective half-life in the liver is similar to that seen in dog and man and indicates that the Chinese hamster may be a useful small animal model for studying the retention, clearance and biological effects of Pu 239 in the liver. There was no significant increase in the frequency of chromosome aberrations in the testes at 64 days after injection, indicating that the genetic risks from Pu 239 citrate are small compared to the risk for life shortening and cancer induction. (Auth)

<34>
Brooks, A.L., and J.A. Mewhinney, Lovelace Foundation for Medical Education and esearch, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

The Frequency of Chromosome Aberrations in the Blood Lymphocytes of the Chinese Hamster Following Inhalation of Plutonium 238 Dioxide Particles. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 230-232), 342 p.

To evaluate the extent to which chromosome aberrations are produced in blood lymphocytes by inhaled plutonium, Chinese hamsters were exposed via inhalation to Pu 238 PuO2 and the chromosome of the blood lymphocytes examined for damage 25 days later. Animals with initial lung burdens of 650 to 920 nCi died with a median survival time of 16 days. Animals with initial lung burdens of 60 to 80 nCi had a 50% reduction in lymphocyte count at 25 days post-inhalation. These animals also had an aberration frequency of 0.014 aberrations/cell while pooled controls showed a frequency of 0.004 aberrations/cell. Further experimentation is needed on this system to make it useful as a model for studying the effect of inhaled toxicants in producing early biological changes in the blood lymphocytes. (Auth)

<35>
Brooks, A.L., J.C. Retherford, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

The Effect of Plutonium 239 Dioxide Particle Number and Size on the Frequency and Distribution of Chromosome Aberrations in the Liver of the Chinese Hamster. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute AnnualReport, 1972-1973, (p. 233-239), 342 p.

Chinese hamsters were injected intravenously with Pu 239 citrate or Pu 239 PuO2 particles. There were four particle sizes injected, 0.17, 0.30, 0.44 and 0.80 um which would vary the local radiation dose rate to the surrounding cells. Additional hamsters were injected with graded levels of activity from 6 x 10(E-5) to 6 x 10(E-3) uCi/gm using 0.30 um Pu 239 PuO2 particles. This changes the particle number and the average dose rate. An experiment was also conducted to determine the retention and distribution of the particles using Cr 51 to trace the Pu 239 PuO2 particles. The particles were concentrated in the reticuloendothelial system with 90% of the injected activity in the liver, 3% in the spleen and the remainder associated with bone and bone marrow. There was particle clumping causing high local doses in all particle sizes studied. The Pu 239 citrate produced a linear increase in the chromosome aberration frequency with a slope of 4.8 x 10(E-3) aberrations/cell/rad. The aberration frequency increased with increasing average dose following injection of the Pu 239 PuO2 particles with little evidence of an effect of particle size on the aberration frequency. This increase in response plateaued at higher average doses. When local dose was related to aberration frequency, the smaller the particles the greater the effectiveness in producing chromosome damage. Following injection of all particle sizes, there was a non-uniform distribution of chromosome damage in the cell population with some individual cells containing as high as 13 aberrations. The non-uniform dose distribution is thus reflected in a non-uniform distribution of biological damage at the cellular level. The number of cells at risk following particulate deposition is much less than from uniform distribution of the same total activity. This may indicate that long-term risks from Pu 239 PuO2 particles would be less than that from uniformly distributed Pu 239 citrate. (Auth)

<36>
Bruenger, F.W., W. Stevens, D.R. Atherton, and B.J. Stover, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

<36> CONT.
The Effect of the Physical-Chemical State of Plutonium on Its Early Distribution in the Liver. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 148-160), 380 p.

The early deposition and subcellular distribution of Pu 239(+4) in canine liver following administration of either strictly monomeric Pu(+4) as a transferrin complex (Pu-Tf), Pu(+4) in citrate buffer pH 3.5 (Pu-M), or largely polymeric Pu(+4) in nitrate pH 6 (Pu-P) has been studied. Large differences in the quantities deposited and the intraorgan distribution pattern in the liver were observed. Liver depositions ranged from 25% of total dose for the strictly monomeric (Pu-Tf), an average of 32% for Pu-M, to approximately 70% for the largely polymeric material. Autoradiographs showed that initially Pu-M was deposited uniformly and diffusely in hepatic cells whereas Pu-P was found largely in random clusters in reticuloendothial cells. Cellular distribution patterns of Pu-Tf and Pu-M injected dogs were quite similar. Liver homogenates from a dog injected with Pu-M and the animal injected with Pu-P also were studied by differential and isopycnic sucrose density gradient procedures. Monomeric plutonium was initially associated with soluble liver proteins (ferritin) and was found at later times with subcellular fractions rich in mitochondria and also with lysosomes. In these organelles, most of the nuclide was either membrane bound or possibly associated with heavy granular material. In liver homogenates obtained from dogs injected with Pu-P most of the nuclide sedimented with nuclei or mitochondria. No association of Pu-P with soluble proteins could be demonstrated at very short times after injection. (Auth)

<37>
Bruner, H.D., U.S. Atomic Energy Commission, Division of Biology and Medicine, Washington, DC. 1971

Distribution of Tritium Between the Hydrosphere and Invertebrates. 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. 303-314), 807 p.

The literature was reviewed in order to establish whether the lower forms of life, and especially those invertebrates eaten by higher orders, exhibit evidence of enrichment of tritium in the organic compounds of their tissues. The data reviewed with one exception, indicate that invertebrates do not enrich the organic fractions of their tissues with tritium. Instead tritium appears to be discriminated against. The exception, DAPHNIA, is puzzling and warrants further study. Samples of biologic materials originating between about 1954 to 1968 are quite likely to have elevated specific activities of tritium in their bound hydrogen or water of combustion. The environmental levels of tritium during these years were as much as 10(E+3) times higher than present levels and samples of biological materials synthesized during that period must be interpreted accordingly. In the appendix, a table is given of the specific activity of tritium in phytoplankton, bioplankton, mollusks, water plants, other flora and insects, relative to the specific activity of the medium in which they live. (FMM)

<38>
Buldakov, L.A., A.P. Nifatov, R.A. Yerokhin, and L.G. Filippova, Not given. 1971

Biological Effect of Plutonium 239 with Cutaneous and Intracutaneous Injection. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 381-387), 574 p.

Rats of the Wistar line were injected with Pu 239 in a sodium citrate solution or with ammonium plutonium pentacarbonate to study the effect of plutonium at the injection site and resorbed plutonium on the rat body. Injected doses ranged from 0.0001 to 1 uCi/rat. One half of the rats were injected subcutaneously, the other half intracutaneously. All of the rats were subjected to a pathologic anatomical autopsy. Computations of the radiation doses in the bones were made on the basis of direct measurements of the plutonium content in 1 g of bone tissue. Following injection of 1 uCi the average lifetime was reduced from approximately 515 days to approximately 427 days. Focal fibrosis, benign and malignant tumors developed at the injection site after both types of injection of soluble plutonium compounds. The frequency of occurrence of scar changes (sclerosis) in the skin and in subcutaneous cellular tissue was dependent on the quantity of injected plutonium and ranged from 8.2 to 30%. Benign tumors of the skin and subcutaneous cellular tissue in from 2.3 to 3.8% of the cases were detected after the injection of 0.0001 to 0.1 uCi and malignant tumors after the injection of 0.001, 0.005, and 0.1 uCi in 2.4, 1.3, and 2% of the cases, respectively. Osteosarcomas in 3/4 and 25% of the rats were discovered with the injection of 0.1 and 1 uCi when the radiation doses in the bone tissue were 40-79 and 400-513 rad respectively. An estimated 40% of the isotope was lost during injection. Changes following subcutaneous and intracutaneous injection were similar. (ST)

<39>
Buldakov, L.A., A.P. Nifatov, N.M. Tolochkova, and I.T. Burov, Institute of Biophysics, Moscow, USSR. 1967

Absorption of Plutonium 239 Through the Skin and from the Subcutaneous Tissue of Young Pigs. AEC-tr-6889; Part of Radiobiology, (p. 167-182), 253 p.; Radiobiologiya, 7(4), 591-601

Two-month-old pigs received injections of topical applications of Pu 239 compounds to study the assimilation of Pu through the skin and from the subcutaneous tissue. The animals were divided into three groups; the first group received plutonium citrate intravenously at a dose of 1 uCi, the second group received 470-1127 uCi of plutonium citrate at a pH of 6.5 applied on shaven and degreased skin near the spine, and the third group received plutonium citrate (pH 6.5) or ammonium plutonium pentacarbonate (pH 8) subcutaneously at a dose of 1 uCi. At various times after administration the animals were sacrificed for histrological, radiometric, and histoautoradiographic studies. The results showed that 0.347% of the applied plutonium citrate was absorbed in six days; 0.183% was absorbed the first day . Its distribution within the organisms was similar to that after internal administration: 81% in the skeleton and up to 18.5% in the liver. During the first 24

<39>

BIOLOGICAL ASPECTS

<39> CONT.
hours the isotope accumulated in the epidermis, hair follicles, and sweat and sebaceous glands. After subcutanous injection the plutonium citrate content in the soft tissues was higher than the content of ammonium plutonium pentacarbonate, while in the skeleton the relationship was the reverse. The microdistribution at the site of injection and in the regional lymph nodes also differed between the two compounds. The assimilation of Pu from the site of injection occurred along the blood and lymph pathways. (Auth) (ST)

<40>
Buldakov, L.A., A.P. Nifatov, and R.A. Yerokhin, Not given. 1971

Biological Effect of Plutonium 239 With Chronic Peroral Administration. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 388-398), 574 p.

Three hundred and eighty-five male and female animals of the Wistar line with an initial weight of 152 plus or minus 0.7-205 plus or minus 1.8 g were used in the experiment. Six times a week the experimental animals were injected with a 1% solution of Pu citrate (Pu 239) in the oral cavity alongside the tongue in a volume of 0.2 ml. The activity of the Pu was 0.01 uCi-10 uCi for the various groups. The experimental and control rats were periodically weighed, and the composition of their peripheral blood was studied. The organs were investigated radiometrically and histoautoradiographically. The LD 50 values for different times with peroral administration are given. It was noted that LD 50/90-240 values in the large intestine (236-369 rad) were 1.4-2.2 times lower than in the skeleton (112-242 rad) and the LD 50/480 values in the large intestine (50 rad) were lower than in the skeleton (57 rad). The mean lifetime of the experimental rats decreased little with the daily administration of 0.5 uCi and decreased considerably with Pu administration of 0.1-10 uCi/dav. The data show that using the criteria of lifetime and weight, protracted peroral administration of Pu is more toxic than single administration. Among the pathological changes noted were peritonitis, anemia, leukopenia, osteosarcomas (7.4% in rats daily receiving 0.5 uCi Pu 239) and tumors in the soft tissues. (FHM)

<41>
Busch, R.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Exfoliative Lung Cytology of Beagle Dogs Exposed to Radon Daughters, Uranium Ore Dust, and Cigarette Smoke. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 246-251), 313 p.

Samples of deep lung cellular material were obtained by pulmonary lavage from beagle dogs exposed to radon daughters with U ore dust plus cigarette smoke, radon daughters with U ore dust, cigarette smoke only, and control dogs. The samples were obtained for the purposes of technique evaluation and cellular detail studies. Comparisons of cell-counting techniques for determining absolute and differential counts were made. Influences on these counts due to method of preparation were studied. Differential cell counts obtained by the methods regarded as most accurate indicated that dogs that were exposed to U ore dust had chronically inflamed lungs while those exposed to only cigarette smoke showed slight evidence of inflammation. (Auth)

<42>
Bushong, S.C., N. Prasad, S.A. Briney, and G.D. Oliver, Jr., Baylor College of Medicine and Veterans Administration Hospital, Department of Radiology, Houston, TX; Anderson Hospital, Houston, TX. 1973

Radiccytogenetic Studies with Californium 252. International Journal of Radiation Biology, 23(2), 105-112

Chromosomal analysis of Chinese hamster ovary cells was conducted after irradiation with either radium or Cf 252. Irradiations were performed at two different dose rates with each radiation source and under aerobic and anaerobic conditions. Low and high dose rates for radium were 79 and 327 rads/hr. Low and high dose rates for Cf 252 were 167 and 406-522 rads/hr. The oxygen enhancement ratio was approximately 2.3 for radium and 1.8 for Cf 252 and was independent of dose rate. The relative biological effectiveness of Cf 252 compared wiith radium ranged from 1.7 to 4.3 depending on radiation conditions. The number of single-and multi-hit abberations per cell are given in tabular form. (Auth) (ST)

<43>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Genetics. Part of Radiation Biology, Chapter 6. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 118-135), 368 p.

This chapter is limited to those radiation induced changes (mutations) in the cell that are not physically visible but which are recognized by a change in phenotype or survival of the progeny. Mutation studies in DROSOPHILA and the mouse are reviewed. The rate of mutation production is examined using different dose rates, fractionation patterns, and cell stages. Somatic mutations and the effect of background and cosmic radiation on evolutionary processes are briefly mentioned. (ST)

<44>
Casarett, A.P., Cornell Uiversity, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Biology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey; 368 p.

Radiation biology is concerned with the description and explanation of the many changes which radiation produces in biological material. The book is intended for use as an introductory textbook on the graduate or undergraduate level, as supplementary reading at the high school or early college level, and as a source of general information for those with a major interest in other fields of science. The book begins with a brief historical introduction to the field with an account of the contributions of early radiobiologists. The next chapters describe the principles of radiation physics, the major characteristics of various types of radiation and their detection and measurement. Typical experimental facilities for exposure of

<44> CONT.
different biological materials and problems of dosimetry and dosage calculation are included. Chapter 4 contains a general description of radiation chemistry and outlines the effects of radiation on chemical systems of varying complexity. The remainder of the book is devoted to the effects of radiation on biological material, starting with simple systems and progressing in order of increasing biological complexity. Emphasis is on the effects on mammalian systems and mammals, but other biological forms are considered whenever pertinent. The final chapter discusses radiation in our environment-sources, uses, exposure levels, and possible risks to the human population. It stresses the relationship of the experimental effects described in preceding chapters to the effects that may occur in humans as a result of the expanding use of radioactivity. To aid the reader in understanding the changes which are described in the various systems, basic biological background information is given. Specific and general references are included at the end of each chapter and at the end of the book. The experimental nature of the field is stressed by the inclusion of many illustrative studies. (ST)

Radiation Biology by Alison P. Casarett is a broad, unified coverage of the effects of ionizing radiation in biological systems at the molecular, cellular, organ, organism, and community levels. Including introductory material on radiation physics, dosimetry, and general biology, the book gives special attention to mammalian radiobiology. Possibly the most outstanding feature of this fully illustrated book is its broad coverage without over emphasis on specific areas. Worthy of note is the coverage of the acute radiation syndrome in mammals (description of effects and possible mechanisms), radiation dosimetry including techniques commonly used for radiating biological specimens, and certain aspects of applied radiation biology giving the exposures to be expected and estimates of the probable effects on present and future generations from current medical, industrial and military applications of ionizing radiation. (Reviewer's comments)

<45>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Effects of Radiation on Higher Plants and Plant Communities. Part of Radiation Biology, Chapter 13. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 284-314), 368 p.

The first two parts of the chapter consider the effects of external radiation sources on plants and plant communities. Consideration is given to the effects of radiation on pollen, developing plant embryos, seeds, growing plants, growth, morphology, tumor incidence, and plant hormones. The radiosensitivity of certain species is discussed. In plant communities radiosensitivity is correlated with type of plant (herbaceous vs woody), growth stage, and interphase chromosome volume. Implications of radiation induced alterations in plant communities are considered. Studies of natural plant communities exposed to chronic gamma radiation at Brookhaven National Laboratory are cited. The lethal exposure for flowering plants lies between 1,000 and 150,000 R. The last part of the chapter is a general discussion of radionuclide cycling within a community. Radionuclide distribution within the components of a food chain is governed by metabolic behavior, concentration factors, and utilization relative to a similar element. The complexities of food chains are illustrated. (ST)

<46>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Effects of Radiation on the Cell. Part of Radiation Biology, Chapter 5. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 90-117), 368 p.

The effects of radiation on the major structures and functions of a typical cell with reference, when possible, to the underlying molecular alterations are described. The discussion first reviews current concepts of the structure and function of the cell, with emphasis on those characteristics of the cell which are related to radiation damage. Cell irradiation leads to changes in membrane permeability, rate of ATP and DNA synthesis, enzyme levels, chromosome structure, cell division cycles, and to cell death. Experimental evidence suggests that the nucleus is the primary site of radiation damage leading to cell death. (ST)

<47>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Acute Radiation Effects in Whole Animals. Part of Radiation Biology, Chapter 10. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 217-235), 368 p.

This chapter deals with the syndromes which occur within one to two months after irradiation. The procedure for estimating lethal dose is outlined and a table of typical LD 50 values for several species of animals is included. The acute radiation syndrome in mammals, including man, is described and the relationship between dose, time of death, and specific organ system damage is given. Three organ systems appear to be most important in the acute radiation syndrome. The central nervous system is most involved with exposures of several thousand rads or more. Between 500 and 2000 rads the gastrointestinal system is of major importance. Exposures of less than 500 rads produce changes which are primarily associated with the hematopoietic system. Discussions of radiation effects on prenatal development and regeneration are included in the chapter. (ST)

<48>
Cohen, N., R.A. Guilmette, and M.E. Wrenn, New York University Medical Center, Institute of Environmental Medicine, New York, NY. 1974

Chelation of Americium 241 from the Liver and Skeleton of the Adult Baboon. Radiation Research, 58, 439-447

Investigations were performed to evaluate DTPA effectiveness in the removal of Am 241 from the adult baboon. By administering therapy at long as well as at shorter times after single IV injections of Am 241, it was possible to study the efficacy of DTPA

<48>

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<48> CONT.
therapy as a function of the site of its deposition in the primate, i.e., the skeleton and/or the liver. Measurements of concentration changes effected in the bone and liver were performed by monitoring Am 241 in tissue biopsy specimens, in vivo scintillation counting and routine radiochemical analysis of excreta. In an animal with an established bone burden of Am 241, a total of 8% of the body burden was removed due to DTPA administered over a 3-wk period, at a treatment regimen duplicating that presently used for man. Approximately 15% of the body burden was removed during a similar time period from an animal still having a significant fraction of its burden in the liver. Partition of activity excreted as a result of chelation therapy was monitored by daily analysis of urine and feces. (Auth)

<49>
Cohen, N., and M.T. Wrenn, New York University Medical Center, Institute of Environmental Medicine, New York, NY. 1972

The Baboon as an Experimental Animal for Metabolic Studies of Bone-Seeking Radionuclides in Man. CONF-7206103 (Part 3); Part of Goldsmith, E.I. (Ed.), Medical Primatology, Proceedings of the 3rd Symposium on Experimental Medicine and Surgery in Primates held in Lyon, France, June, 1972. Karger, Basel, New York, New York, (p. 226-236)

The adult female baboon was chosen as the experimental animal for the study of the retention and distribution of Pb 210 and Am 241 for several reasons including its size and metabolic similarity to man. Studies in progress, including metabolic characteristics of Pb 210, short term metabolism of Am 241, and lead toxicity, were reviewed. (ST)

<50>
Cole, K.S., and C.L. Prosser, University of Chicago, Chicago, IL. 1945

Biological Research Section. CN-2786; Part of Health Problems Relating to Product for Month of March 1945, (p. 8-12), 35 p.

The effects of valence state and complexing agents on rates of absorption and subsequent distribution of plutonium compounds were studied following solution inhalation by rats. Pu(+4) was absorbed slowly from the lung with a half-time of about 13 days. Pu(+6) or complexes of Pu(+4) with citrate or calgon were absorbed rapidly at first, but slowed to the rate of absorption of Pu(+4) within one day. There was no difference in rate of absorption between the (+4) and (+6) citrates. Pu(+4) was deposited in liver and skeleton at a very slow rate; Pu(+6) was considerably faster, and the citrates reached very high concentrations in both of these organs within a day. Liver actively decreased following cessation of rapid absorption from the lung. A similar phenomenon was observed with the skeleton. There was no difference in the metabolism of freshly prepared solutions and solutions that were several hours old. Plutonium administered intramuscularly to rats as the citrate (+6) was more toxic than the nitrate. (Auth) (ST)

<51>
Comar, C.L., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, Ny. 1972

Biological Effects of Implanted Nuclear Energy Sources for Artificial Heart Devices. COO-3167-28; Part of Progress Report, July 1, 1971 to May 31, 1972, Phase 4, (p. 223-247), 256 p.

Progress is reported on studies of the biological effects of radiation from nuclear power sources implanted in the flank of Labrador Retriever dogs. During the past year a fourth group of animals was implanted. This group consisted of 4 blanks, 4 dogs implanted with 0.0745 ug Cf 252 and 6 mCi Sr 90 sources, and 4 dogs implanted with 0.37 ug Cf 252 and 30 mCi Sr 90 sources. A summary of all dogs implanted to date and their current status is given in tabular form. Clinical tests showed a relative lymphopenia, beginning about one month after surgery, in the large source (500 mCi Sr 90 + 0.37 g Cf 2^{52}) dogs. Males in this group also showed a complete lack of spermatozoa. The clinical history, pathological changes, and postmortem examination results of one female with a large power source are described in the text and detailed in the appendices. Abnormalities were similiar to those of other dogs in this group previously described. The ovary nearest the source was severely atrophied. Examination of the amputated humerus of one of her offspring irradiated in vitro and immediately postnatally revealed a chronic osteomyelitis of unknown etiology. Externally observable changes have not occurred in any of the implanted animals except for a loss of hair and hyperpigmentation of the skin over the source of the large source animals. These animals also appear to be aging faster. (ST)

<52>
Craig, D.K., J.R. Decker, R.L. Buschbom, D.L. Catt, and Park J.F., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Relationships Between Respiration Parameters of Unanesthetized Adult Beagle Dogs During Training and During Plutonium 239 PuO2 Aerosol Inhalation Exposures. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 200-211), 313 p.

Prior to subjection of dogs to aerosol inhalation exposures, they are trained daily for 2 weeks to familiarize them with the exposure procedures. Respiration rate and volume are measured and used to estimate the volume of air inhaled by each dog during its exposure to aerosols. An instrument for continuous monitoring of tidal volume (TVAM) is used. With this instrument the mean tidal volume (TV), the mean respiration rate (RR), the minute volume (MV), and the total inhaled volume for each dog during exposure can be determined. Complete respiration data during both training and exposure have been gathered for 98 dogs and compared in order to determine the reliability of the estimates of inhaled volume of dogs in those instances where the data were not obtained during aerosol exposure. The results showed that, despite the apparently significant differences between the means of the respiration data gathered during training and during inhalation exposure, the TV and MV data were both significantly correlated at the 99% level. This was not consistently true for the RR data. Therefore, equations were derived to enable TV and MV values to be estimated from the training data when

<52> CONT.
necessary. (Auth)

<53>
Decker, J.R., B.D. Bingham, and J.F. Park, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

An Instrument for Continuous Monitoring of Tidal Volume of the Beagle Dog During Exposure by Inhalation of Radioactive Aerosols. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 223-230), 313 p.

A data acquisition system for continuously monitoring and recording the tidal volume of beagle dogs during inhalation exposure to radioactive aerosols has been constructed and evaluated. PuO2 aerosols were used. The system consists of a dog inhalation mask, venturi air velocity meter, two differential pressure transducers with associated carrier preamps, a venturi transducer to digital integrator interface signal conditioning system, analog strip chart recorder, voltage to frequency converter, digital clock and a digital integrator and printer. The velocity profile which is useful in analyzing variations in breathing patterns is recorded by the analog strip chart recorder. Tidal volume, as well as elapsed time from the beginning of exposure, is automatically printed out in digital form at the end of each breath. The system is capable of measuring tidal volumes ranging from 30 cc to 33 cc and total inspired air volume up to 1000 liters with an error less than 5%. (Auth)

<54>
Decker, J.R., and D.K. Craig, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

An Instrument for Rapid Determination of Concentration of Alpha-Emitting Aerosols for Use in Animal Inhalation Studies. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 212-222), 313 p.

Studies to determine the biological effects and metabolism of inhaled Pu 239 PuO2 in beagle dogs require alveolar burdens over a 1500-fold range from 2 nCi to 3 uCi to be deposited in unanesthetized dogs by aerosol inhalation. Aerosols with concentrations ranging from 0.1 nCi/l to 5 uCi/l were generated by nebulizing water suspensions of Pu 239 PuO2. To facilitate control of alveolar deposition, an aerosol concentration monitor, which is capable of rapidly determining alpha radioactive aerosol concentrations immediately preceding and during dog exposures, was designed and fabricated. Successive aerosol samples of 0.5 to 4.0 liters are drawn through an absolute filter by a remote controlled, automatically timed solenoid in a vacuum line. The filter remains in its original position while, immediately following sampling, alpha particles are counted by a system comprising a zinc sulfide scintillator and a photomultiplier. The detector is separated from the filter paper which is contained in a plastic filter holder by an air tight mylar cover. Several samples can be accumulated on a single filter paper. The monitor is capable of measuring the concentration within 2 min after initiation of sampling with an error not exceeding plus or minus 20%. (Auth)

<55>
Dilley, J.V., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Taurine Excretion in Beagle Dogs after Inhalation of Plutonium Oxide. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 73-74), 207 p.

Pre-exposure lymphocyte levels were determined in beagle dogs acclimated to metabolism cages. The animals were then exposed to Pu 239 PuO2 aerosols with 6-33 uCi being deposited in their lungs. Lymphocyte counts and 24-hr urine samples were taken periodically over the following 3-month period. The results show that the dogs excreted increased levels of urinary taurine within the 3-month period following the inhalation. It is suggested that the increased urinary taurine levels are associated with the destruction of circulating lymphocytes. (Auth) (FMM)

<56>
Doty, S.B., C.W. Yates, W.E. Lotz, W. Kisecleski, and R.V. Talmage, Rice University, Biological Laboratories, Houston, TX; Argonne National Laboratory, Biology Division, Argonne IL; U.S. Atomic Energy Commission, Division of Biology and Medicine, Washington, DC. 1965, May-September

Effect of Short-Term Alpha Irradiation on Parathyroid Activity and Osteoclast Numbers. Proceedings of the Society for Experimental Biology and Medicine, 119, 77-81

A study of the distribution of plutonium 239 in bone, and its effects on bone cells was presented and correlated with endogenous parathyroid activity. The Pu in the form of the nitrate (1 uCi) was injected intraperitoneally into rats weighing 180-200 g. There was no measureable effect on the function of existing osteoblasts or osteoclasts during this short term (5 day) experiment. Also, incorporation of plutonium into osteoclasts did not disrupt the ability of parathyroid hormone to maintain normal calcium levels. However, it could be demonstrated that plutonium, for the first 48 hours after administration, affected certain of the undifferentiated bone cells, which in turn prevented the increased osteoclast production normally seen following endogenous parathyroid stimulation. (Auth)

Table 3 shows effect of Pu 239 on Thymidine-H 3 and Proline-H 3 uptake.

<57>
Dougherty, J.H., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Toxicity to Blood Cells of Americium 241 Compared to Other Transuranium Nuclides. CCO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 272-281), 380 p.

A comparison of the effects of the bone surface seekers Pu 239, Am 241 and Th 228 and the bone volume seeker Ra 226 on leukocytes of dogs has been made for the first year following injection using the technic of probit analysis. Hematological responses for total white blood cells, polymorphonuclear

<57>

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<57> CONT.
leukocytes, lymphocytes and monocytes were evaluated at six time periods from 30-360 days postinjection. The probit of the percentage depression of the various cells when plotted against the log of the injected activity yielded approximately straight lines from which ED 50's (50% depression of leukocytes) were calculated. Using Ra 226 as a standard nuclide, toxicity indices (Ra 226 uCi per kg/nuclide uCi per kg for 50% depression) were determined. From these data the hematological RBE's (Ra 226 rads per day/nuclide rads per day for 50% depression) were computed for the various leukocytes over the first year. The surface seekers, Pu 239, Am 241 and Th 228 showed considerably greater toxicity than Ra 226. The pattern of depression and recovery of leukocytes is most similar for Am 241 and Pu 239 as shown by the probit method. (Auth)

<58>
Dougherty, J.H., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1971, March 31

Early Hematologic Effects of Californium in the Beagle. COO-119-244; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 117-125), 424 p.

The hematologic changes following intravenous injection of Cf 249 or Cf 252 into 11 young adult beagles are reported for the first 8 weeks post-injection. Three dogs which received 2.8 uCi/kg of Cf 249 developed a severe depression of granular leukocytes and platelets which was maximal 2 to 3 weeks following injection with approximately little recovery by 8 weeks. The lymphocytes were decreased below normal by 2 weeks and continued to fall thereafter to one-third of pre-injection values. Changes in granular leukocyte values of 4 dogs injected with approximately0.28 uCi/kg of Cf 249 were compared to those of 4 dogs injected with 0.28 uCi/kg of Cf 252. There was a greater and more prolonged depression in the Cf 252 injected dogs probably due to the added bone dose rate from fission fragments on bone surfaces which would cause a greater irradiation of bone marrow. There have been no changes thus far in red cells, platelets or lymphocytes in dogs receiving 0.28 uCi/kg of either Cf 249 or Cf 252. (AUTH)

<59>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program. COO-119-246; 380 p.

Progress is reported on the University of Utah beagle dog studies comparing the relative toxicities of Ra 226, Pu 239, Ra 228, Th 228, Sr 90, and Am 241. Current test animals, injection levels, and cause of death are listed. Studies on St. Bernard dogs and mice are included. The report concentrates on three principle radionuclides: plutonium, americium, and californium. Parameters studied were effects of physical and chemical state; effects of type of compound administered; tissue and cellular concentration, retention, and distribution; tissue dose rate as a function of dose level; toxicity; tumor incidence; genetics; effects of low doses of radiation; and plasma steroid levels. The tissues studied were bones, teeth, blood, liver and several soft tissues. Included are notes on barium 133 and rubidium 83 half-life determinations. Twenty articles were selected and abstracted separately for the data base. (ST)

<60>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Injection Tables. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 9-105), 380 p.

Toxicity--those animals that will be maintained until sacrifice becomes a clinical necessity--and test animals--those animals that may be sacrificed as needed for special studies--are listed in tabular form. The numbering system for the injection levels of the six radionuclides studied is explained. The tables include the calculated dose in rads to the skeleton at death and comments on the factors that had the most prominent effect on the clinical status of the animal. (ST)

<61>
Dougherty, T.F., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1966, March 31

Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program. COO-119-234; 326 p.

Progress is reported on studies at the University of Utah using beagle dogs to study the toxicity of Ra 226, Pu 239, Ra 229, Th 228, and Sr 90. The current injection program is limited to Ra 226 and Pu 239 at lower dose levels. There are five retained dose levels for each radionuclide except Sr 90, in which case they are greater by a factor of 10. Dose level 1 is the basis of the scheme and is 10 times the maximum permissible dose of Ra 226 in man. Included are injection tables which present the lesions or factors that had the most prominent effect on the clinical status of the animal. Three papers on Pu 239 were abstracted separately for the data base: translocation in beagle livers, effect on rat bones, and effect on serum transaminase levels and other serum constituents in the dog. (ST)

<62>
Dougherty, T.F. (Ed.), W.S.S. Jee (Ed.), C.W. Mays (Ed.), and B.J. Stover (Ed.), University of Utah, College of Medicine, Salt Lake City, UT. 1962

Some Aspects of Internal Irradiation. Proceedings of a Symposium held at The Homestead, Heber, Utah, May 8-11, 1961, 529 p.

Thirty-two papers concerning the pathological changes induced by internal irradiation were presented. The problems of metabolism and dosimetry and a variety of pathological endpoints were considered. A dose-response relationship was observed for many hematological and biochemical alterations, bone pathology, alterations in the central nervous system and eyes, and to the general overall change in rate of the aging process. Two of the papers presented material aimed at the fundamental mechanisms by which

<62> CONT.
irradiation might induce malignancy: endocrine mediated carcinogenesis and viral carcinogenesis. Some indirect mechanisms by which pathological changes of a wide variety may be induced were discussed. Beagle dogs, rats, monkeys, miniature swine, rabbits, and man were used to study the effect of radium, plutonium, strontium, thorium and thorotrast on bones, carcinogenesis, the nervous system, hematology, aging, steroid biosynthesis, blood forming tissues, lung, and fetuses. Fifteen papers were selected for separate abstracts in the data base. (ST)

<63>
Elkina, N.I., Institute of Biophysics, Moscow, USSR. 1967

Calcium and Phosphorus Metabolism in Rabbit Bone Under the Effect of Plutonium 239. AEC-tr-6886; Part of Radiobiology, (p.53-72), 256 p.; Radiobiologiva, 7(1), 42-47

In a study of normal rabbits, it was established that the Ca and P in the diaphysis of tubular bones was 10-34% higher than in the porous part of the bones, while the rate of inclusion of Ca and P, as indicated by experiments with Ca 45 and P 32, was 2.3-2.8 times lower in the diaphysis than in the porous part. Between the ages of 90 and 635 days, the rate of uptake of Ca and P into the bones decreased by a factor of 2-6, while the content of these elements in the bones did not change significantly. On administration, (by a single intravenous injection) of Pu 239 (as Pu nitrate, at pH 2) in a dose of 2 or 7 uCi/kg to rabbits, the Ca and P content in bone was not altered significantly from the normal. With 7 uCi/kg dose, the rate of uptake of Ca 45 and P 32 in bone decreased: 30 days after administration of Pu 239 to the rabbits, the Ca 45 activity was 66% in the diaphysis and vertebrae and 52% in the epiphysis vs. controls, while the activity of P 32 was 59% in the diaphysis and 67.5% in the porous part of tubular bones and of vertebrae vs. controls. Between the 30th and 180th day after Pu administration, the rates of uptake of Ca and P showed a tendency to return to normal. On administration of Pu 239 at a dose of 2 uCi/kg, changes in the uptake rate of Ca 45 and P 32 took place at a later time than after administration of the larger dose. The rate of uptake of Ca 45 and P 32 in osteosarcomas that developed after administration of Pu 239 at a dose of 2 uCi/kg was higher by a factor of 9-15 and 2-16, respectively, as compared with the non-tumorous bone tissue of the rabbits with tumors. (Auth) (FMM)

<64>
Elkina, N.I., Not given. 1962

Blood Serum Proteins of Rabbits and Dogs Affected by Plutonium. AEC-tr-5433; Part of Radiobiology, (p. 48-53); Radiobiologiya, 11(6), 834-837

Experiments were conducted on male and female rabbits, weighing 2.5-3.0 kg, and adult dogs. Plutonium 239 was injected intravenously, in a solution of the nitrate (pH 2) in doses of 7 uCi/kg (rabbits) and 2 uCi/kg (dogs). At fixed times after the injection of the Pu 239 the protein fractions of the blood serum were investigated by paper electrophoresis. It was shown that the injection of plutonium into the animals led to a reduction of total protein in the blood serum. The reduction is due mainly to a decrease in the albumin content. A calculation of the ionization doses received by the liver of the rabbits and dogs showed that the reduction in total protein and albumins did not occur until the cumulative dose was very high. For instance, in rabbits these changes occurred at doses above 3748 rad, and in dogs at doses above 796 rad. These data indicate that the liver of dogs is more sensitive than that of rabbits to the action of plutonium alpha rays. (FMM)

<65>
Fairchild, R.G., H.L. Atkins, R.M. Drew, and J.S. Robertson, Brookhaven National Laboratory, Medical Research Center, Upton, Long Island, NY. 1973

Biological Effects of Californium 252 Neutrons. CONF-731030; Part of Proceedings of the 2nd Symposium on Fundamental and Practical Aspects of the Application of Fast Neutrons in Clinical Radiotherapy held at The Hague, Netherlands, October 3, 1973, (14 p.)

The biological effects of Cf 252 neutrons have been studied with cultured cells, and with intact tissues. Measurements available to date, of the relative biological effect (RBE) and of the oxygen enhancement ratio (OER), are summarized and discussed. An increase in RBE with decreasing dose rates was demonstrated. However, a comparison of results was complicated by the fact that RBEs can be quite sensitive to the gamma standard dose rate used. Biological evidence is presented for an enhanced effect on tumors because of a reduced necessity for the presence of oxygen during the period of irradiation. Biological considerations suggest caution in the use of Cf 252 in a hospital environment. The lack of recovery from cellular damage due to neutrons results in high values for RBE, particularly for low doses and low dose rates. (Auth) (RAF)

Tables 1 and 2 present RBE and OER data in biological systems.

<66>
Frazier, M.E., and T.K. Andrews, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Detection of Cytotoxic Lymphocytes in Beagles with Plutonium 238-Induced Bone Tumors. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 37-38), 103 p.

The experiment was designed to investigate the transmissibility of Pu 238-induced canine bone tumors. Bone tumor cells from a beagle that had been exposed to Pu 238 by inhalation were injected intraperitoneally into neonatal puppies. These animals at 9 months of age showed no evidence of tumors, but they were producing lymphocytes that were cytotoxic to cultured Pu 238-induced canine bone tumor cells. Preliminary experiments suggest that cell lines prepared from canine bone tumors have at least one antigen which is common to bone tumors found in other dogs that inhale Pu 238. Dogs with these bone tumors also possess lymphocytes that are cytotoxic to cultured bone tumor cells from heterologous animals. Cultured cells from a spontaneous mammary tumor and Pu 239-induced canine lung tumor cells were not killed by these lymphocytes, implying a degree of specificity based on tumor type. In addition, a specific serum-blocking factor, capable of preventing the cytotoxic effect of lymphocytes directed

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<66> CONT.
against canine bone tumor cells, has been found in one dog dying from such a bone tumor. (Auth) (RAF)

<67>
Garner, R.J., United Kingdom Atomic Energy Authority, Authority Health and Safety Branch, Radiological Protection Division, Harwell, Didcot, Berkshire, England. 1965

Natural Uranium and Grazing Animals. Health Physics, 11, 323

With the advent of new information on the behavior of U in large animals and of revised recommendations from the International Commission of Radiological Protection the author recognizes the necessity of a review of the situation. Findings show that considerably more of the daily intake (about 1.4 x 10(E-3)%) of U by a dairy cow may appear in each liter of milk than was originally supposed but that the amount of U excreted in the urine and milk together is consistent with the assumption that 1% of ingested U is absorbed from the gut. The maximum permissible concentration of natural U in drinking water currently recommended by ICRP, in relation to individuals in the population, is 6 x 10(E-7) uc/ml, equivalent to a daily intake, by an adult, of 1.3 x 10(E-3) uc or 4 x 10(E-3)g. The permissible daily intake by a child can thus be assumed to be 4 x 10(E-4)g. The permissible concentration of natural U in meat is then 2 x 10(E-5)g/g (assuming a child to drink 0.7l milk daily). The permissible concentration in mutton and beef would be attained if the daily intake of the sheep or cow were 1 g and 7 g respectively. Similarly, to give the permissible concentration in milk, the daily intake of a cow would have to be about 4 g. These amounts are greater than the daily intakes which were estimated to produce slight malaise in sheep and a transient depression of milk yield in (0.05 g and 0.4 g respectively). (Auth) (RAF)

<68>
Gillis, M.F., J.R. Decker, J.M. Creer, R.D. Carmichael, N.R. Gordon, F.T. Cross, L.G. Smith, and J.L. Beamer, Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Physics and Instrumentation Department, Richland, WA. 1973, February

Biological Effects of Intracorporeal Radioisotope Heat Sources. BNWL-1850 (Part 4); Part of Nielsen, J.M., Annual Report for 1973, (p. 85-88), 117 p.

A 50-watt intrathoracic Pu 238 PuO2 heat source in a miniature swine produced no clinical signs of untoward effect over a period of almost 10 months, in spite of aortic occlusion and burnup some time prior to sacrifice. Retroperitoneal abdominal implant experiments indicate surface heat flux tolerance limits of less than 0.01 watts/cm2 immediately postoperatively, increasing to nearly 0.04 watts/cm2 within one month, exploiting surface tissue ingrowth techniques. A miniature swine continues on experiment with a 29-watt Pu 238 PuO2 heat source implanted retroperitoneally in a discoid aluminum container with a velour fabric coat. (Auth)

<69>
Gillis, M.F., J.R. Decker, W.K. Winegardner, M.T. Karagianes, and F.T. Cross, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Biological Effects of Intracorporeal Radioisotope Heat Sources. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 67-69), 103 p.

As part of a study on the long-term effects of radiation from an abdominally located radioisotope (plutonium 239) heat source, a 5 in diameter silastic sphere weighing 2 lb was covered with nylon velour fabric and implanted retroperitoneally in the abdomen of a miniature swine. Healing was rapid ans without incident except for a single small peritoneal adhesion. The implant did not migrate or produce deleterious effects. A heat exchanger device has been perfected which cools the source by rapid transfer of heat to the thoracic aorta. Two surgical control animals were implanted with thoracic heat exchangers in their descending aorta and are being observed. In the event that intravascular heat exchangers are necessary, a porous, surface-passivated titanium alloy tube implanted in the thoracic aorta of a miniature swine was tested. There was no evidence of thrombi a month later. (ST)

<70>
Gillis, M.F., R. Decker, B.D. Bingham, M.T. Karagianes, N.R. Gordon, W.K. Winegardner, and F.T. Cross, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Biologic Effects of Intracorporeal Radioisotope Heat Sources. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 296-301), 313 p.

Thoracic intraaortic implantation of heat exchangers containing 50 watt, medical gradePu 238 PuO2 heat sources for long-term studies of the effects of added endogenous heat and radiation in miniature swine presents a number of bioengineering problems. Through the implantation and 3 month evaluation of three sham devices and by subsequent dress rehearsal implantation of two control exchangers most of these problems have been solved. Development of techhniques for intraabdominal implantation of heat sources is in progress. (Auth)

<71>
Gomez, L.S., Colorado State University, Department of Radiation and Radiation Biology, Fort Collins, CO. 1973, May

Lymph Transport of Plutonium 239 PuO2 in Dogs. COO-1787-17; Ph.D. Thesis, Colorado State University; 76 p.

The translocation of high-fired plutonium 239 PuO2 via the lymphatic system from a simulated puncture wound in a dog's paw was studied with two objectives in mind. The first was to study the effect of lymphadenectomy on PuO2 translocation, and the second was to determine the mode by which PuO2 is rapidly translocated from wound site to lymph node. Lymph node excisions were carried out on the day of the Pu implant, as well as 14 days after implant. Comparisons were made between dogs with and without excision of the left superficial cervical lymph node. Higher levels of Pu were found

<71> CONT.
in the liver, spleen and hepatic lymph nodes of lymphadenectomized dogs than in the intact dogs. Implications of the data to therapeutic lymph node removal from workers contaminated with Pu are discussed. Chelation therapy and/or wound site excision may increase the therapeutic value of excision of Pu-contaminated lymph nodes. Data suggest that PuO2 is primarily transported by the cellular fraction of the lymph. The PuO2 transported in the cellular fraction was mainly associated with the beta-globulin protein fraction, which includes transferrin, the major Pu-transport protein in plasma. The data also suggest that the rapid PuO2 transport was associated with the protein-bound Pu; the slower transport of large PuO2 particles was via the cellular fraction of the lymph. (Auth) (RAF)

<72>
Hahn, F.F., and B.A. Muggenburg, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

In Vitro Migration of Alveolar Macrophages From Dogs that Inhaled Cerium 144 Fused Clay Particles or Plutonium 239 Oxide. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 219-222), 342 p.

Alveolar macrophages are an important constituant of pulmonary defense mechanisms and any decrease in their function such as might be produced by radiation may be detrimental to the integrity of the lung. The effect of alpha and beta irradiation from inhaled radioisotopes on the in vitro migration of lavaged cells was examined. Cells obtained from lavage of the lungs of dogs exposed to either Ce 144 fused clay aerosols or Pu 239 PuO2 aerosols were tested at various intervals from 2 to 56 days post-inhalation exposure. Inhalation of Ce 144 fused clay did not significantly affect the in vitro migration of lavaged cells at any time tested from 1 to 56 days post-exposure. However, inhalation of Pu 239 PuO2 did significantly depress migration at all times tested, 2, 7, 10, 14, 21, 28, 36, 42 and 49 days post-exposure. A possible mechanism relates to alpha radiation-induced cell death, and release of inhibitory factor from dead or dying cells. (Auth)

<73>
Haller, W.A., R.W. Perkins, and L.A. Rancitelli, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Radiological Sciences Department, Radiological Sciences Section, Richland, WA. 1968, October

The Instrumental Determination of Seventeen Elements in Uranium Miners Tissue by Neutron Activation Analysis and Germanium (Lithium) Spectrometry. BNWL-715 (Part 2); Part of Nielson, J.M. and Pierce, D.W. (Ed.), Annual Report for 1967, (p. 124-127), 230 p.

Instrumental neutron activation analysis has been employed to determine 17 elements in lung tissue. In addition to the elements normally found in tissue such as P, Fe, Zn, Rb, Na, K, Br, Se, Co and Hg, several other elements were detected. Abnormally high concentrations of Ag, Au, Sc, Cr, W, U and Sb were observed. The uranium content can be determined from the Np 239 activation product or the (Ba-La) 140 fission product. (Auth)

<74>
Hamilton, J.G., University of Chicago, Chicago, IL. 1945

Technical Progress Report on the Metabolic Studies of Product. CN-2786; Part of Health Problems Relating to Product for Month of March 1945, (p. 29-35), 35 p.

Studies of bone radioautographs and their coresponding stained sections revealed that the endosteum and cancellous bone are the principle sites for the deposition of plutonium in the rat skeleton following intramuscular injection. There were no significant differences in the deposition pattern for the three valence states studied. The inhalation of PuO2(NO3)2 sprays resulted in the initial retention of almost half of the inhaled product by the lungs. At the end of 17 days almost 20% of the material inhaled was deposited in the skeleton. An examination of the size of both PuO2 smoke and Pu2(NO3)2 spray particles with the aid of the electron microscope indicated that the particles inhaled by the animals were fairly homogenous in size (0.10-0.30 u in diameter). A preliminary study of the long term excretion of plutonium from the lungs following inhalation of PuO2 smoke indicated that the rate of elimination at the end of six months was of the order of 1% per day of the retained material. This rate remained relatively constant from the second to the sixth month after exposure. (Auth) (ST)

<75>
Hodge, H.C., University of California, Department of Pharmacology, San Francisco, CA. 1973

A History of Uranium Poisoning (1824-1942). Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonic Elements, Chapter 1. Springer-Verlag, New York, New York, (p. 5-68), 995 p.

Early experiments done on the effects of U on animals are reviewed. Some examples of U administration to persons with diseases such as diabetes are noted. Selected data on the toxicity of U compounds in animals are presented in tabular form. Experiments are described of the use of U to induce experimental nephritis. Certain changes in the glomerular loops indicated a possible vulnerability of the glomerula in regard to U, thus experiments to differentiate glomerular injury versus tabular injury are given much attention. Experimental nephritis in relation to urinary glucose and the means by which glucose excretion occurred in U poisoning is reported, as are studies of albuminuria, urinary acetone, organic acids, phenols, sodium, potassium, chloride and phosphate. The affects of U on the cardiovascular system, blood chemistry, liver, muscle, nervous system, enzymes, protein and lipid metabolism are discussed. Several therapeutic measures are described for treatment of U poisoning and the protection by sodium bicarbonate against kidney injury from U nitrate in dogs is described. The tissue contents of U in U poisoning is given for several animals and some of the analytic methods are described. There is an extensive bibliography. (PMN)

<76>
Hollins, J.G., A. Durakovic, and M.C. Storr, National Research Council of Canada, Division of

<76>

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<76> CONT.
Biological Sciences, Ottawa, Ontario, Canada. 1973

The Retention of Americium and Calcium by the Skeleton of Growing and Mature Female Rats. Calcified Tissue Research, 12(3), 239-246; NRCC-13241; 8 p.

The retention of Ca 47 and Am 241 by 14 parts of the skeleton of growing and mature female rats 7 days after injection has been measured. The various parts of the skeleton possessed widely differing abilities to concentrate both these elements. The bones of the younger rats had a significantly greater ability to concentrate Am 241 but not Ca 47. Americium concentrated much more on resorbing surfaces than on actively calcifying surfaces. Results indicate that the long bones are most at risk. The implications of these results for the radiation dosimetry of internal contamination by Am 241 are discussed. (Auth) (RAF)

<77>
Horstman, V.G., P.L. Persing, and L.K. Bustad, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1961, January 10

Effects of Intradermal Injection of Plutonium in Swine. HW-69500; Part of Hungate, F.P. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1960, (p. 64-66), 195 p.

In a study designed to define the acute and long-term effects of plutonium in the skin of minature blond swine, 24 to 30 sites in the lateral thoracico-abdominal region of each of two animals were injected intradermally with 0.0016, 0.008, 0.04, 0.2, 1, and 5 uCi of Pu nitrate. Erythema, swelling, and foci of necrosis were evident after 24 hours. A 40 to 60% retention of Pu was observed 1 to 2 months after administration. Scabs which formed at these sites contained over 80% of the retained dose. Injected areas showed a discoloration that still remained after 6 months. Swelling was observed in some of the highest level sites 5 months following injection. (Auth) (BBM)

<78>
Hsieh, J.J.C., F.P. Hungate, and S.A. Wilson, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1965, January

Ultrahigh-Speed Gross Alpha Autoradiography. BNWL-122; Part of Thompson, R.C. and Woods, S.W. (Eds.), Hanford Biology Research Annual Report for 1964, (p. 110-112), 116 p.

High-speed gross alpha autoradiograms can be obtained using ZnS:Ag as an intensifier in conjunction with high-speed film. The technique requires approximately 1/1000 of the exposure time needed by conventional methods of using Kodak's NTB plates (nuclear track emulsion for beta particles). Experiments are described demonstrating the usefulness of the technique. Autoradiography was done on rat femur sections with deposited Pu 239. Both the conventional and the high-speed techniques were compared. The critical level of Pu in urine samples was determined from autoradiographs made from electrolytically deposited samples. For detecting a Pu sliver in or on the skin an exposure time of 40 sec. was required using the high-speed autoradiographic technique. (Auth) (FMM)

<79>
Hungate, F.P., and D.W. Baxter, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Einsteinium 253 and Berkelium 249 in Rat Tissues Following Intragastric and Intravenous Administration. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 88-92), 313 p.

Tissue distributions of Es 253 (1 mCi in 2 ml of 0.2 N HCl) and Bk 249 (0.5 mCi in 2 ml of 0.2 N HCl) were measured following intravenous and intragastric administration of the chloride in young adult male rats weighing approximately 400 g. Approximately 4 x 10(E-3) percent of each element was recovered in body tissues 21 days following intragastric intubation. Following intravenous injections, gross tissue distributions of two radionuclides were generally similar with highest persistent concentrations in bone, followed by spleen, kidney, and liver. The biological half-life of Bk 249 in bone appears to be less than 100 days, unusually short for an actinide. Little loss of Es 253 from bone was observed, suggesting a behavior typical of most actinides. Urinary excretion of Es 253 was initially very high with nearly 40% of the ingested dose excreted during the first day postinjection. (Auth)

<80>
Hungate, F.P., B.I. Griffin, J.H. Jarrett, and M.F. Gillis, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Development and Evaluation of Blood Irradiators. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 69-70), 103 p.

A new type of irradiatior, consisting of a 2-inch stainless steel wire coated in its mid segment with Pu 238 covered by a thin layer of Pt, was implanted in the aorta of a dog by inserting the wire diagonally through the vessel and suturing the wire in place at both ends. The dose was designed to be in the range of 50 to 100 rads/day. Some loss of radionuclide has occurred as evidenced by Pu 238 in the urine and feces. This irradiator has been in place for 6 months. No change has been observed in lymphocyte levels nor in the mobility of peripheral cells challenged by antigen in vitro, nor was there any effect on time of allograft rejection. Principal emphasis is currently on the development of portable extracororeal irradiators adaptable to arteriovenous shunts, such as are typically installed in renal transplant patients. (Auth) (RAF)

<81>
Ivannikov, A.T., Not given. 1965

On the Significance of the Reabsorption of Bicarbonates in the Injurious Effect of Uranium Upon the Kidneys and Its Elimination From the Organism. AEC-tr-6603; Part of Radiobiology, (p. 136-145), 238 p.; Radiobiologiya, 5(6), 867-872

The influence of diacarb, (a sulfanilamide preparation), on the excretion of uranium was studied in 132 white female rats, weighing 160-220 g. Uranyl nitrate was injected subcutaneously in a dose of 5 and 10 mg/kg of body weight in the form of a 0.25% aqueous

<81> CONT.
solution. Fonurit, which was injected intragastrically in the form of a finely pulverized powder in a 0.5% starch solution, 200 mg/kg of body weight (optimum dose for urinary effect), was used as the carboanhydrase inhibitor. Parallel experiments were conducted with the intraperitoneal injection of sodium bicarbonate in the form of a 5% solution in a dose of 200 mg/kg of body weight, after administering uranyl nitrate at intervals of 3.5-4 hours. The results show that the administration of diacarb gives rise to an inhibition of the reabsorption of bicarbonates, which promotes acceleration of the excretion of uranium with the urine and reduces the kidney injury. The administration of diacarb in conjunction with sodium biocarbonate is more effective in accelerating the excretion of U than either of them used individually. Although a 40% death rate was observed when sodium bicarbonate was administered one hour after U poisoning, and the clinical course of severe U poisoning developed when diacarb was administered, when they were combined all the rats experienced only a slight sickness without signs of pronounced depression and tremors. The joint administration of diacarb and sodium bicarbonate is also useful in that the deposition of U in the skeleton is substantially reduced. (FMM)

<82>
Ivannikov, A.T., Not given. 1966

Effect of 2-Acetylamino-1, 3, 4-Thiadiozole-5-Sulfonamide on the Elimination of Uranium from the Organism and on the Course of Acute Uranium Poisoning. AEC-tr-6944; Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 678-687), 718 p.

Uranium elimination can be accelerated and injury to the organism prevented by suppressing the reabsorption of biocarbonates from renal canaliculi with the aid of diacarb--a chemical acting as carboanhydrase inhibitor. Diacarb is effective in the early stages of acute uranium poisoning. The protective effect of diacarb decreases with increase in the dose of uranyl nitrate and in the time elapsed since the administration of that dose. Treatment with diacarb in late stages of uranium poisoning aggravates the course of the poisoning. The effectiveness of diacarb is magnified by administering it in a combination with sodium bicarbonate, with respect to both accelerating the elimination of uranium and increasing the survival rate of the experimental animals. The most distinct protective effect was produced by prophylactic (1-3 hours prior to poisoning) administration of diacarb in a combination with sodium bicarbonate. A single-dose administration of diacarb together with sodium bicarbonate prevents the development of severe uranium poisoning and death of the animals following the injection of a uranyl nitrate in a dose causing 100% mortality of white rats. (Auth)

Table 2 shows the uranium content in kidneys and skeleton of rats (in percent of administered dose) on the 6th day following poisoning with uranyl nitrate in a dose of 5 mg/kg and following treatment with diacarb and sodium bicarbonate.

<83>
James, A.C., Royal Free Hospital, School of Medicine, Physics Department, London, England. 1972

Dose to Osteogenic Cells from Plutonium 239 Deposited in Rat Bone. Radiation Research, 51(3), 654-673

Six to eight-week-old Marshall-August rats were given a single IV injection of 4.5 uCi/kg soluble $Pu(NO3)4$, a dose-level expected to give an approximately 80% yield of osteosarcomas. Localized dose-rates were measured at fixed reference distances between 5 and 20 um from bone surfaces by counting alpha-flux entering small cylindrical targets located in a thin nuclear emulsion in contact with a bone section. Dose-rates 1 day after the injection ranged from 22-57, 12-37 and 7-26 rads/day at distances of 5, 12.5 and 20 um, respectively, from a number of different endosteal surfaces selected for measurement. These local dose-rates changed with time by factors of the order of 2, in either direction, depending on the prevailing conditions of remodeling. Histological evidence of "preferred" sites for the development of osteosarcomas is discussed in relation to local alpha-dose. A cumulative alpha-dose of about 2000 rads (delivered to primitive cells at trabecular surfaces over a period of 36 wk) may be associated with a 10% probability of developing a tumor in an individual femoral epiphysis. (Auth)

<84>
James, A.C., and N.F. Kember, Royal Free Hospital, School of Medicine, Department of Medical Physics, London, England. 1970

Alpha Particle Incidence in Small Targets. Physics in Medicine and Biology, 15(1), 39-46

A method for the direct measurement of the frequency distribution of alpha-particle incidence in targets of similar dimensions to cell nuclei is described. In addition to yielding the value of the mean dose in rads, these measurements enable the variation of dose in small targets to be expressed as percentages of cell nuclei receiving zero, single or multiple incidences in a stated time interval. The relevance of this particle incidence concept of dose is discussed in relation to carcinogenesis and illustrated by actual measurements in bones containing Pu 239. (Auth)

<85>
Jee, W.S.S., and J.S. Arnold, University of Utah, College of Medicine, Division of Radiobiology, Department of Anatomy, Salt Lake City, UT. 1960, August

Radioisotopes in the Teeth of Dogs. 1. The Distribution of Plutonium, Radium, Radiothorium, Mesothorium, and Strontium and the Sequence of Histopathologic Changes in Teeth Containing Plutonium. Archives of Oral Biology, 2, 215-238

Jaws and teeth containing radioisotopes from adult beagles were studied to determine the location of the activity and the sequence of histopathologic changes. Radioautography after a single intravenous injection of bone-seeking radioisotopes (plutonium, radium, mesothorium, radiothorium and strontium) in young adult beagles yielded the same distribution pattern in dental tissues. The sequence of changes observed in dogs injected with plutonium (serially sacrificed dogs and dogs allowed to live until moribund) involved the formation of secondary dentine, disturbance in cementum

<85>

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<85> CONT.
formation, resorption of cementum and dentine with metaplastic bone formation, damage to periodontal membrane, ankylosis of teeth and loss of teeth. There was a direct relationship between the sites of plutonium deposits and locations of dental lesions. No tumor arose from dental tissue, but a few osteogenic sarcomas occurred in the jaws. (Auth)

<86>
Jee, W.S.S., and J.S. Arnold, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1959

Structural Changes in Dog Skeleton Containing Plutonium. COO-218; Part of Stover, C.N., Jr. (Ed.), Annual Progress Report, (p. 214-215), 229 p.; Part of Proceedings of the 5th Annual Meeting of the Orthopedic Research Society held in Chicago, Illinois, January 23-24, 1959, (2 p.)

Bone changes were observed in 30 young adult beagles containing body burdens of 2.5, 0.81 or 0.27 uCi/kg of plutonium 239, a bone seeking alpha emitter, using celloidin, radiographic, microradiographic and autoradiographic techniques. The impairment of vascular supply was also studied by India ink injection of the hindlimb at autopsy. The sequence of bone changes was studied in 13 serially sacrificed dogs containing 2.5 uCi/kg of plutonium. Plutonium deposited on calcified bone surfaces and produced bone changes by direct and indirect mechanisms. Early bone changes occurred in trabecular bone, while late changes generally occurred in cortical bone. The early effect was observed in formation of acellular marrow cavities, peritrabecular fibroses, trabecular resorption and endosteal bone growth. The continuous effect was observed in plugging of haversian canals resulting in osteocytes death followed by disturbance in bone remodelling producing excessive numbers and irregular shaped resorption cavities, irregular shaped, hypercalcified and hypocalcified haversian system, eroded periosteal surfaces with fibroses and fractures. The translocation of plutonium as a function of bone remodelling, correlation of sites of bone change and plutonium localization, and comparative toxicity of various dose levels will also be discussed. (Complete text) (Auth)

<87>
Jee, W.S.S., J.S. Arnold, T.H. Cochran, J.A. Twente, and R.S. Mical, University of Utah, College of Medicine, Division of Radiobiology, Department of Anatomy,, Salt Lake City, UT. 1962

Relationship of Microdistribution of Alpha Particles to Damage. 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, Oxford, England, (p. 27-45), 529 p.

Studies by autoradiography of the distribution of plutonium, radium, mesothorium, and radiothorium, the relationship of distribution to damage, and the consideration of dose parameters in relating dose to damage are summarized. Adult beagles were used to study the histological changes and incidence of tumors over a wide range of radiation doses. The pattern of distribution of Th 228 and Pu 239 was similar. The initial deposits were on mineralized bone surfaces and in the reticuloendothelial system. Bone remodeling altered the initial surface deposits by bone resorption and apposition. Radiation injury to the bone vascular system is reviewed and the problems involved in calculating local doses due to differential uptake of isotopes, bone remodeling, and change in cells at risk are discussed. Ra 226 and Ra 228 deposited in high concentration in rapidly calcifying bone matrix beneath osteoblastic surfaces and throughout the pre-existing old bone in areas of more uniform concentration. The deposition of the four radionuclides in teeth was similar. In general, there was a high concentration on newly formed dentinal surfaces of the pulp chamber, an intermediate concentration in the cementum and alveolar bone enveloping the peridontal membrane, and a much lower concentration in the enamel. Most of the initial deposition persisted. In soft tissues generalized vascular changes, nephrosclerosis and regenerative liver nodules occurred in high level radiothorium dogs. Concentrations of alpha particles occurred within the aortic media. (ST)

<88>
Jee, W.S.S., P. Ottosen, R. Mical, and M. Lowe, University of Utah, College of Medicine, Radiobiology Division, Salt Lake City, UT. 1957, March 31

Bone: Histopathologic and Autoradiographic Findings. AECU-3522; Part of Annual Progress Report, (p. 86-114), 177 p.

This preliminary report deals with the histologic survey of 47 beagles reaching autopsy to date this includes 43 toxicity and 4 normal dogs. A brief summary and discussion of the important histopathologic findings are presented. The findings show that the four alpha emitters, plutonium, meso and radiothorium, and radium, produce identical types of histopathologic bone changes. These detectable changes are disturbances in normal bone metabolism which alter the normal microscopic architecture of bone. They fall under four major categories: 1) response to alpha emitters by endosteal and bone marrow cells 2) disturbance in normal bone growth 3) disturbance in normal bone remodelling or reconstruction and 4) formation of osteogenic sarcoma. The detail autoradiographic studies are in progress and will be summarized in the next report. (LCW)

Table 1 gives the positive histopathological findings in autopsied beagles for Pu, Ra, MsTh and RdTh. Table 2 gives the number of fractures, teeth lost and microscopic identification of osteogenic sarcomata found at autopsy in beagles which survived more than six months after isotope administration for Pu, Ra, MsTh, RdTh and Sr.

<89>
Jones, D.C.L., and J.S. Krebs, Stanford Research Institute, Menlo Park, CA. 1972, August

Radiobiology of Large Animals. PYU-8150; AD-752049; Annual Report for 1972; 43 p.

A review has been completed of all experiments concerned with radiation-induced lethality in sheep and conducted by the Naval Radiological Defense Laboratory and/or the Stanford Research Institute under the auspices of the Defense Civil Preparedness Agency. After consideration of a series of experiments involving sheep exposed to Co 60 gamma radiation at various continuous,

<89> CONT.
intermittent, or combined irradiation schedules at dose rates of 4 R/hr or less, it appears that the major factor determining mortality in such experiments is the average dose per day over the entire exposure period, and not the specific dose rate during the irradiation itself. A mathematical model has been developed that describes the dynamics of injury and repair as a function of daily average dose rate. Studies of cell kinetics in the bone marrow of mice have revealed that differences in mortality following irradiation at different dose rates may be related to corresponding differences in repopulation rates in this critical time, rather than with differences in cell destruction at the two dose rates. (Auth)

Sixty-day mortality in sheep following weekly exposure to Co 60 gamma rays at different rates is given in Tables 1-3. Tables 4 and 5 contain the number of colony forming cells and total number of bone marrow cells in mice after irradiation with Co 60.

<90>
Jones, D.C.L., and J.S. Krebs, Stanford Research Institute, Life Sciences Division, Menlo Park, CA; Civil Defense Preparedness Agency, Washington, DC. 1973, August

Radiobiology of Large Animals. AD-770131; 28 p.

Hematologic changes occurring during and after complex sequences of low-dose-rate exposure of sheep to gamma radiation (Cobalt 60) were evaluated. Erythrocytic values were depressed early in the irradiation sequence, with further gradual depression after cessation of exposure. Leukocytic values decreased in a stepwise fashion during the irradiation sequence, with the patterns of decrease and post-irradiation recovery dependent on the particular parameters of radiation exposure. Studies of bone-marrow cell kinetics in mice receiving single exposures showed that post-irradiation changes in total cellularity depend on dose rate. Further studies of lethality in sheep irradiated at low dose rates indicated that a previously developed mathematical model relating parameters to lethality may require modification when the exposure dose rate is of the order R/hr or higher. (Auth)

<91>
Jones, Y.M., P.O. Jackson, and W.J. Bair, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Radiological Sciences Department, Radiological Sciences Section, Richland, WA. 1968, October

The Determination of Plutonium to Americium Ratios in Biological Specimens. BNWL-715 (Part 2); Part of Nielsen, J.M., et al, Annual Report for 1967, (p. 140-141), 230 p.

To aid in the evaluation of biological translocation of Pu and Am, two precise measurement techniques were developed to determine the Pu to Am ratios in organs of animals which had inhaled a mixed Pu-Am oxide. In one method, after wet ashing, the actinides in the sample were electroplated and alpha pulse height analysis was used to determine the ratio. In the other, the ashed samples was precisely mounted and photon spectrometry was used for the determination. (Auth)

<92>
Ishima, H., O. Matsuoka, and M. Kashima, National Institute of Radiological Sciences, Chiba, Japan. 1970, October 1

The Effects of Calcium DTPA on the Whole Body Retention and the Tissue Distribution of Monomeric Plutonium and Polymeric Plutonium. NIRS-Pu-7; Part of Research Report on Internal Exposure to Plutonium in April 1969-March 1970, (p. 57-61), 91 p.

The effects of Ca DTPA on tissue distribution with regards to the whole body retention of monomeric and polymeric Pu were investigated. A single intravenous injection of 1 uCi (about 0.03 uCi/g body weight) of monomeric Pu or polymeric Pu was given to forty-six male mice. On the day after injection of Pu, six mice which were given monomeric Pu were sacrificed to determine the tissue distribution as controls, and the first of 12 intraperitoneal injection of Ca DTPA, or of saline, spaced 3 days apart, was given to the other forty mice. The individual dose of Ca DTPA was 100 mg/kg body weight. During the experimental period the whole body activity was determined using three thin NaI(Tl) crystals. Immediately before the mice died the liver, spleen and salivary gland were removed and analyzed for Pu by a liquid scintillation counter. From the results of whole body retention, monomeric Pu is more readily excreted than polymeric Pu and the effect of Ca DTPA on the excretion of polymeric Pu is smaller than that on monomeric Pu. It seemed the effect of Ca DTPA on the excretion of Pu, both in monomeric and polymeric Pu, gradually decreased as time passed. The tissue distribution data indicate that the so-called 'monomeric Pu' contain considerable amounts of polymeric Pu. In the liver and salivary gland, monomeric Pu which mainly exists in the extracellular fraction is easily chelated by Ca DTPA. On the other hand, polymeric Pu which is engulfed by the spleenic reticuloendothelial cell is not chelated because the cell membrane is relatively impermeable to Ca DTPA. But even if Ca DTPA can permeate the cell membrane, engulfed polymeric Pu will not be chelated because of its physiochemical property. A new concept on "Ca DTPA chelatable Pu" and "Ca DTPA unchelatable Pu" was proposed. Because all of the chelatable Pu was excreted, the later Ca DTPA treatments had little effect on the whole body retention of Pu. (Auth)

<93>
Kalmykova, Z.I., Not given. 1969

On Certain Changes in the Red Blood and Hemodynamics Under the Inhalation Injury of Rats by a Citrate of Plutonium 239. AEC-tr-7195; Part of Moskalev, Yu.I. (Ed.), Radioactive Isotopes and the Body, (p. 354-363), 458 p.

Rats of the Wistar strain, weighing 140-170 g were subjected to inhalation of Pu 239 citrate with a pH of 6.5 in a special chamber. The animals were divided into three groups: the first and 2nd groups were treated to single inhalation with an initial content in the lungs of 0.648 and 0.106 uCi of Pu, and the 3rd group was treated to chronic inhalation for 160 days with daily deposition of 0.004 uCi of Pu in the lungs. There were also two control groups. It was observed that under a single inhalation of Pu 239 citrate with a preliminary concentration in the lungs of 0.648 uCi, different shifts on the part of the red blood and the hemodynamics occurred depending on the

<93>

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<93> CONT.
periods of injury. For example, on the first day after inhalation, the following changes were seen: macrospherocytosis of erythrocytes, a shift in the erythrogram to the left, a drop in the saturation of arterial blood with oxygen, a sharp increase in the mass of circulating blood and an acceleration of maturation of reticulocytes. In subsequent periods (8-64th day) there appeared a tendency toward normalization of saturation of the blood with oxygen and the mass of blood, macrospherocytosis of erythrocytes was replaced by normo- and microplanocytosis, the erythrogram shifted to the right or did not change from that in the control, and the rate of blood flow and maturation of reticulocytes slowed down. On the 128th day spherocytosis of erythrocytes and a shift of the erythrogram to the left were again observed, hypoxemia was depressed and a disturbance of the elastic force of the lungs appeared more clearly and maturation of reticulocytes again accelerated. Under a single inhalation of Pu 239 citrate with an initial concentration in the lungs of 0.106 uCi all these changes were less sharply expressed than in rats of the first group. Under chronic inhalation of Pu 239 citrate for 160 days with a daily deposition in the lungs of 0.004 uCi, macrocytosis with spherocytosis of the erythrocytes was noted on the 40th day of dosage, macro- and planocytosis immediately after stopping inhalation, and at the end of the observations (by the 40th day) the dimensions of the erythrocytes were not different from the control. The erythrogram during the period of macrospherocytosis shifted to the left and coincided with the control in the period of micro- and normocytosis. (Auth) (FMM)

<94>
Kashima, M., D.D. Mahlum, and M.R. Sikov, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Plutonium and the Liver of the Immature Rat. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 77-81), 313 p.

Both parenchymal cell function and reticuloendothelial function of the liver were studied 3 weeks after intracardial or intravenous injection of monomeric (60 uCi/kg) or polymeric (30 uCi/kg) Pu 239 to newborn, week-old, weanling, or adult rats. The adult and weanling groups showed little effect of the Pu 239 on these parameters. Marked impairment of both parenchymal cell and reticuloendothelial function was found in those injected at birth or at 1 week of age, especially after treatment with the monomer. (Auth)

<95>
Kember, N.F., Brookhaven National Laboratory, Upton, Long Island, NY. 1962

Kinetics of Population of Bone-Forming Cells in the Normal and Irradiated Rat. 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, Oxford, England, (p. 309-316), 529 p.

Tritiated thymidine was used as a tracer for DNA synthesis in bone cells in normal rats and following hind limb x radiation (1750 and 3500 rads), whole body gamma irradiation (84, 176, and 415 rads/day), and P 32 injection delivering more than 300 rads to the cells of the primary spongiosa in the first day following injection. Autoradiographs were used to make labeled cell counts. Labeled cells of hind limb irradiated rats initially fell in number followed by an abortive recovery, and at 16 days full recovery at the lower dose. At the higher dose there were few labeled cells after 28 days. In the continuously irradiated rats the number of labeled cells fell rapidly; but at 84 rads the cells continued to divide at a reduced rate. Following injection of P 32 there was an immediate drop in numbers of labeled cells followed by recovery. These results were confirmed in one study using Am 241. Although numbers of labeled cells returned to the normal value fairly rapidly in the P 32 experiments, differential cell counts showed that 80-100% of the labeled cells were spindle cells which normally comprise only 25-30% of the labeled cell population. (ST)

<96>
Khodyreva, M.A., Not given. 1966

Absorption of Plutonium 239 Through the Skin of Animals and Its Distribution in the Organism. AEC-tr-6944; Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 99-105), 718 p.

The results of experiments on rabbits established the possibility of the absorption of Pu nitrate through the skin into the organism. On the 14th day following the application of a solution of nitrate salt of Pu 239 to the skin in amounts of 0.4 and 4 ucuries/cm2 the body of the animals contained 0.15 percent of the dose applied. On the 14th day after the application of a single dose of plutonium nitrate to the skin of the rabbit the bulk of the absorbed dose was detected in the skeleton, liver and muscles. (Auth)

<97>
Khodyreva, M.A., R.Y. Sitko, G.M. Parkhomenko, and V.A. Sarycheva, Not given. 1972

The Desactivation (Decontamination) of Skin from the Transuranium Elements. Gigiena i Sanitariya, 37(12), 57-61 (Russian, English Summary)

A relative accumulation of the isotope was found to take place in the skin layers depending on the type of contamination and the mode of decontamination. On the basis of the investigations performed the most efficient chelates for the decontamination of skin from Am 241 were elaborated and certain measures were suggested for complete prevention or at least for diminishing the extent of skin contamination with radioactive substances. (Auth)

<98>
Klepper, B., and D.K. Craig, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1974, January

Deposition Characteristics of Aerosol Particles Onto Foliage and Other Surfaces. BNWL-1850 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1973, (p. 51-54), 200 p.

An aerosol exposure wind tunnel has been constructed and calibrated for use in studies concerned with interactions between foliage

<98> CONT.
and airborne Pu particles. The wind tunnel is 9 ft long and is enclosed in a plexiglass glovebox comprising 3 sections: a transfer hatch, an experimental section where material is put into and removed from the wind tunnel, and an aerosol generation section. The glovebox is continually exhausted at a rate of about 40 cfm through an absolute filter. Plants are grown in pint ice cream cartons in Ritzville siltloam topsoil. Ten-day old bean seedlings with unifoliate leaves fully expanded were used in experiments where a Au 198-labelled colloidal gold aerosol was generated and deposited at several wind speeds. The short half-life (64.8 h) and easily measured gamma decay energy (400 keV) make Au 198 a convenient isotope to use. Plants were oriented in various directions. Also, 1 in. wide strips of masking tape were exposed at different orientations to the wind. At an air velocity of 0.42 cm/sec, about 0.1% of the total activity passing through the test section was deposited on the above ground surfaces of 2 bean seedlings. The aerosols had an AMAD of about 0.8 uM and a GSD of 1.65. The deposition velocity for plant surfaces is 4.10 x 10(E-3) cm/sec, and is greater than the value from an inert horizontal surface. (Auth) (RAF)

Figure 2.10 shows a transverse section of a glovebox and aerosol exposure wind tunnel. Table 2.17 gives deposition of aerosols on horizontal surfaces. Table 2.18 gives deposition of aerosols unto bean plants under constant conditions in a wind tunnel.

<99>
Klepper, B., and D.F. Craig, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1973, March

Interactions of Plutonium Aerosols with Plant Foliage. BNWL-1750 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1972, (p. 2.1-2.2), 105 p.

The preliminary design is shown of the glove box and aerosol exposure chamber in which interactions between Pu particles and plant foliage can be investigated. In the first experiments, two-week-old bean seedlings will be exposed to Pu 239 nitrate aerosol particles in the size range of AMAD equal to 1-3 um, G.S.D. equal to 1.5-3, at a wind speed of 50 ft/min. Later experiments will involve Pu 238 particles, chemical forms other than the nitrate, slower wind speeds and plant species other than bean. (FMM)

<100>
Konstantinova, V.V., Not given. 1963

Physicochemical Changes in Deoxyribonucleic Acid Under the Effect on Plutonium 239 In Vivo. AEC-tr-5436; Part of Radiobiology, (p. 11-17); Radiobiologiya, 3(3), 11-17

Rabbits weighing 2.9-3.2 kg were intravenously administered a single dose of 7 uCi/kg of Pu 239 nitrate. After 3-6 months the animals were killed and DNA preparations were obtained from the liver. The results showed that the DNA of the experimental animals had a lower molecular weight, 31.5-18% less than the control. The yield of DNA estimated per 1 g of wet tissue was distinctly decreased at all periods of investigation. Upon study of the nucleotide composition of DNA it was found that 6 months after injection of plutonium a decrease of cytosine content (by 13%) occurred. (Auth) (FMM)

<101>
Konstantinova, V.V., and P.E. Libinson, Not given. 1958

The Content and Synthesis of Nucleic Acids in Liver Under Subacute Intoxication with Plutonium. Voprosy Meditsinskoi Khimii, 4(5), 339-344 (Russian, English Summary)

Data are presented relating to the effect of Pu on the content and synthesis of nucleic acids in rat liver. Plutonium nitrate was injected intraperitoneally in doses equivalent to 0.02 uCi/g body weight. Investigations were carried out 1 and 2 weeks and 1 and 2 months following injection: Four hours before being sacrificed, the animals were injected with radioactive phosphate (P 32 labeled Na2HPO4) in the amounts of 4 uCi/100 g body weight. Estimations were made of the nucleic acid content of the livers and of the rates of P 32 incorporation into RNA and DNA. One or 2 months follwoing the injection of Pu, the amount of RNA was increased an average of 25%, while the amount of DNA was an average of 26% lower than normal 2 weeks after injection and thereafter. The rates of RNA and DNA synthesis were increased more than twofold during the whole period of investigation. The permeability of liver tissue for radioactive P is increased under conditions of Pu intoxication. (Auth)

<102>
Koshurnikova, N.A., V.K. Lemberg, A.P. Nifatov, and A.A. Pozyrev, Not given. 1968

Pneumosclerosis in Rats after Intratracheal Administration of Soluble Plutonium 239 Compounds. Gigiena Truda i Professional'nye Zabolevaniya, 11, 27-32 (Russian, English Summary)

The frequency and severity of pneumosclerosis in rats following intratracheal administration of Pu 239 nitrate in doses of 0.00042 to 1.0 uCi/rat and sodium plutonyl triacetate in a dose of 1.0 uCi/rat were studied. Penumosclerosis was as frequent in rats following administration of a 0.01 N solution of nitric acid as in rats receiving the lowest dose of Pu nitrate. Following administration of 0.048 to 1 uCi, an increase in the frequency of pneumosclerosis occurred. At remote intervals after administration of both compounds, microdistribution in the lungs was characterized by nonuniformity. Injury to the structural elements of the lungs was more marked than to the lung lymphatic tissue or regional lymph nodes. (ST)

<103>
Lamerton, L.F., Institute of Cancer Research, Royal Cancer Hospital, Physics Department, London, England. 1962

The Relationship Between Alpha and Beta Dosimetry. 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. 397-407), 529 p.

The extent to which detailed investigations of radiation dose distribution are practical and worthwhile in studies with bone-seeking radionuclides is summarized. Problems

<103>

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<103> CONT.
encountered are a reflection of the essential complexity of the action of bone-seekers. Without some knowledge of the distriution of radiation doses in any given case, it is too easy to make false deductions or miss an important conclusion. Dose distribution studies lacking a close correlation with histological factors are of little use, and investigators in the field are presented with major problems. Autoradiography, the only technique available at the time, is a laborious method for alpha emitters such as plutonium and the short range beta emitters, and full dose distribution is generally an impractical aim. Measuring doses received by primative osteogenic cells in bone requires knowledge of radiation dose distribution in bones and the distribution of the cells themselves. For alpha and short range beta emitters, any useful estimate may be impossible. If tumor production is affected by general tissue disorganization or is the result of induced cytological abnormalities, dose rate independence will not apply. Statistical problems involving the interaction between radiation and matter arise in considering radiation dose distribution at low levels of dose. (BBM)

<104>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Excretion and Deposition of Americium and Plutonium. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 13-15), 61 p. (Declassified November 21, 1955)

Fifteen rats were injected via the tail vein with 0.03 uCi of americium per gram of body weight. Daily urine and feces collections were made. Animals were sacrificed at 4, 16, 32, and 48 days for tissue deposition studies. Curves indicating a comparison of urinary and fecal excretion rates of americium (administered as AmCl3) and plutonium (administered as Pu(NO3)4) were graphed. Data on plutonium was obtained from a previous study. Data show that at the end of 32 days 9.91% of the injected dose of AmCl3 was excreted in urine compared to 1.46% PuCl3, 2.07% Pu(NO3)4, 2.58% Pu(+4) citrate, and 10.04% PuCl3, 2.07% Pu(NO3)4, 2.58% Pu+4 citrate, and 10.04% PuO2(NO3)2. For feces, the percent of injected dose excreted was 24.3% AmCl3, 39.74% PuCl3, 32.81% Pu(NO3)4, 27.68% Pu +4 citrate, and 18.6% PuO2(NO3)2. (BBM)

<105>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Relative Effects of Americium and Plutonium on the Peripheral Blood. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 22-23), 61 p. (Declassified November 21, 1955)

Hematological observations were conducted on surviving rats used for the acute lethal studies conducted in the laboratory. Varying amounts of AmCl3 and Pu+4 citrate were injected into the animals. Blood counts were taken over a 300 day period post injection. Granulocytes and lymphocytes were equally depressed immediately following injection. The proportion of granulocytes and lymphocytes remained essentially unchanged despite the wide variations in the total white counts. Morphological changes in white blood cells were the same as those noted in other types of ionizing radiation damage and consisted of bizarre nuclear forms and increased cytoplasmic basophilia in the lymphocytes. (BBM)

Data is included in Figures 7 and 8 comparing the effects of americium and plutonium on red and white blood cell counts.

<106>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Relative Effects of Americium and Plutonium on General Health and Life Span. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 26-27), 61 p. (Declassified November 21, 1955)

Rats were injected intravenously with varying amounts of plutonium and americium, and the life history and general health were followed for a year. In general, Am and Pu given in equivalent microcurie amounts seem to have comparable effects on the survival of rats. Nearly all animals injected with 0.032 uCi/g of body weight or greater appeared in poor health. A high percentage failed to gain weight, sustained multiple fractures and suffered from chronic upper respiratory infection at some time prior to death. Occasional animals surviving beyond 300 days gained weight normally and appeared to be in good general health. Survival curves are graphed. (BBM)

<107>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Relative Effects of Americium and Plutonium on Skeletal Structures. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 24-25), 61 p. (Declassified November 21, 1955)

Eight weeks after injections of americium and plutonium, rats developed limb deformities. Radiological findings noted were: pathological fractures of the long bones of the limbs; osteoporosis; densities along epiphyseal growth lines; bone necrosis; and marked thinning of the cortex of long bones with occasional pseudo fibrocystic changes. There were no differences between groups receiving plutonium and americium. At death microscopic observations of decalcified sections showed extensive areas of bone necrosis. (BBM)

<108>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Relative Production of Bone Sarcoma by Americium and Plutonium. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 25-26), 61 p. (Declassified November 21, 1955)

Four osteosarcomas were seen in rats injected with plutonium and americium. The tumors were discovered at the time of death or shortly before. Metastases, predominantly pulmonary, occurred in four of the ten

<108> CONT.
animals with osteosarcomas. Two fibrosarcomas were seen in animals injected with americium. (BBM)

<109>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Relative Effects of Americium and Plutonium on the Bone Marrow. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 24), 61 p. (Declassified November 21, 1955)

Rats that had been injected with plutonium and americium were sacrificed and femoral bone marrow was obtained. Examination showed no significant deviation in the relative numbers of the various marrow cells. There was a fairly marked increase in the general cellularity of the femoral marrow. (BBM)

<110>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

The Relative Physiological and Toxicological Properties of Americium and Plutonium. LA-1309; 61 p. (Declassified November 21, 1955)

The relative physiological and toxicological properties of americium and plutonium have been studied following their intravenous administration to rats. The urinary and fecal excretion of americium was similar to that of plutonium administered as $Pu(NO_3)_4$. The deposition of americium in the tissues and organs of the rat was also similar to that observed for plutonium. The liver and the skeleton were the major sites of deposition. Zirconium citrate administered 15 minutes after injection of americium increased the urinary excretion of americium and decreased the amount found in the liver and the skeleton at 4 and 16 days. LD 50/30 studies showed americium was slightly less toxic when given in the acute toxic range than was plutonium. The difference was, however, too slight to be important in establishing a larger tolerance dose for americium. Survival studies, hematological observations, bone marrow observations, comparison of tumor incidence and the incidence of skeletal abnormalities indicated that americium and plutonium have essentially the same chronic toxicity when given on an equal uc basis. These studies support the conclusion that the tolerance values for americium should be essentially the same as those for plutonium. Separate sections of the report have been entered into the data base. (Auth)

Twenty-one pages of tables and figures give data from the studies.

<111>
Langham, W., and P.F. Carter, University of California, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Relative Toxicological and Physiological Effects of Americium and Plutonium. LA-1309; Part of the Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 20-22), 61 p. (Declassified November 21, 1955)

Five groups of 20 rats were injected with solutions of Pu +4 citrate of varying strengths, and seven groups of 20 rats were injected with AmCl3 in varying strengths. Data from the test show that the median lethal dose of plutonium had a maximum likelihood estimate of 0.071 uCi/g body weight with a fiducial probability of 95% that the median lethal dose might be expected to lie between 0.056 and 0.086 uCi/g. For americium, the median lethal dose had a maximum likelihood estimate of 0.110 uCi/g body weight, with a fiducial probability of 95% that the median dose may be expected to lie between 0.090 and 0.130 uCi/g. The ratio of the most likely LD 50/30 doses of americium and plutonium is 0.110/0.071 = 1.6, and there is a 99 to 99.9% chance that the two are different. (BBM)

Table 6 gives the uCi of material injected and the 30 day mortality of each group of animals.

<112>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Effect of Zirconium Citrate on Excretion and Deposition of Americium. LA-1309; Part of the Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 17-20), 61 p. (Declassified November 21, 1955)

Twelve rats were injected intravenously with 0.03 uCi/g body weight of Americium as AmCl3. After 15 minutes, 6 of the rats were injected intraperitoneally with 40 mg of zirconium citrate. The total excretion of americium in feces and urine during the first 24 hours was 37.7% of the injected dose for animals receiving zirconium and 6.9% for the control group. The single dose of zirconium had essentially no effect on urinary and fecal excretion of americium after the first 24 hour period. Total excretion for the 16 days of the experiment was 48.9% for treated animals and 27.4% for control animals. The effect of zirconium on the deposition of americium in various tissues and organs at 4 and 16 days was investigated. At 4 days after treatment, zirconium had materially affected the deposition of americium. The livers of control animals contained an average of 38.3% of the injected dose compared to 17.9% for treated animals. Skeletons of the untreated group contained 30.7% compared to 22.5% for the treated group. The 16 day results are relatively unimportant because the zirconium treatment is effective only during the first 24 hrs. (BBM)

Data from the study is indicated in Tables 4 and 5 of the report.

<113>
Langham, W., and R.E. Carter, Los Alamos Scientific Laboratory, Los Alamos, NM. 1951, November 15

Comparison of Tissue Deposition of Americium and Plutonium. LA-1309; Part of The Relative Physiological and Toxicological Properties of Americium and Plutonium, (p. 15-17), 61 p. (Declassified November 21, 1955)

Rats were injected with 0.03 uCi of AmCl3 per gram of body weight. Tissue deposition was compared with data from a previous study of $PuCl_3$, $Pu(NO_3)_4$, Pu(+4) citrate, and $PuO_2(NO_3)_2$. Although results may not be completely comparable, data show that americium, like plutonium in its various valence states, deposits primarily in the

<113>

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<113> CONT.
liver and skeleton. AmCl3 is comparable to Pu(NO3)4 and PuCl3 with 38.3% of americium, and 39.7% of Pu(NO3)4 located in the liver and 30.7% of americium and 29.4% of Pu(NO3)4 located in the skeleton. Comparison of other tissues and organs is of little significance because of the small fractions of the total doses which they contain, although values for americium and plutonium are roughly comparable. The qualitative similarity of the mode of deposition of americium and plutonium was demonstrated by autoradiography. These autoradiographs show the great selectivity of both americium and plutonium for the epiphyseal line and for the endostium and their complete exclusion from cartilage and dense bone. (BBM)

Table 3 presents data which detail the deposition of the radionuclides.

<114>
Leach, L.J., C.L. Yuile, H.C. Hodge, G.E. Sylvester, and H.B. Wilson, University of Rochester, School of Medicine and Dentistry, Department of Radiation Biology and Biophysics, Rochester, NY. 1973, September

A Five-Year Inhalation Study with Natural Uranium Dioxide (UO2) Dust. 2. Postexposure Retention and Biologic Effects in the Monkey, Dog and Rat. Health Physics, 25, 239-258

Inhalation studies show that dogs, monkeys and rats can breathe a natural uranium dioxide (UO2) aerosol of approximately 1 um mass median particle diameter (MMD), at a mean concentration of 5 mg U/m3(25 x threshold limit value (TLV) or 28 x MPCa), for periods as long as 5 yr with little evidence of serious injury. Some of these animals were observed for protracted postexposure periods during which pulmonary neoplasia developed in a high percentage of the dogs examined 2-6 yr after exposure. Pulmonary and tracheobronchial lymph node fibrosis, consistent with radiation effects, apparently dose dependent, and more marked in monkeys than in dogs was also noted. No evidence of uranium toxicity was found in records of body weights, mortality, various hematologic parameters or the histologic condition of the kidneys. (Auth)

Tables 3, 4 and 5 show uranium concentrations in dog, monkey and rat tissues. Table 9 shows canine lung tumor incidence associated with inhaled Pu 238 PuO2, Pu 239 PuO2 or natural UO2 aerosol.

<115>
Lebedinskii, A.V. (Ed.), and Yu.I. Moskalev (Ed.), Not given. 1961

Distribution, Biological Effects, and Migration of Radioactive Elements. AEC-tr-7512; 409 p.

The report contains forty-one papers on the distribution, accelerated excretion, biological effects, and migration in the biosphere of several radionuclides including cesium 137, strontium 89, strontium 90, barium 140, cerium 144, lanthanum 140, ruthenium 106, plutonium 239, and yttrium 91. The report is divided into three parts. The first part submits data that characterize the distinctive features of distribution of cesium, strontium, barium, cerium, lanthanum, ruthenium, and phosphorus in different animal species as related to route of access, physiological state of the organism, form of compound administered, pH of the initial solution, and quantity of isotope carrier. Several studies were made of the route of distribution within the organism. Particular attention was given to the distribution and coefficients of accumulation of cesium 137 and strontium 90 following prolonged intake through the gastrointestinal and respiratory tract. The possibility of absorption through the skin was studied. In the second part data is presented which establishes the levels of acute, subacute, and chronic effective doses of several radionuclides including plutonium 239. The effect of small doses, optimum and minimum blastomogenic doses, and the effects of temperature, complexing agents, and splenectomy on the course of radiation sickness induced by strontium 89 and strontium 90 are included. The third part discusses the migration of strontium 90 and other radioisotopes in biological chains. Movement with groundwater, effects on microflora and fish, and accumulation in fish were studied. Two articles were selected and abstracted separately for the data base. (ST)

<116>
Lemberg, V.K., N.A. Koshurnikova, A.P. Nifatov, Z.M. Bukhtoyarova, and N.P. Kudasheva, Not given. 1966

Effect of Additional Pathological Factors on the Long-Term Consequences of Plutonium 239 Poisoning. AEC-tr-6944; Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 484-492), 718 p.

Pu 239 was administered to rats in single doses of 0.63 x 10(E-3) and 2 x 10(E-3) uCi/g in the form of the nitrate salt. Additional pathological factors were applied including aseptic inflammation, produced by introducing turpentine under the skin, multiple repeated blood lettings, bone fractures and injection of carbon tetrachloride. It was found that the combined effect of Pu and the additional factors caused a decrease in the average life span of rats of all series compared with the controls, except for the female rats which received Pu in a combination with repeated blood lettings. The total number of tumors occurring in the animals which received Pu in a combination with bloodlettings was markedly higher than in control animals and in animals receiving Pu above. A similar pattern was observed for male rats receiving Pu in a combination with repeated bone fractures. Repeated injection of CCl4 in a combination with incorporation of Pu intensified degenerative processes in the liver. (FMM)

<117>
Lindenbaum, A., J.F. Markley, M.W. Rosenthal, W.M. Westfall, and E.S. Moretti, Argonne National Laboratory, Argonne, IL. 1963, May

Progress Report: Plutonium Removal. 5. Ultrafilterability and Disappearance of Plutonium from Plasma as a Function of DTPA Treatment and of the Physical State of the Plutonium. ANL-6723; Part of Biological and Medical Research Division Semiannual Report, January through June 1962, (p. 146-148), 259 p.

Two plutonium injection solutions were prepared. The monomeric contained 9.7 uCi Pu per ml; citrate:Pu ratio equals 60; pH equals 6.0. The polymeric solution contained 7.8 uCi Pu per ml; citrate:Pu ratio equals 2; pH equals 7.1. Ninety Sprague-Dawley female rats, weighing about 250 g, were injected intravenously with the plutonium solutions in either form at 7.2 or 10.6 uCi/kg. The

<117> CONT.
treated rats received Ca DTPA at 500 mg/kg intraperitoneally 1/2 hr after plutonium administration. Plutonium analyses were performed on whole blood, plasma and plasma ultrafiltrates by alpha-counting. The results showed that the plutonium content of the total plasma was about equal to that of the total blood, indicating that there is no significant fraction of the plutonium contained in the cellular components of the blood. Although the plasma levels of the two forms of plutonium in the untreated rats were about the same at the beginning (40% at 1/2 hr) and at the end (8-10% at 24 hr) of the period examined, the rate of disappearance was faster for the polymeric form than for the monomeric (at 2 hr, polymeric equals 21% and monomeric equals 32%). DTPA therapy increased the rate of disappearance of both forms markedly; for example, at 2 hr after plutonium injection, the Pu levels in the plasma of the treated rats were 4% for the monomeric and 9% for the polymeric. The percentage of the plasma plutonium that was ultrafilterable was very low for both forms (<0.01%) in the absence of DTPA therapy. Treatment increased this considerably, and exerted a more pronounced and sustained effect on the monomeric form. For example, at 3 hr, the monomeric plasma Pu was about 37% ultrafilterable as compared with about 9% for the polymeric plasma Pu; corresponding values at 12 hr were about 10% and 1%. (FMM)

<118>
Lloyd, R.D., D.R. Atherton, S.S. Gaufin, C.W. Mays, and G.N. Taylor, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Americium 241 Skeletal Distribution in Beagles. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 263-265), 380 p.

Data on the skeletal distribution of Am 241 in beagle dogs is given in tabular form. It is concluded that retention patterns are determined by dose level. A transcribing error in an earlier report (COO-119-244) is corrected and the corrected percents of injected Am 241 in the total skeleton are given in tabular form. (ST)

See also Report COO-119-244, (p. 151-158), 1971

<119>
Lloyd, R.D., C.W. Mays, W.S.S. Jee, and G.N. Taylor, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Skeletal Distribution of Americium 241 and Plutonium 239 in Beagles: Can They Be Compared?. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 249-262), 380 p.

No statistical justification was found for rejecting data of a dog sacrificed 1 day after the injection of Pu 239 from the mean percent skeletal Pu per bone values which included data from 19 other dogs sacrificed 5 to 769 days after Pu 239 injection. An equivalent conclusion was drawn from corresponding data for dogs injected with Am 241 and sacrificed 1 and 7 to 1533 days later. Comparison of the mean skeletal distribution of retained Pu with retained Am emphasizes similarities more than differences. Whereas the relative distribution of Pu in the skeleton was not generally dependent upon time after injection, a highly significant relationship between relative skeletal distribution and burden time was revealed for Am, with vertebrae, tail, and sternum, which have much trabecular bone, exhibiting a decreasing fraction of retained Am with increasing time. (Auth)

Table 1 shows distribution of injected Pu 239 in the beagle skeleton.

<120>
Lloyd, R.D., C.W. Mays, D.R. Atherton, G.N. Taylor, S.S. McFarland, and J.L. Williams, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1973, March 31

Californium Retention in Beagles During the First Two Years after Injection. COO-119-248; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 156-162), 400 p.

Retention of Cf in the total body and in the liver of 21 beagles injected with Cf 249 and 19 beagles injected with Cf 252 has been determined by total body and partial body counting techniques for burden times of more than 2 years. Total body retention was as if 23.8% of the injected Cf was retained with a biological half-life of about 1.6 days and 76.2% with a half-life of about 3129 days equal to 8.6 years. Liver retention was as if 9.6% of the injected Cf was retained with a half-life of 2.5 days and 18.5% with a half-life of 1192 days equal to 3.3 years. It appeared that there was no important differences between these two Cf isotopes in either total body or liver retention. (Auth)

<121>
Lloyd, R.D., C.W. Mays, D.R. Atherton, and S.S. Gaufin, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Californium Retention in Beagles During the First Year After Injection. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 289-298), 380 p.

Measurements of the retention of citrate complexed, intravenously injected Cf 249 and Cf 252 in the total-body and liver of beagles have been extended to one year after injection. The biological half-time of Cf in the total body appears to be in the order of 6 years. Sacrifice of 2 additional dogs for distribution studies confirm an earlier conclusion that liver, skeleton, thyroid, and kidney were the tissues with highest Cf concentration. Fission product iodine isotopes were found in the thyroid glands of Cf 252 injected dogs. (Auth)

Table 1 shows distribution and concentration of injected Cf 249 and Cf 252 in the tissues of beagles.

<122>
Lloyd, R.D., C.W. Mays, D.R. Atherton, G.N. Taylor, and J.L. Williams, University of Utah, College of Medicine, Radiobiology Division,

<122>

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<122> CONT.
Department of Anatomy, Salt Lake City, UT. 1971, March 31

Californium Retention, Excretion and Distribution in Beagles Soon After Injection. COO-119-244; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 102-116), 424 p.

The metabolism of californium has been studied in 11 beagles from 0 to 82 days after intravenous injection with Cf 249 or Cf 252 as Cf(+3) in citrate buffer. Total excretion during the first 21 days after injection was mainly urinary. Of the Cf eliminated in this 3 week period, about 3/5 appeared in the first day's collection. Nearly twice as much californium was excreted in 3 weeks after injection as has been observed with beagles given Am 241 or Pu 239. A combination oftotal-body and partial-body gamma-ray counting of the living dogs indicated that at 1 week about 20% of the injected Cf was deposited in the liver and that nearly 60% remained in non-liver tissue (mainly skeleton). This retention pattern persisted until at least 82 days after injection. In contrast, the retention of Am 241 during a corresponding period averaged about 50% of the injected activity in liver and 40% in skeleton, while values for were sacrificed for distribution studies 7 and 21 days after the injecton of Cf 249. Tissues exhibiting relatively high Cf concentrations were liver, skeleton, kidney, dura, connective tissue, and, in the 7 day dog, the thyroid. Although liver concentration of Cf was lower relative to that of Pu 239 or especially Am 241, kidney concentration of Cf was significantly higher. Skeletal Cf concentration was similar to that for Pu 239 but was about double that for Am 241 at corresponding burden times. Average thyroid concentrations of these 3 elements were highest for americium and californium but lowest for plutonium. Tissues at risk from incorporated californium appear to be liver, skeleton, kidney, and thyroid. (Auth)

Tables 2-7 show the excretion, biological retention and distribution of Cf 249, Cf 252, Pu 239 and Am 241.

<123>
Lyaginskaya, A.M., Institute of Biophysics, Moscow, USSR. 1973

Estimation of Permissible Radiation Doses from Iodine 131, Strontium 90, HTO, and Americium 241 to the Gonads. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 181-184), 655 p.

Experiments were performed on rats that were subjected to a single administration of Sr 90 in a dose range of 0.004-20 uCi/g, HTO-from 8 to 300 uCi/g or Am 241-from 0.0005 to 0.02 uCi/g. Functional and structural changes were studied in the gonads at various time periods after administration of the radionuclides and the absorbed doses in the whole body and in the gonads were estimated. The results showed that Am 241 caused a loosening of tubule structures while Sr 90 caused a tightening and reduction in size. HTO and external radiation induced progressive development of degenerative changes and I 131 caused excess proliferation of initial spermatogenesis cells. The data on development of fetuses and progeny from damaged males showed that such progeny was characterized by higher mortality. It was concluded that the genetical risk associated with the radionuclides was principally determined by the dose long absorbed in the testes and did not depend on radionuclide distribution and the dose absorbed in the whole body. Sensitivity comparison of the male and female gonads showed that female gonads were more sensitive to the action of the given radionuclides. This may be probably explained by increased radionuclide affinity to the ovaries as compared to the testes. As evidenced by the recent data, if the maximum permissible concentrations recommended by ICRP to the gonads as the critical organ are taken into account, it should be reviewed towards their decrease: for the ovaries by 2.7 times, for the testes by 3.6 times (I 131); for the ovaries by 3 times, for the testes by 1.5 times (Ru 106); for the testes by 14-45 times (Am 241); from the data of the author for the testes by 3-5 times (HTO); and by 1.5-2 times (I 131). (PMM)

<124>
Lyubchanskii, E.R., Institute of Biophysics, Moscow, USSR. 1972

Behavior and Nature of the Microdistribution of Plutonium 239 in the Rat Organism after Chronic Inhalation of Its Soluble Compounds. AEC-tr-7362; Part of Radiobiologiya, (p. 170-180); Radiobiology, 12(2), 272-278

The behavior and microdistribution of plutonium 239 in the organs during and after the end of 160-day inhalation of Pu citrate and ammonium plutonium pentacarbonate were studied in experiments on 205 rats. Good correlation was established between the actual and calculated accumulations of the isotope in the lungs and skeleton during the process of inhalation. A nonuniform distribution of plutonium in the lungs was revealed by the method of histoautoradiography. (Auth)

The content of Pu 239 in the organs of rats following inhalation of soluble Pu compounds is given in a table.

<125>
Lyubchanskii, E.R., Institute of Biophysics, Moscow, USSR. 1967

The Behavior of Plutonium 239 in Rats After a Single Inhalation of Some of Its Chemical Compounds. AEC-tr-6889; Part of Radiobiology, (p. 84-96), 253 p.; Radiobiologiya, 7(4), 541-547

Aerosols of Pu compounds differing in solubility and valence state were inhaled for 20 min by 591 rats of the Wistar line weighing 140-200 g.. The compounds were plutonium citrate (+4), sodium plutonyltriacetate (+6), ammonium plutonium pentacarbonate (+4), plutonium chloride (+3), plutonium nitrate (+4), and ammonium plutonium pentacarbonate (+4). The animals were sacrificed immediately after inhalation and after 1, 8, 32, 64, 128, and 230-256 days. Pu content was determined in the lungs, bifurcated lymph nodes, femur, liver, spleen, and kidneys. Initial deposition of Pu 239 (28.6% of the intake) did not depend on chemical form and concentration in the inspired air. In all subsequent periods the level of Pu in the lungs depended substantially upon the inhaled form. The soluble compounds were deposited mainly in

<125> CONT.
the lungs and skeleton. Pu 239 was excreted from the lungs in 1 to 256 days with two half-lives, 15.5 days (34-65%) and 175 days (8.76-23.5%). Original deposition in the lungs was uniform; 32 days later accumulation was present in the form of stars. Most of the translocated Pu was deposited in the skeleton where it did not exceed 9-30% and in the liver (4-7%). The effect of chemical form on accumulation, translocation, and elimination are discussed. (Auth) (ST)

<126>
Mahlum, D.D., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Effects of Irradiating Skin. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 10-11), 313 p.

Observation of pigs, which were exposed to 1-40 krads of beta radiation from Tl 204 plaques approximately 3 years ago, continues. Areas that were exposed to 6, 15, or 40 krad when the animal was an adult appear as thin whitened circles with an area only slightly larger than that originally exposed. Areas which received 1 or 2.5 krad are not grossly visible. In contrast, in animals exposed as neonates, lesions were noted at 2 krad and the affected area was several times that originally irradiated. Additional analyses have been obtained from tissues from pigs which received Pu 239 intradermally 8-10 years ago. No skin tumors have yet been found. The concentration of Pu 239 in liver was as great or greater than that in bone. Estimated radiation dose to the liver ranged between 65 and 465 rads per year based on the concentration of Pu 239 in the liver at time of death. (Auth)

<127>
Mahlum, D.D., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Skin Irradiation Studies. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 15-16), 103 p.

During the past year no changes have occurred in the skin of Hanford miniature swine exposed four years ago to graded radiation doses form Tl 204 plaques. Areas of 0.5 cm2 and greater, exposed to doses of 6.25 krad and higher, appear as thin, whitened areas. Animals exposed at eight days of age show extensive enlargement of the exposed area, accompanied by considerable scar tissue formation. Damage in adult and newborn rats exposed to as much as 50,000 rads from Pu 239 plaques is limited to a slight outline of the exposed areas in a few animals. (ST)

<128>
Mahlum, D.D., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Plutonium in Miniature Swine. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 11), 103 p.

The last of the miniature pigs injected intradermally with 0.0016 to 5 uCi of Pu 239 approximately 11 yr ago was necropsied, and tissues taken for histologic examination and radiochemical analyses. As with previous animals, there were minimal skin lesions--small depressions with scar tissue built up around the depression. None of these animals showed gross evidence of skeletal tumors. The radiochemical data from these animals has been used to calculate radiation doses, particularly to the liver and to the skeleton. Doses to bone have exceeded those which resulted in a substantial incidence of osteogenic sarcoma in the University of Utah dogs. These data derived from only six pigs, strongly indicate the need for additional long-term studies in a large animal other than the dog. A number of liver lesions, including tumors, were noted in these pigs; and attempts are being made to determine whether these are in excess of those normally expected. (Auth) (Complete text)

<129>
Mahlum, D.D., and W.J. Clarke, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Influence of Internal Emitters on Chemical Carcinogenesis. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 123), 242 p.

Female rats were injected intravenously with the radionuclide (2 uCi Pu 238, or 2 or 20 uCi Ce 144-Pr 144) and then fed a diet containing 0.06% dimethylaminoazobenzene (DMAB). It was shown that animals that received both radionuclide and DMAB tended to have a slightly lower incidence of tumor formation than those that received DMAB alone. The types of neoplasms observed appeared to be predominantly of the biliary adenocarcinoma type. (FNM)

<130>
Mahlum, D.D., F.P. Hungate, and M.R. Sikov, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Einsteinium and Berkelium Toxicity and Metabolism in Rats. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 12-13), 103 p.

Rats injected intravenously with Es 253 as adults showed greater mortality and osteosarcoma incidence than did rats injected as weanlings. The incidence of mammary tumors was increased in males injected as adults. Absorption, of Bk or Es given in HCl from the gastrointestinal tract was increased nearly 100 fold when the normality of the acid was increased from 0.01 to 0.5. (Auth) (ST)

<131>
Mahlum, D.D., and M.R. Sikov, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Effect of Age on Absorption of Plutonium from the Gastrointestinal Tract of Rats. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 40-41), 207 p.

Plutonium(+4) citrate was administered by gavage to groups of rats of 1, 20 (1 day before weaning), 21 (immediately postweaning), or 35 days of age. Animals from these groups were sacrificed at serial times ranging from 1 hr to 20 days postadministration. It was shown that the absorption of plutonium(+4) citrate was substantially greater in the day-old rats

<131>

BIOLOGICAL ASPECTS

<131> CONT.
than in the rats of 20, 21, or 35 days of age. Retention was higher in the preweanling (1 and 20 day) rats than in the older animals and there was an evident tendency for translocation of Pu to bone in the preweanling rats which was less evident with increasing age. (FMM)

<132>
Mahlum, D.D., and M.R. Sikov, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Influence of Age on the Late Effects of Monomeric Plutonium 239 in the Rat. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 75-76), 313 p.

The protocol for a study of the influence of age on the late effects and on the eventual tumor response of rats to Pu 239 is described. Adult, weanling, new born, and 19 day fetuses were exposed to monomeric Pu 239 by a single intravenous or intracardiac injection or by intravenous injection of the dam. Dose levels were selected to give the same average radiation doses (7, 23, and 70 rads) to the femur in the first 10 days postexposure. The doses were: prenatal dose to dam, 6.0 to 60 uCi/kg; newborn, 3.0 to 30 uCi/kg; and weanling and adult, 0.3 to 3 uCi/kg. No results are yet available. (ST)

<133>
Mahlum, D.D., M.R. Sikov, and M. Kashima, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Distribution and Subacute Toxicity of Einsteinium 253 in Weanling and Adult Rats. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 82-85), 313 p.

The highest concentration of Es 253 was found in the skeleton of the rat whether it was administered to newborns, weanlings, or adults; substantial concentrations were also found in the liver, spleen and kidney. Mortality was greater among adults treated with 50 to 150 uCi/kg doses of Es 253 but skeletal defects were more prevalent and severe among animals treated as weanlings. Marked effects on dentition were noted in both weanlings and adults treated with Es 253. This may be related to an early localization of the nuclide in or near the tooth bud. (Auth) (RAF)

<134>
Matsusaka, N., and W.J. Bair, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Biliary Excretion of Plutonium after Pulmonary Deposition in Rats. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 3.20-3.22), 253 p.

Biliary excretion of plutonium was measured in rats after intratracheal injection and inhalation of several plutonium compounds. Maximum biliary excretion occurred after inhalation of $Pu(NO_3)_4$. This amounted to about 35% of the total plutonium excreted between the seventh and thirty-eighth day after exposure. (Auth)

<135>
Mays, C.W., W.S.S. Jee, C.J. Nabors, Jr., G.N. Taylor, W. Stevens, J. Dougherty, W.R. Christensen, and T.F. Dougherty, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1973, March 31

Some Scientific Advantages in the Use of the Beagle in Long Term Radiobiological Studies. COO-119-248; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 110-140), 400 p.

The beagle was originally chosen as an experimental animal in radiobiology primarily because of its relatively long lifespan and metabolic similarity to man. Some obvious scientific advantages in using the beagle are: skeletal similarity to man, important jaw syndrome induced in man and beagles, but not rodents, relevant radiographic information, osteosarcoma location, possible difference in shape of dose-response: rodents vs. large mammals, unique sex difference in bone sarcoma induction: mice vs. humans and beagles, growth dynamics of osteosarcomas, liver retention of Pu 239, advantage in obtaining sequential blood samples in beagles, corticosteroid production similarity between man and beagle, transaminase and alkaline phosphatase similarities between man and beagle, and advantage of larger organ size in radionuclide distribution studies. (Auth)

<136>
Mays, C.W., and R.D. Lloyd, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1973, March 31

Dose-Response Relationships for the Induction of Bone Sarcomas by Beta and Alpha-Emitters and the Effect of Dose-Rate on Delayed Somatic Effects from Low Let and Alpha-Radiation (A summary prepared for the NAS-NRC Low Dose-Study Group meeting of July 25, 1973). COO-119-248; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 370-377), 400 p.

The dose-response relationship for the induction of bone sarcoma by long-lived beta-emitters is strongly sigmoid. For alpha-emitters such as Pu 239, Th 228, Ra 228 and Ra 226, the relationship appears linear for rodents, but may be sigmoid for man and dog. In 10 intercomparisons of life shortening and the induction of neoplasms from low LET radiation, the effect per rad at low dose-rates averaged 0.2 of that at high dose-rates. In contrast, for alpha irradiation from Ra 224, the incidence of bone sarcomas from a given dose increased as the dose-rate was lowered. (Auth)

<137>
McClanahan, B.J., and H.A. Ragan, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Plutonium-Contaminated Wound Studies in Swine. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 101-103), 207 p.

Four years after intradermal injection of plutonium nitrate in swine, liver and skeletal burdens were 11% and 13%,

<137> CONT.
respectively, of the administered dose. Plutonium was also present in lymph nodes. Tourniquet application appeared to reduce the absorption of subcutaneously implanted plutonium in the foreleg of swine. Chilling the contaminated foreleg did not reduce absorption. (Auth)

Table 1 shows retention of Pu in swine 4 years after intradermal injection.

<138>
McClanahan, B.J., D.H. Wood, V.G. Horstman, H.A. Ragan, and L.K. Bustad, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Effects of Plutonium in Swine Skin and Its Removal. HW-80500; Part of Kornberg, H.A. and Swezea, F.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 120-122), 242 p.

Blond miniature swine were injected on each foreleg with 5 uCi of Pu 239(+4) nitrate in 0.01 ml of a 0.2 N HNO3 solution. Four hours later the first of four consecutive daily injections of the trisodium calcium salt of diethylenetriaminepentaacetic acid (Na3Ca DTPA) was administered intravenously. It was found that increasing the quantity of Na3Ca DTPA administered intravenously following subcutaneous injection appeared to further reduce the amount of Pu 239 retained. Suffusing the injection site with chymotrypsin did not increase Pu 239 translocation, while application of a tourniquet or cold pack did not reduce translocation. Four hundred and eighty skin sites on nine Hanford miniature swine injected intradermally with 0.0016 to 5.0 uCi Pu 239 nitrate per site, 22 to 30 months ago, were examined. Only 250 sites were detectable as depressed and/or thickened keratinized areas, and they were limited to sites injected with 0.008 uCi or more; however, at no level were all sites detectable. (Auth) (PMM)

Table 1 shows effect of Na3CaDTPA (mg/kg) on retention of Pu 239 in liver, skeleton and regional lymph nodes.

<139>
McClellan, R.O. (Ed.), and F.C. Rupprecht (Ed.), Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

Inhalation Toxicology Research Institute Annual Report, 1972-1973. LF-46; 342 p.

Fifty-five papers are included in the 1972-1973 annual report. Progress is reported on studies conducted to evaluate factors influencing the toxicity of inhaled radionuclides including plutonium. Several experimental animals including mice, Chinese hamsters, Syrian hamsters, rats, and beagle dogs are being routinely used. Sections one through seven are concerned with research directed toward developing an improved understanding of the nature of radioactive aerosols, including their production and characterization for use in animal exposures; obtaining an understanding of the radiation dose pattern resulting from inhalation of radioactive aerosols of diverse character; establishing the relationship between exposure to various levels and types of aerosols and the resulting biological effects; developing an improved understanding of the pathogenesis of radiation induced disease, especially as produced by internally deposited radionuclides that enter the body via inhalation; developing effective therapeutic procedures for treating individuals accidentally exposed to radioactive aerosols; developing respiratory tract deposition models; and finding the retention pattern and effects of repeated exposures to radioactive aerosols. Appendix A contains data on the status of longevity and sacrifice experiments in beagle dogs. Data are presented on selected parameters relative to total body and lung content of radionuclides and the resultant radiation dose received by individual dogs. Information is provided on the current interpretation of the most prominent clinico-pathological features associated with death of the animals. Thirteen papers were selected and abstracted separately for the data base. (ST)

<140>
McClellan, R.O., W.J. Clarke, V.G. Horstman, J.R. McKenney, M.E. Kerr, and L.K. Bustad, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1961, January 10

Comparative Toxicity of Strontium 90, Radium 226 and Plutonium 239 in Miniature Swine. HW-69500; Part of Hungate, F.P. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1960, (p. 13-15), 195 p.

Male miniature swine of three different ages injected intravenously with Sr 90 (64 uCi/kg), Ra 226 (6.4 uCi/kg) or Pu 239 (1.3 uCi/kg) have exhibited only minimal pathological damage in nine to fifteen months. Hematological and blood biochemistry determinations were made routinely on all animals. The right hind and fore limb of each animal were radiographed every three months for detection of possible skeletal pathology. Although damage has been minimal to date, changes noted have included a thickening of the cortical bone, outgrowths of cortical bone into the medullary canal, loss of definitive medullary canal and increased trabeculation of spongiosa. The changes noted do not appear to be distinctive for any of the radionuclides injected. (PMM) (HP)

<141>
McDonald, K.E., J.F. Park, R.J. Olson, R.H. Busch, and C.L. Sanders, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Removal of Inhaled Plutonium 239 Dioxide from Beagle Dogs. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 157-163), 313 p.

Beagle dogs were exposed to plutonium 239 PuO2 aerosols and treated with DTPA, Phenergan (promethazine hydrochloride), DTPA plus Phenergan, or pulmonary lavage to determine the efficacy of these treatments in removing inhaled Pu. Lavage was accomplished by using a double lumen Carlen's bronchospirometry catheter, lavaging the right lung only with 0.9% NaCl, leaving the left lung to serve as control. Treatment continued on all groups for approximately 20 weeks. The drug-treated groups retained essentially the same amount of Pu as the control group, while the lavage animals had a reduction of 50% in the lavaged lung. The final burden of the lavaged group was 67% of the initial alveolar burden compared to 93% for the controls and 91% for the other

<141>

BIOLOGICAL ASPECTS

<141> CONT.
treated animals. At the present time pulmonary lavage is the most effective method to remove inhaled plutonium 239 PuO2 from the lung. (Auth) (RAF)

<142>
Metivier, H., D. Nolibe, R. Masse, J. Lafuma, and A.A. Horvath (Translator), Commissariat a l'Fnergie Atomique, Centre d'Etudes de Bruyeres le-Chatel, Montrouge, France. 1972, December 18

Neoplasms Induced in Baboon Apes (PAPIO PAPIO) by the Inhalation of Plutonium Dioxide. Comptes Rendus Academy of Science, Series D, 275(25), 3069-3071; LF-tr-80; 6 p.

Young baboon apes (PAPIO PAPIO) exposed to Pu 239 oxide were found to exhibit lung cancer three months after inhalation of the toxic substance. The types of tumors observed, epidermal carcinomas and adenocarcinomas, are comparable to those observed in man and the prospect of extrapolating these results to man is emphasized. (FMM)

<143>
Mewhinney, J.A., A.L. Brooks, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1971, November

Retention and Distribution of Injected Californium 252 in Rats and Chinese Hamsters. LF-44; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1970-1971, (p. 96-101), 373 p.

The retention of californium 252 in rats and Chinese hamsters was observed for 64 days following intraperitoneal injection of a citrate complex of californium 252. Organ distribution was determined by serial sacrifice of groups of six animals at 1, 2, 4, 8, 16, 32 and 64 days post-injection for each species. Comparison of the whole-body retention pattern of Cf 252 in the rat and Chinese hamster revealed significant differences. Although whole-body clearance was nearly equal at comparable times post-injection through 64 days, differences were reflected in the number of exponential components needed to adequately describe the data and in the effective half-times of the long-term components of the two equations. For rats the long-term component was clearly a function of avid skeletal retention whereas the long-term component for Chinese hamster retention was a function of combined liver and skeletal retention. The greater contrasts between the two species were noted in organ distribution and retention. The rat initially deposited much lower quantities in the liver and kidney. Elimination from these organs was characterized by half-times of approximately 5 days. In the Chinese hamster, initial deposition in the kidney and liver was greater than in the rat. The hamster kidney deposition was eliminated much like the rat with short effective half-time. However, the liver of the hamster retained the initial burden much longer than did the rat liver. (Auth)

<144>
Mewhinney, J.A., A.L. Brooks, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1972, June

Comparison of the Retention and Distribution of Injected Californium 252 in Rats and Chinese Hamsters. CONF-710919; Part of Thompson, R.C. and Bair, W.J. (Eds.), Proceedings of the 11th Hanford Symposium on the Biological Implications of the Transuranium Elements held at Richland, Washington, September 27-29, 1971. Published in Health Physics, 22(6), 695-700

The retentions of Cf 252 in the rat and Chinese hamster were compared for 64 days following intraperitoneal injection of the citrate complex. Organ distribution was determined by serial sacrifice of groups of 6 animals at 1, 2, 4, 8, 16, 32 and 64 days postinjection for each species. Comparison of the whole-body retention pattern of Cf 252 in the rat and Chinese hamster revealed significant differences. Although whole-body clearance was nearly equal at comparable times postinjection through 64 days, differences were reflected in the number of exponential components needed to adequately describe the data and in the effective half-times of the long-term components of the two equations. For rats, the long-term component was clearly a function of avid skeletal retention whereas the long-term component for Chinese hamster retention was a function of combined liver and skeletal retention. The greater contrasts between the two species were noted in organ distribution and retention. The rat initially deposited much lower quantities in the liver and kidney. Elimination from these organs was characterized by half-times of approximately 5 days. In the Chinese hamster, initial deposition in the kidney and liver was greater than in the rat. The hamster kidney deposition was eliminated much like the rat with a short effective half-time. However, the liver of the hamster retained the initial burden much longer than did the rat liver. (Auth)

<145>
Miller, S.C., and W.S.S. Jee, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1973, March 31

The Effects of Disodium Ethane-1-Hydroxy-1, 1-Diphosphonate (EHDP) and Disodium Dichloromethanediphosphonate (C12MDP) on Bone of the Proximal Tibia of the Growing Rat. COO-119-248; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 274-287), 400 p.

In rats treated for 10 days with EHDP and C12MDP, observations from past studies, such as endochondral growth inhibition, bone formation decreases, mineralization defects, and abnormal metaphyseal modeling were confirmed. The current studies also found the labeling index of osteoprogenitor cells was depressed by higher doses (1.0 and 5.0 mg P/kg/day) of both compounds. The number of osteoblasts was lower for all doses and further evidence of decreased bone formation. Only 2.5 mg P/kg and 5.0 mg P/kg lowered appositional bone formation rates. The number of osteoclasts along with the number of nuclei/osteoclast, was higher at all doses. Understanding of the diphosphonates is important because of the possibility that they may affect the skeletal binding and metabolism of bone-seeking radionuclides such as ^{239}Pu. (HP)

<146>
Moghissi, A.A., and M.W. Carter (Eds.), National Environmental Research Center, Las Vegas, NV.

<146> CONT.
1971

Tritium. CONF-710809; Proceedings of a Symposium held in Las Vegas, Nevada, August 30-September 2, 1971. Messenger Graphics, Publishers, Las Vegas, Nevada, 807 p.

The book is prepared from papers presented at the Tritium Symposium, held on August 28 to September 3, 1971 in the Frontier Hotel, Las Vegas, Nevada. Eighty-four papers are included, thirty-four of which have been abstracted separately for the Data Base. The following topics are covered: historical and current perspectives of tritium, tritium production in reactors and by nuclear weapons, detection and measurement of tritium, chemical and biological effects of tritium, kinetics of tritium in biological systems such as its behavior in fish excretion and in man turnover in mammals, environmental aspects of tritium, such as its behavior in the soil, environmental monitoring techniques and data including tritium releases from nuclear power stations, applications of tritium in biological, medical and hydrological studies and tritium health physics related studies. (PMM)

<147>
Mole, R.H., Medical Research Council, Radiobiological Research Unit, Harwell, England. 1962

Problems of Low-Level Irradiation. 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. 207-232), 529 p.

In this review paper, low-level radiation is defined as a level of radiation which produces a low level of effect rather than a specific dose or dose rate. Non-specific life shortening is not a consequence of radiation exposure, and most of the presentation concerns carcinogenesis. Some human evidence points to the idea that tumor induction by radiation is a multiplication of a natural process rather than an independent and additive phenomenon. The general principles of extracting information from data are the same whatever level of effect is being looked for, but because it is so much more laborious to look for low level effects, there is a strong temptation to lower the standards of experimental planning and of interpretation below the scientifically permissible. The radiobiological aspects of low level radiation and cancer as a rare effect are discussed with respect to different studies, several involving plutonium, radium, strontium 89 and 90, and calcium 45. Extrapolating data from animal experiments to humans is extremely difficult and can be misleading. Forty-one papers are reviewed. (PMM)

<148>
Morgan, T.J., R.P. Laudolt, and J. Hamelink, Purdue University, Bionucleonics Department, West Lafayette, IN. 1971

Behavior of Tritium in Fish Following Chronic Exposure. 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. 378-391), 807 p.

A preliminary evaluation of the uptake and elimination of tritium by fish grown in tritiated water is presented. The tritium contained in the fish tissue was analysed by liquid scintillation spectrometry. For the uptake studies bluegills and channel catfish were exposed to tritiated water concentrations of 40 n Ci/vol at a water temperature of 23 C, pH 7.5 and a methylorange alkalinity of 85 ppm. Fish sizes ranged from 4 to 20 g for catfish and 10 to 65 g for bluegills. For elimination studies catfish were exposed to tritiated water at a concentration of 20 n Ci/ml for 20 days, then transferred to uncontaminated water. The rate of uptake of tritium was rapid and reached maximum values within approximately four hours, channel catfish exhibiting a more rapid rate than bluegills. The maximum concentration of tritium in both species was approximately 75% of that of the media. Channel catfish exhibited a rapid release of tritium with essentially all the tritium being eliminated in 4 hours after removal from tritiated water. The rate of uptake of tritium by the gills and muscle tissue was found to be slightly more rapid than for the gut and kidneys. (RAF)

<149>
Moskalev, Yu.I., Institute of Biophysics, Moscow, USSR. 1973

Some Important Problems of Biological Action of Transuranium Elements. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 187-195), 655 p.

Results obtained on the problems of biological action of Pu 239 and other transuranium elements are presented. Biological action of various compounds of these radionuclides is considered as a function of the dose and route of intake into the body, including inhalation, intravenous and intraperitoneal administration of the isotopes. Much attention is given to the analysis of late effects developing in the body as a result of injury by Pu 239, Am 241 and Np 237, dose-effect curves for bone and lung tumors, estimation of minimum carcinogenic dose levels and doses not affecting the natural life-span. A comparative analysis of the data on the biological effect of Pu 239, Am 241, Cm 244 and Np 237 reveals that they are all highly toxic. The acute (LD 50/30) and subacute (LD 50/120) effective doses for Pu 239 are markedly lower than for Am 241 and Cm 244. The chronically effective doses (LD 50/360) for Pu 239 and Am 241 are the same, but for Cm 242 they are considerably lower. The LD 50/30 values for Np 237 are 20 to 38 times, and the LD 50/350 values 3 to 8 times lower than for Pu 239, Am 241, and Cm 244. A comparison of data on Pu 239 toxicity, as related to the entry pathways, indicates that inhaled Pu 239 is far more toxic than plutonium introduced intraperitoneally. Thus, when comparing the doses causing a minimum reduction of rat life expectancy, Pu 239 in far more toxic than plutonium introduced intraperitoneally. Thus, when comparing the doses causing a minimum reduction of rat life expectancy, Pu 239 (citrate or plutonium-ammonium pentacarbonate) when inhaled (0.00073 uCi/g) proved to be about seven times as toxic as when administered intraperitoneally (0.0050 uCi/g). When comparing the potential hazards of Np 237, Pu 239 and Am 241 arising from

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alpha irradiation by these isotopes, it is revealed that in inducing osteosarcomas and lung cancers Np 237 exhibits the highest efficiency, Pu 239 occupies second place, and Am 241 is the least effective of the three radioelements. (Auth) (FMM)

Table 1 shows LD 50 values following intravenous administration of transuranic elements to rats.

<150>
Moskalev, Yu.I., and V.S. Kalistratova, Not given. 1972

Biological Effects of Radiation from External and Internal Sources. AEC-tr-7457; 515 p.

The book contains investigations by several authors of the biological effects of ionizing radiation from both external and internal sources. Twenty-five papers have been abstracted separately for the data base. Data are presented on the biological effects of fission neutrons, as well as mixed gamma and neutron radiation. The results of these studies show conclusively that the biological effect of irradiation is related to the distribution of absorbed energy in the organism and radiation conditions (instantaneous, brief, long-term). Studies on metabolism and biological effects of the following radionuclides, Gd 153, Np 235, Pu 239, and Am 241 are reported. Also included are data on distribution of radioactive isotopes, on kinetics of metabolism of transuranic (Np 237, Am 241, Cm 242, Pu 239) and rare-earth elements (Gd 153, La 140, Ce 144, Pm 147, Eu 152, Tb 160), the quantitative relation between some parameters of metabolism of radioactive substances and their physicochemical properties, the effects of external irradiation on the behavior of radioisotopes in the animal organism, as well as mathematical methods describing the characteristics of radionuclide metabolism in the organism, data on the role of the geometric factor, and coefficient of nonuniformity of dose distribution in expression of the biological effect. Data are reported on the biological effects of transuranic elements and, specifically, data on the kinetics of metabolism and biological effects following inhalation thereof; some experimental data are given on the functional changes in the respiratory, cardiovascular, and other systems, as well as information about morphological changes in organs at short and long terms of observation, as related to different routes of administration. The long-term effects of exposure to external and internal ionizing radiation, the high carcinogenic activity of incorporated radioisotopes, and the optimum and minimum tumorigenic dose levels for different radioisotopes are discussed. (FMM)

<151>
Moskalev, Yu.I., G.A. Zalikin, I.K. Petrovich, and V.P. Panova, Not given. 1971

Characterisitcs of the Biological Effect of Americium 241. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 434-440), 574 p.

Am 241 in the form of a chloride solution was administered to 450 white rats and 20 common dogs. The rats received single doses from 0.0025 to 0.2 uCi/g with a total of 8 doses. The dogs were administered doses of 0.001 to 0.06 uCi/g with a total of 6 doses. The life time of the animals, morphological composition of sternum bone punctuates, peripheral blood, changes in weight, blood distribution of the isotope in the organs and tissues, and kinetics of its elimination from the animal body was studied. Results were compared with earlier collected data on the Am 241 distribution in rats. With intravenous administration of Am 241 to dogs the isotope was distributed for the most part the same as in the bodies of rats, other than for a somewhat higher content in the skeleton, but it was eliminated considerably more slowly than from the bodies of rats. For all methods of administration, Am 241 was selectively deposited in liver and bone tissue. The acutely toxic doses for dogs (0.01-0.06 uCi/g) were lower than for rats (0.11-0.2 uCi/g). This fact indicates a greater radiosensitivity of dogs than rats. Both rats and dogs exhibited a slowing of weight gain with all doses used. Hematological tests showed that with large doses of Am 241 (0.01-0.06 uCi/g) the dogs developed acute radiation sickness, hemorrhaging, and blood formation aplasia. Radiation damage was more pronounced in dogs than in rats. Marked impairment of bone marrow formation in dogs was demonstrated. After 345 days of observation the rats developed osteosarcomas with doses of 0.025 to 0.0025 uCi/g Am 241. (Auth) (RAP)

The results of experiments for the study of the Am 241 distribution in the body of rats have been published in Radiobiologiya, 8(1), 65, 1968

<152>
Moskalev, Yu.I., G.A. Zalikin, I.K. Petrovich, E.I. Rudnitskaia, and K.A. Veselovskaia, Institute of Biophysics, Moscow, USSR. 1972

Radioresistance and Radiosensitivity of Animals to Exposure to Transuranium Elements. UCRL-Trans-1462; 3 p.; Translated from Radiatsiia i Organizm. Sbornik Material ov Konferentsil. Obinsk, 1, 76-78, 1967

Dogs, rats, and rabbits have been used in studying the biological action and toxicology of Am 241 and Np 237. The LD 50 and the longevity of animals, species sensitivity, and causes of death of the animals were studied, along with changes in peripheral blood and spinal cord punctures, isotope distribution investigated by historadiography, pathomorphological changes in organs and tissues, and the functional status of the cardiovascular system. Upon intravenous administration to rats of a hydrochloride solution of Am 241, 57% accumulated in the liver and up to 30% in the skeleton. The distribution of Am 241 in the organs of dogs did not differ from its distribution in rats. Americium 241 clearance from the liver of dogs was slower than in rats; by the eighth day rat liver contained 33.3% of the amount administered, as compared to 32% in dogs. After 32 days, 4.2% was found in rat liver and 33% in dog liver. When Am 241 was given intratracheally, it was slowly sorbed from the lungs with an effective period of 66 days. The sorption of Am 241 from the gastrointestinal tract does not exceed 0.03%, and when the citrate complex was administered--not more than 0.1%. The LD 50 values for rats when the hydrochloride solution of Am 241 was given intravenously were as follows: LD 50/15--0.14 uCi/g; LD 50/30--0.11 uCi/g; LD 50/60--0.06 uCi/g; and LD 50/120--0.043 uCi/g. In dogs, pronounced signs of hemorrhagic diathesis were striking, and aplasia of the hematopoietic organs was found. Autohistoradiography showed that the

<152> CONT.
substance in organs and tissues during these periods is in the finely disperse state and is distributed uniformly except for the kidneys where a large amount is found in the cortical layer. A rise in neutrophil and lymphocyte counts of 30 to 60% or more was noted after Am 241 doses that caused death in 7 to 14 days. By day 5 to 7, the nuclear element count in the spinal tap as well as the leukocyte count in the peripheral blood was reduced by 80 to 90%. Beginning from day 3, a trend toward bradycardia and hypotonia was noted in animals receiving Am 241 in the amount of 10 millicuries/kg and 2.5 millicuries/kg. The thermoregulatory mechanism and respiratory systems were not changed during the month of the investigation. At different times after exposure to Am 241, a low leukemogenic and carcinogenic effect was noted (isolated osteosarcomas with metastasizing in the lungs and the bones of other regions of the body and tumors in the mammary glands, induced against a background of fibro-osteal mastopathy, which indicates dyshormonal status). Noteworthy was the presence of significant species differences in animal sensitivity to Am 241: dogs > rabbits > rats. Doses causing 50% fatality in animals during the first months after Am 241 administration are in the ratio 1:3:15 (LD 50/30 was adopted as the unit in the case of dogs). The high chemical activity of the Np 237 is most important in rats given the isotope intravenously as a nitrate solution. LD 50 was 0.003 uCi/g; however, this amount of isotope causes death of animals during day 3 to 4, while a reduction in the dose causes death 6 months after administration. The distribution of Np 237 when given intravenously as a pH 3 nitrate solution proceeds with the predominant accumulation in the skeleton up to 35%, up to 6% in the kidneys, and up to 9% in the liver (of the amount of isotope administered). Adipose dystrophy of the liver and lesions of the epithelium of the convoluted tubules were found soon after isotope administration. Changes in the liver were similar to changes during acute jaundicial dystrophy. Lesions of the liver and the hemopoietic organs were noted, which can be explained by the redistribution of the isotope, its deposition in bone tissue, and, therefore, constant irradiation of the spinal cord. (HP)

<153>
Muggenburg, B.A., J.J. Miglio, J.A. Mewhinney, D.O. Slauson, and R.O. McClellan, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

Bronchopulmonary Lavage and DTPA Treatment for the Removal of Inhaled Plutonium 239 Aerosols of Varied Solubility in Beagle Dogs. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 255-260), 342 p.

This work was initiated to determine the efficacy of bronchopulmonary lavage and chelation therapy for removing Pu 239 following inhalation of Pu 239 aerosols of differing in vivo solubility character in Beagle dogs. The four aerosols used were nebulized from a solution of Pu239 Cl4 and heat treated at temperatures of 325, 600, 900 and 1150 C. Six beagle dogs were exposed to each of the four aerosols and subsequently 3 dogs in each group were treated by lavage and intravenous DTPA and 3 dogs served as controls. The treated animals received 10 unilateral bronchopulmonary lavages during the period 2-49 days post-exposure and 18 intravenous injections of the chelating agent diethylenetriaminepentacetic acid (DTPA) over the experimental period of 56 days. Complete results are available for tissue distribution of Pu 239 on all dogs in the study and complete excreta results are available for one treated and one control dog exposed to aerosols treated at 325 and 1150 C. Bronchopulmonary lavage removed 37 and 54% of the initial lung burden of Pu 239 for the 325 and 1150 C treated aerosols, respectively. Urinary excretion of Pu 239 was increased by DTPA therapy at both aerosol treatment temperatures. Deposition of Pu 239 in liver and bone following solubilization in the lung was signficantly depressed by DTPA therapy in the dog exposed to the 325 C aerosol; at an aerosol treatment of 1150 C only minute quantities of Pu 239 were solubilized in the lung and hence the effect of DTPA therapy on deposition in liver and bone was difficult to assess. (Auth)

<154>
Mushkacheva, G.S., Ministry of Health, Institute of Biophysics, Moscow, USSR. 1972

Activity of Nucleases in Rabbit Lungs after Inhalation of Plutonium. Voprosy Meditsinskoi Khimii, 17(3), 301-305 CORPAUTH> Institute of Biophysics, Moscow, USSR

Activities of acid DNase and both acid and alkaline RNases after a single plutonium inhalation (1.5 uCi) into rabbit lung were studied within 4 months. An increase (up to 139%) in the acid DNase activity per 1 g of the fresh tissue during the first two weeks after inhalation was noted. An increase in the total activity of acid DNase took place within the period of investigation, the maximal increase (185% of the control) being within the first month after inhalation. The total activity of acid RNase was increased (106-173%) within the period of investigation. The activity of alkaline RNase was increased (183%) only within a month after inhalation. The problem of the importance of nucleases activation under irradiation-induced damages and during postirradiation recovery is discussed. (Auth)

<155>
Nabors, C.J., Jr., University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Biochemical Changes Produced by Low Dose of Radiation. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 358-364), 380 p.

Long term studies on low dose level nuclide-bearing animals are reported. Beagles bearing Pu 239 burdens show the most marked alterations in serum alkaline phosphatase and serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminases. Low dose level animals appear to have a much longer latent period prior to the appearance of altered serum biochemistry than do animals with higher dose levels. (Auth)

<156>
Neely, W.C., R.C. Smith, R.M. Cody, J.R. McDuffie, J.A. Lansden, and S.P. Ellis, Water Resources Research Institute, Auburn University, School of Arts and Sciences, Department of

<156>

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<156> CONT.
Chemistry, Auburn, AL; Water Resources Research Institute, Auburn University, School of Agriculture and Agricultural Experiment Station, Department of Animal and Dairy Sciences, Auburn, AL; Water Resources Research Institute, Auburn University, School of Agriculture and Agricultural Experiment Station, Department of Botany and Microbiology, Auburn, AL. 1973, February

Biological and Photobiological Action of Pollutants on Aquatic Microorganisms. WRRI-BULL-9; 121 p.

The various aspects of the biological and photobiological action of pollutants on aquatic microorganisms have been explored in a series of studies covering a wide range of chemical species and two classes of aquatic microorganisms, paramecia and bacteria. It has been shown that certain metal ions, insecticides, polycyclic amines and mycotoxins are capable of drastic alteration of the life processes in test strains of either bacteria or paramecia or both. In some cases concurrent exposure to light and the pollutants was necessary and in others the toxic and/or mutagenic reactions were independent of light exposure. In particular the uranyl ion, beta naphthyl amine, and alfatoxin B sub 1 were found to be phototoxic while the insecticide, phygon, was found to be strongly dark-toxic. All agents affected PARAMECIUM CAUDATUM and all but aflatoxin B sub 1 affected ESCHERICHIA COLI. In addition, the uranyl ion caused morphological mutations in E. COLI. The public health hazard connected with such alterations in life cycles resulting from water-borne pollutants is difficult to assess from laboratory data, but the possibility should be further investigated. (Auth)

<157>
Nenot, J.C., Commissariat a l'Energie Atomique, Departement de la Protection Sanitaire, Fontenay-aux-Roses, France. 1970

Study of the Effect of Irradiation on Lung Clearance. CONF-700931; Part of Walton, W.H. (Ed.), Proceedings of the 3rd International Symposium on Inhaled Particles held in London, England, September 14-23, 1970, Vol. 1. Unwin Brothers Limited, The Gresham Press, Old Woking, Surrey, England, (p. 239-246), 1090 p.

The influence of radiation exposure on lung clearance in rats was studied from a functional point of view. Exposure was delivered in two ways: either external exposure at L.D. 50 or internal exposure with Pu 239 aerosols at different concentrations. Three levels of alveolar contamination in alpha emitters were studied: 1, 0.1 and 0.007 uCi/g of lung. Lung clearance was then tested 10 days after exposure, with Fe 59 oxide insoluble particles administered to the animals by inhalation. External exposure did not modify either retention or clearance rate, whereas internal exposure to alpha particles largely modified clearance kinetics. This study will be carried on with an investigation of cellular mechanisms. (Auth)

<158>
Nenot, J.C., M. Morin, J. Lafuma, and H.G. Parker (Translator), Commissariat a l'Energie Atomique, Department de la Protection Sanitaire, Fontenay-aux-Roses, France. 1972, June

Experimental Study of Decontamination of the Skeleton After Inhalation of Americium Nitrate. UCRL-Trans-1477; 11 p.; Translated from Health Physics, 21, 395-400, 1971

Sprague-Dawley rats were injected intramuscularly twice a week with DTPA at a dose of 50 mg/kg body weight 20 days after inhaling Am 241 nitrate. For the first 20 days, 20% of the Am 241 activity translocated from the lungs to bones. At the termination of the experiment, 4 months after inhalation, the DTPA-treated rats had a bone burden reduced by a factor of 1/3. For the first 20 days posttreatment, the urinary elimination by the treated animals was from both lungs and bone, but later the elimination was exclusively from bone. From the 1st to the 104th day of treatment, the decrease in osseous activity is 4.1%, in pulmonary activity is 5.8%, and the increase in urinary activity is 10.7%. (HP)

<159>
Newcombe, H.B., Atomic Energy of Canada Limited, Biology and Health Division, Chalk River, Ontario, Canada. 1973, August

Benefit and Harm from Exposure of Vertebrate Sperm to Low Doses of Ionizing Radiation. Health Physics, 25, 105-107

Exposures of trout sperm to 25 and 50 rad of ionizing radiation are shown to have both harmful and beneficial effects. Although more of the embryos from the irradiated sperm are malformed, embryo production and embryo survival are both enhanced by the treatment. With higher doses to the sperm, however, the effects are consistently harmful. Although induced genetic changes are presumed to be involved in the production of the observed differences in embryo mortality, the dose-response curve is unique in that it is not only non-linear but actually changes direction at its low-dose end. The results have a bearing on the estimation of genetic risks to man. A need for caution is indicated in attempts to equate small radiation exposures of human germ cells with apparent increases in fetal and infant mortality. (Auth)

<160>
Nifatov, A.P., L.A. Buldakov, and L.G. Filippova, Not given. 1971

Comparative Toxicity of Americium 241 Nitrate and Citrate. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 425-433), 574 p.

Rats of the Wistar line were injected intraperitoneally with the nitrate or citrate form of Am 241 in a single dose to study the relative toxicity of these two compounds and to evaluate the relative biological effectiveness (RBE) of Am 241 relative to Pu 239. Doses ranged from 139 to 418 uCi/kg (nitrate) and 2.56 to 275 uCi/kg (citrate). Following administration of the isotope a systematic study of the peripheral blood, change in weight, time of onset of death, and morphological changes in the principal organs of deposition as shown by histoautoradiograms were made. Damage symptoms appearing during the first seven days were similar to the clinical picture of other radioactive substances and were dose dependent. Earliest changes were detected in the peripheral blood and were manifested by a leukopenia and lymphopenia. Using a leukopenic criterion the RBE of americium relative to Pu 239 was 0.15 to 0.25. The RBE increased with

<160> CONT.
decreasing dose. Comparable quantities of citrate and nitrate produced identical damage to the blood system. Only acute doses of americium nitrate were more toxic than the citrate in shortening the mean lifetime of the rats. A dose rate of 0.26 rad/day could be regarded as safe using the criterion of shortening of lifespan. Bone morphological changes were similar to those observed following Pu 239 injection. Liver damage was greater in rats that received the isotope in the nitrate form and was caused by dissimilar radiation doses. It was concluded that morphological changes in rats damaged by Am 241 are similar to the changes caused by the administration of a plutonium citrate complex in lesser quantities. Degenerative processes leading to death at different dose rates are discussed. (ST)

<161>
Nifatov, A.P., and L.A. Buldakov, Not given. 1971

Microdistribution of Plutonium 239 in the Bone Tissue of Rats During Chronic Peroral Administration of the Isotope. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 399-405), 574 p.

The microdistribution of plutonium 239 in the hip bones of Wister rats dying from 32 to 663 days after chronic peroral administration of the isotope was studied using the technique of histoautoradiography. The rats were given a 1% citrate solution six times a week; activities ranged from 0.01 to 10 uCi. During all observation periods up to the 600th day there was a nonuniformity of isotope distribution with greatest concentration in the endosteum and periosteum, primarily of the epimetaphyseal part of the hip. The maximum number of osteosarcomas (7.4%) was found in rats receiving 0.5 uCi daily. Repeated irradiation of the cambrial elements in bone were responsible for the development of malignant growth. (ST)

<162>
Not given, U.S. Atomic Energy Commission, Technical Information Center, Oak Ridge, TN. 1967

Radiobiology. AEC-tr-6889; 253 p.

The scope of the 25 articles in this volume is wide, covering the effects of radiation and administered radionuclides in plants, animals, microorganisms, and cell cultures in a variety of laboratory situations. A large percent of the articles covered the effects of external radiation (primarily x) on plants seeds, seedlings, and compounds; high molecular weight molecules including glucose polymers, DNA, and enzymes; cultured cells in various media; body cells and organ systems; and electroretinograms. The remainder of the articles covered the behavior, metabolism, physiology, transport, distribution, absorption, and effects of radionuclides including Pu 239, Sr 90, Cs 137, tritium, Po 210, and Ce 144 in various laboratory animals. In addition the modifying effects of media nutrients and ion content, radiprotective substances, and various doses on recovery were studied. One article concerned the construction of a mathematical model for calculating effective dose. Two articles on Pu 239 behavior and absorption were selected and abstracted separately for the data base. (ST)

<163>
Not given, University of Chicago, Chicago, IL. 1945

Health Problems Relating to Product, Month of March, 1945. CN-2786; 35 p.

Progress is reported on studies concerning the metabolism, toxicity, and excretion of plutonium following administration by various routes, of several valence states, and of different compounds to the rat and dog. In one study clinical observations, including onset of radiation sickness, excretion, blood levels, protein binding, hematology, and blood chemistry, are reported in the dog. Building, equipment, and personnel alpha exposure surveys are reported and methods of plutonium detection in urine and feces are discussed. All five sections of the report: clinical medicine and medical research, biological research, medical and industrial hazards, effect of product upon dogs, and the technical progress report on metabolic studies were abstracted separately for the data base. (ST)

<164>
Not given, Brookhaven National Laboratory, Upton, Long Island, NY. 1971, January

Cell Culture Studies. Californium 252 Progress, 6, 1-52

At Brookhaven National Laboratory, the continuing evaluation of Cf 252 in radiation therapy has included cell culture studies on Chinese hamster cells to determine the dose rate effect, the relative biological effectiveness (RBE), and the oxygen enhancement ratio (OER) of Cf 252. The progress of these studies is reported in several issues of the journal. Cell survival curves were obtained with Chinese hamster cells at Cf 252 dose rates of 18.6 and 13.5 rads per hour to observe the effects of a faster cell doubling time (approximately 10 hours for hamster cells vs approximately 20 hours for HeLa cells). Survival curves for the hamster cells were also obtained with cesium 137 at 37.3 rads per hour. The Do's, (that is, the absorbed dose required to reduce survival by a factor of 1/e or the mean lethal dose.) for Cf 252 dose rates of 18.6 and 13.5 rads per hour were 160 and 210 rads, respectively. When compared to the Do of 500 rads for cesium 137 at 37.3 rads per hour, RBE's of 3.13 and 2.38 were obtained. A survival curve was also obtained for cesium 137 at 16 rads per hour. Cell recovery and proliferation almost nullify the effects of irradiation at this dose rate. (JNM)

<165>
O'Brien, R.D., and L.S. Wolfe, Cornell University, Department of Entomology, Ithaca, NY; Montreal Neurological Institute, Department of Neurochemistry, Montreal, Quebec, Canada. 1964

Radiation, Radioactivity, and Insects. Academic Press, New York, New York; 211 p.

This monograph, one of a series, was written to direct attention to biologists' increasing utilization of radiation and radioisotopes.The book is intended for the entomologist and biologist and for those knowledgable in work with irradiation and radioisotopes. Chapter 1 was written as an

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<165> CONT.
introduction to the structural, functional, and behavioral features of insects. Succeeding chapters show how research with radiation and radioisotopes has advanced understanding of insects and for what kinds of problems the insect is a suitable organism. An appendix gives a brief introduction to concepts, techniques, and units of measure. Genetic effects of radiation upon insects are not discussed. The book is intended to give a comprehensive account of academic and utilitarian radiation work that has been applied to insects and also of the diverse uses of radioisotopes in entomology, for labelling and control of insects and for elucidation of biochemical, physiological, and toxicological mechanisms. (ST)

<166>
Palmer, R.F., and B.O. Stuart, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Comparative Effects in Hamsters, Rats, and Mice of Exposure to Simulated Uranium Mine Atmospheres. BNWL-1750 (Part 1); Part of Thompson, P.C. (Ed.), Annual Report for 1972, (p. 50), 103 p.

Progress is reported on studies involving 90 hr/wk exposures of SPF rats, hamsters, and mice to atmospheres containing Rn daughter levels ranging from 3000 to 6000 WL with or without 18 mg/m3 U ore dust. The purpose of the experiments is to provide interspecies comparison of the effects of these uranium mine inhalation hazards. The three species are exposed simultaneously in the same chambers. Animals are sacrificed when moribund and tissues are retained for histopathologic examination. Mortality is nearly complete and histopathology on sacrificed animals is in progress. (ST)

<167>
Park, J.F., W.J. Bair, and E.B. Howard, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Acute Toxicity of Inhaled Plutonium 239 Nitrate in Beagles. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 3.22-3.26), 253 p.

Beagle dogs died of pulmonary insufficiency 3-10 months after inhalation of Pu 239(NO3)4. Body burden at death ranged from 5-65 uCi, of which approximately half was present in the lungs. The lung lesions were similar to those seen in dogs dying within a year after inhalation of Pu 239 PuO2 and the lethal dose on a uCi/g of lung at death basis was also similar. About 50% of the plutonium was translocated to the liver and skeleton causing lesions in trabecular bone and a leucopenic response. Inhaled Pu 239(NO2)4 is considerably more toxic on a uCi/kg basis than intravenously injected plutonium. (Auth) (FMM)

<168>
Park, J.F., W.J. Bair, W.J. Clarke, and E.B. Howard, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Chronic Effects of Inhaled Plutonium Dioxide in Dogs. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 57-61), 207 p.

The present status of experiments involvi ng forty beagle dogs given a single 10-30 minute exposure to Pu 239 PuO2 aerosols 4-7 years ago for study of long-term translocation and biological effects is summarized. Twenty dogs have died or were sacrificed when death was imminent 29-79 months post exposure. The plutonium burden at death ranged from 0.3-3 uCi with 23-75% of this Pu in the lungs, 16-44% in the tracheobronchial lymph nodes, 1-32% in the mediastinal lymph nodes, 2-26% in the liver, and 1-7% in the bone. The calculated radiation dose to the lungs ranged up to 13,600 rad. Respiratory insufficiency and lymphopenia were the primary clinical signs associated with severe fibrosis of the tracheobronchial and mediastinal lymph nodes. Twelve of the dogs showed primary pulmonary neoplasia. One dog had a lymphangiosarcoma in a mediastinal lymph node and two dogs showed neoplastic changes in the vasculature of the lung. (Auth) (ST)

<169>
Park, J.F., W.J. Bani, and W.J. Clarke, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1966, January

Chronic Effects of Inhaled Plutonium Dioxide in Dogs. BNWL-280; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1965, (p. 45-47), 139 p.

Forty beagle dogs, given single 10 to 30 min exposure to Pu 239 PuO2 aerosols 3 to 6 years ago, are being held for study of long-term translocation of Pu 239 and for observation of biological effects. Of the 40 dogs exposed, 13 died after 29 to 66 months. The body burden at death ranged from 0.5 to 3 uCi with 40 to 75% of the body burden in the lungs, 20 to 50% in the bronchial and mediastinal lymph nodes, 2 to 21% in liver, and 1 to 7% in skeleton. Cause of death was pulmonary insufficiency resulting from the severe pulmonary fibrosis. Seven animals showed bronchiolo-alveolar carcinomas. (Auth) (FMM)

<170>
Park, J.F., W.J. Clarke, and W.J. Bair, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Chronic Effects of Inhaled Plutonium 239 PuO2 in Beagles. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 3.3-3.4), 253 p.

A long-term study of the biological effects of inhaled Pu 239 PuO2 in dogs is in its ninth year, and the results of this study have been reported annually. Of 40 dogs exposed, 20 have died or were sacrificed when death was imminent, while five were sacrificed to obtain tissue distribution data. Twelve of the 20 dogs have had primary pulmonary tumors. Several of the 14 surviving dogs show radiographic evidence of lung tumors. Most show lymphopenia, which has been a consistent finding in the study. All of the mortality and tumor data obtained tc date from several experiments with dogs which inhaled Pu 239 PuO2 are summarized. Data thus far available indicate that a level of Pu 239 which would not cause life shortening in dogs is that amount which would result in a lung burden of less than about 2 nCi/g lung 15 years after exposure.

<170> CONT.
(Auth) (FMM)

significant differences between the experimental and control fish with respect to all of the characteristics investigated. (ST)

<171>
Park, J.F., and W.J. Clarke, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1963, January 15

Chronic Toxicity of Inhaled Plutonium in Dogs. HW-76000; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1962, (p. 118-125), 269 p.

Beagle dogs were given a single exposure to Pu 239 oxide aerosols. Two dogs died 855 and 933 days after deposition of 6 uCi in the lung. Average radiation dose to the lung tissue was 12,000 rads. Dyspnea and lymphopenia were the primary symptoms prior to death. Gross and microscopic histopathological changes occurred in the lungs and associated lymph nodes which contained 80 to 95% of the Pu content of the dogs. Autoradiographs indicated radioactivity associated with histopathological changes. Increased respiration rates and lymphopenia are the primary clinical symptoms in dogs that are alive three years post-exposure. (Auth)

<172>
Patin, S.A., V.L. Pechkurenkov, and I.A. Shekhanova, All-Union Research Institute of Sea Fisheries and Oceanography, Moscow, USSR. 1971

Kinetics and Mechanism of Accumulation of Plutonium by MISGURNUS FOSSILIS Spawn. AEC-tr-7306; Part of RDIOBIOLOGY| (p. 153-159); Radiobiologiya, 11(5), 742-746

A series of experiments was performed to study the accumulation of plutonium 239 by live and dead MISGURNUS FOSSILIS spawn. The intensity of accumulation was found to be related to the phase of embryogenesis because of change in the membranes of the spawn. The bulk of the plutonium was adsorbed on the membrane of live spawn. In dead spawn, the adsorption of plutonium was virtually irreversible. Physicochemical and chemical forms of Pu in solution affected its uptake by developing spawn. (Auth) (RAF)

<173>
Pechkurenkov, V.L., I.A. Shekhanova, and I.G Telysheva, All-Union Research Institute of Sea Fisheries and Oceanography, Moscow, USSR; Atlantic Research Institute for Sea Fisheries and Oceanography, Kaliningrad, USSR. 1972

The Effect of Chronic Small Dose Irradiation on the Embryonic Development of Fishes and the Validity of Various Assessment Methods. Journal of Ichthyology, 1, 71-79

A study was made of the effect of four radionuclides, Sr 90-Y 90, Pu 239, and Cs 137, on the embryonic development of loach, salmon, and pike fish and an assessment was made of the use of various tests for comparison of experimental and control variants. Eggs of the loach, obtained following pituitary injection, were incubated in Pu 239 solutions with activities of n x 10(E-11), n x 10(E-10), and n x 10(E-8) Ci/l. Parameters studied were egg mortality and larval deformaties. The coefficients of reproduceability of the characteristics investigated varied widely. Comparison of the experimental and control data by means of a nonparametric test of comparison showed that in most instances there were no

<174>
Popplewell, D.S., Atomic Weapons Research Establishment, Berkshire, England. 1973, October

Plutonium Uptake by Cell Cultures in Presence of Some Chelating Agents. Health Physics, 25, 413-420

A study has been made of the uptake of plutonium and radioiron into HeLa-S3 and Chang liver cells. The influence of various chelating agents on this uptake has been examined, the object being to set up a method of assessment of the value of potential therapeutic agents for the removal of accidentally ingested plutonium from humans. Although it has been shown that chelating agents which alter the distribution of ingested plutonium in animals are capable of influencing the rate of uptake of plutonium into cultured cells, there are variations in results between different cell species. This means that the cell culture evaluation method for chelating agents can only be used to supplement rather than replace animal experiments. (Auth)

<175>
Price, K.R., Battelle Memorial Institute, Pacific Northwest Laboratories, Ecosystems Department, Richland, WA. 1973, May

Tumbleweed and Cheatgrass Uptake of Transuranium Elements Applied to Soil as Organic Acid Complexes. BNWL-1755; 9 p.

Plant uptake of radioactive waste materials is a biological interaction important to the environmental management of waste storage sites. This study on the uptake of transuranium elements from soil by plants demonstrates that shoot uptake is clearly influenced by the chemical form of the transuranic. It is unclear at this time whether soil and/or plant mechanisms are responsible. Future studies are planned to investigate these aspects. The observation that some organic acids suppress plant uptake of americium and curium will be investigated further to evaluate the use of soil additives to suppress plant uptake of transuranics. Test results indicate that organic acid complexes of plutonium such as oxalate or citrate can increase plant uptake when added to soil as compared to uptake from dilute nitric acid solutions. (Auth)

<176>
Prosser, C.L., University of Chicago, Metallurgical Laboratory, Chicago, IL. 1947, September

The Clinical Sequence of Physiological Effects of Ionizing Radiation in Animals. Presented at the 32nd Annual Symposium of the Radiological Society of North America held in Chicago, Illinois, December 1-6, 1946, (14 p.); Radiology, 49, 299-313

Different types of ionizing radiation were administered at different dose rates to various animals to study the clinical sequence of physiological effects of ionizing radiation. Results were summarized and showed that external and internal radiation from deposited material were similar in their clinical action; nearly every organ system was affected by lethal doses of every type of

<176>

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<176> CONT.
radiation; no single clinical reaction was peculiarly specific for irradiation damage; and the clinical picture and the conditions resulting in death varied with the dose rate and the duration of exposure for both external and internal radiation. A series of clinical patterns leading to death after irradiation were identified: immediate death at very high doses and high dose rates with general cellular destruction; initial shock-like death within 48 hr after x irradiation in some animals; early deaths at high doses in dogs and rats; acute deaths with all types of radiation, except beta, within nine to 21 days after treatment; subacute pathological changes, primarily anemias, liver degeneration, and bone lesions; chronic irradiation deaths from tumors and premature aging. (ST)

<177>
Ragan, H.A., B.J. McClanahan, and P.L. Hackett, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Einsteinium Toxicity and Metabolism in Miniature Swine. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 13-15), 103 p.

Weanling miniature swine were injected intravenously with 3 uCi/kg of Es 253 citrate to study the toxicity and metabolism of this element in swine. At 24 hr postinjection the liver contained the largest amount (15%) of the injected dose. The femur contained 3.4%. About 6% was excreted in 7 days. Granulocytes and platelets were initially depressed but returned to control levels within 4 months postinjection. Total lactic dehydrogenase (LDH) values showed an immediate decrease but had recovered within 42 days, although LDH isoenzyme patterns differed from those of controls at 235 days. (Auth) (ST)

<178>
Rahman, Y.E., and A. Lindenbaum, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1964

Lysosome Particles and Subcellular Distributions of Polymeric Tetravalent Plutonium 239. Radiation Research, 21(4), 575-583

Tissue fractionation studies were made of livers of rats 1 day, 8 days, and 28 days after they received a single intravenous injection of 0.5 uCi of polymeric plutonium, Pu 239(+4). The subcellular distribution of the Pu was found to be nearly identical with the distribution of the acid phosphatase, indicating concentration of Pu in the lysosomal fraction. Based on the release of acid phosphatase from liver lysosomes, no difference in sensitivity to a nonionic detergent, Igepal-630, was found between the membranes of lysosomes of rats receiving plutonium and of uninjected controls for at least 14 days after plutonium injection. (Auth)

<179>
Rahman, Y.E., M.W. Rosenthal, and E.A. Cerny, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1973, April 20; 1972, December

Intracellular Plutonium: Removal by Liposome-Encapsulated Chelating Agent. ANL-7970; Part of Annual Report, 1972, (p. 125-126), 246 p.; CIENCE| 180(4083), 300-302

Chelating agents, such as ethylenediaminetetraacetic acid (EDTA) and diethylenetriaminepentaacetic acid (DTPA) were successfully encapsulated within lipid spherules (that is, liposomes). Encapsulated (C 14) EDTA, given intravenously to mice, was retained longer in tissues than nonencapsulated (C 14) EDTA. Encapsulated DTPA, given to mice 3 days after plutonium injection, removed an additional fraction of plutonium in the liver, presumably intracellular, not available to nonencapsulated DTPA. It also further increased urinary excretion of plutonium. Introduction of chelating agents into cells by liposomal encapsulation is a promising new approach to the treatment of metal poisoning. (Auth)

<180>
Rehfeld, C.E., University of Utah, Radiobiology Laboratory, Salt Lake City, UT. 1959, March 31

Toxicological Aspects of Ionizing Radiation Due to Bone-Seeking Radioisotopes. COO-218; Part of Stover, C.N., Jr. (Ed.), Annual Progress Report, (p. 213), 229 p.

Studies are being made of the effects on beagle dogs of intravenous administration of 5 bone-seeking radionuclides, the beta emitter Sr 90 and alpha emitters Ra 226, Ra 228, Th 228, and Pu 239. When these radionuclides are incorporated into the body structure they introduce extra energy which the body is unable to dissipate harmlessly. The toxic effect of this ionizing radiation is to break chemical bonds, create highly reactive substances such as HO2 and H2O2 and to inactivate enzymes. Toxicity is expressed in this study by formation of bone tumors, destruction of bone resulting in spontaneous fractures, aplastic anemia, lesions of the eye, renal changes, liver pathology, and premature loss of teeth. Each isotope produces its individual pattern. (BBM)

<181>
Rehfeld, C.E., B.J. Stover, G.N. Taylor, and C.W. Mays, University of Utah, College of Medicine, Division of Radiobiology, Department of Anatomy, Salt Lake City, UT. 1962

Fracture Incidence In Beagles Receiving Single Injections of Radium or Plutonium. 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, Oxford, England, (p. 131-143), 529 p.

Pure bred beagles were given either Ra 226 or Pu 239 by intravenous injection. A complete radiographic record was made of the skeleton at sufficiently frequent intervals so that any gross bone changes could be tabulated chronologically. The results show that the fracture rate is highest in the highest dose levels. There is a good correlation for fracture incidence and the dose rate when dogs were injected with Ra 226 but such correlation is less obvious with Pu 239. Rib fractures were more numerous in the dogs given Ra 226 and rate of repair was much greater than with Pu 239. Only Ra 226 treated dogs had long bone fractures and only Pu 239 treated dogs had pelvic fractures. Approximately equal numbers of both groups had fractures of irregular bones but the average number per dog was greater for Pu

<181> CONT.
treated animals. (Auth) (PHM)

<182>
Rosenthal, M.W., Argonne National Laboratory, Argonne, IL. 1971

Quantitative Comparison of Monomeric and Polymeric Plutonium in Rabbit Marrow and Bone. Radiation Research, 47(1), 330

Tibia of young adult female Dutch Belted rabbits were used to compare the uptake of two different physical-chemical forms of plutonium in marrow and bone separately. The animals were killed three days after a single intravenous injection of approximately 0.33 uCi/kg of monomeric Pu 239 citrate (90% ultrafilterable) or of graded mid-range polymeric Pu 239 nitrate (15% ultrafilterable). The marrow was pushed out of the tibias after making a cross cut 1 cm from each end of the bone. The marrow deposition of plutonium was significantly higher after injection of the polymeric form. The marrow contained 40% of the total tibial radioactivity after polymeric injection as compared to 3% following monomeric injection. The average concentration of the polymeric form was 0.254% as compared to 0.015% for the monomeric form of the injected dose per gram wet weight. Marrow concentration of both forms was variable and was correlated with the spatial distribution of the red (erythropoietic) marrow. Polymeric plutonium was up to 30 times more concentrated in predominently red than in fatty marrow. Monomeric plutonium was 1.3 to 2.8 times more concentrated in red marrow. This preferential deposition of plutonium, especially the polymeric form, in the hematopoietic marrow increases the probability of plutonium-induced leukemia and anemia. (Auth) (ST)

<183>
Rosenthal, M.W., and A. Lindenbaum, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1969

Osteosarcomas As Related to Tissue Distribution of Monomeric and Polymeric Plutonium in Mice. CONF-670938; Part of Mays, C.W., et al (Eds.), Proceedings of a Symposium on Delayed Effects of Bone-Seeking Radionuclides held in Sun Valley, Idaho, September 12-14, 1967. University of Utah Press, Salt Lake City, Utah, (p. 371-386), 519 p.

The long-term effects of intravenously injected polymeric plutonium (about 66% ultrafilterable) and of monomeric plutonium (93% ultrafilterable) were compared in adult CF#1 female mice, 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 resulted from DTPA therapy. Interpolation 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 with polymeric plutonium, began dying earlier with osteosarcomas and had about twice as high an incidence of osteosarcomas (twice as many mice with tumors and more tumors per mouse). The higher concentration of monomeric plutonium on bone surfaces is considered primarily responsible for these differences. Other possible factors are also discussed. (Auth)

Table 2 shows retention of polymeric or monomeric Pu in bone and liver of mice after intravenous injection, with and without DTPA therapy.

<184>
Rosenthal, M.W., A. Lindenbaum, J.J. Russell, E. Moretti, and D. Chladek, Argonne National Laboratory, Division of Biological and Medical Research, Argonne, IL. 1972, August

Metabolism of Monomeric and Polymeric Plutonium in the Rabbit: Comparison with the Mouse. Health Physics, 23, 231-238

Young adult female Dutch Belted rabbits were given a single intravenous injection of polymeric Pu 239 nitrate (15% ultrafilterable) or of monomeric Pu 239 citrate (90% ultrafilterable) and killed at 3 days. The plutonium content of the intact femur (bone plus marrow) was higher after the polymeric form. Physical removal of marrow from bone in the tibia showed the plutonium content of the bone to be slightly lower and of the marrow to be 17-fold higher after polymeric than after monomeric plutonium. Polymeric plutonium was also more concentrated in spleen, ovaries, intestines (with contents), skeletal muscle and urine but less concentrated in liver. About the same levels of the two forms of plutonium were found in blood, bile and lung. For the first 30 min after injection, the polymeric plutonium was cleared from the circulation more rapidly than the monomeric. After about 60 min, the two forms were cleared at generally comparable, decreasing rates. Polymeric plutonium was as much as 10-30 times more concentrated in predominantly red (erythropoietic) marrow than in fatty marrow. Monomeric plutonium was 1.3-2.8 times more concentrated in the red marrow. Mice injected with the same plutonium solutions as the rabbits showed, in comparison, a higher per cent of the injected monomeric plutonium in the femurs and a lower per cent in the liver; they showed a higher uptake of polymeric plutonium in the marrow, and a higher uptake of both forms in the spleen and lungs than did the rabbits. (Auth)

Table 1 and 3 give the distribution of polymeric and monomeric Pu 239 in rabbit and mouse tissues three days after intravenous injection.

<185>
Rosenthal, M.W., J.F. Markley, and A. Lindenbaum, Argonne National Laboratory, Argonne, IL. 1963, October

Progress Report: Plutonium Removal. 4. Tumor Incidence Studies. ANL-6790; Part of Biological and Medical Research Division Semiannual Report, July through December 1962, (p. 87-91), 236 p.

Preceeding studies in the series have determined survival and bone tumor incidence in mice following the injection of a polymeric form of plutonium. These were correlated with the degree of removal of skeletally deposited plutonium by therapy with DTPA. In this parallel experiment, the monomeric form of plutonium was administered to compare tumor incidence following the two forms of plutonium, with and without DTPA therapy, and also to determine the effect of immediate therapy. Female mice received 2.7 uCi of Pu 238/kg. 500 mg/kg of DTPA or a saline control was given either 1 hour or 3 days afterwards and once per day for 12 days. Animals were sacrificed at intervals and

<185> CONT.
excretion data were compiled. In controls, the plutonium was about equally divided between bone and liver at time when uptake was at a maximum level (between 1 and 6 days after injection). The level of plutonium in bone at 6 days remained constant for 90 days. However, it had dropped about one third by 300 days. When DTPA therapy was begun 3 days after plutonium injection, loss of plutonium from liver was accelerated so that almost all was removed after 3 days, and the level in bone was reduced by about one half after 12 days. When initiated after 1 hour, the same course of therapy again removed one half of the deposited plutonium from bone and nearly all from liver. In addition, it prevented all deposition in bone after 1 hour, so that the total retention in bone in these treated mice was less than one quarter of that of the saline controls. The amount of plutonium lost from the liver is the same as that in the feces, and that removed from bone is equal to the amount appearing in the urine. Data showed that 12 days of therapy was sufficient and further daily injections of DTPA would have promoted little or no increased effect. Only a preliminary survey of bone tumor incidence can be made at the present time. Data suggest that after administration of monomeric plutonium, bone tumors appeared earlier and there was a higher proportion of mice with a bone tumor at death than after administration of the same dose of polymeric plutonium. In the group receiving therapy at 1 hour, the latent period was longer and tumor incidence was lower than in the 3 day treated group. (BBM)

<186>
Rosenthal, M.W., J.F. Markley, and A. Lindenbaum, Argonne National Laboratory, Argonne, IL. 1963, May

Progress Report: Plutonium Removal. 3. Tumor Incidence Studies. ANL-6723; Part of Biological and Medical Research Division Semiannual Report, January through June 1962, (p. 144-145), 259 p.

The effects of 2 and 12 days of DTPA therapy following a single intravenous injection of 2.6 uCi/kg Pu 239 on bone tumor incidence are summarized. DTPA was injected intraperitoneally at a concentration of 500 mg/kg 3 days after Pu administration; controls received saline injections. The index of radiation effect was the proportion of mice that had at least one malignant bone tumor at death. DTPA treatment given for 12 days removed 43.2% of the plutonium deposited in the bone and reduced the fraction of mice with bone tumors by 42.5% at the time the last untreated mouse died (515 days). Treatment for 2 days had less effect on removal and tumor incidence, and the two indices of effect were not as closely correlated. Tumor rate increased with time in all groups and was reduced by DTPA therapy. (ST)

<187>
Rosenthal, M.W., J.F. Markley, and A. Lindenbaum, Argonne National Laboratory, Argonne, IL. 1963, October

Progress Report: Plutonium Removal. 6. Chemical Removal of Marrow and Its Associated Plutonium from Bone. ANL-6790; Part of Biological and Medical Research Division Semiannual Report, July through December 1962, (p. 92-93), 236 p.

In the estimation of radiation dose absorbed by bone after skeletal deposition of a bone-seeking radionuclide, it is essential to distinguish quantitatively between the radionuclide located in the bone itself and that deposited in the marrow. A chemical technqiue using the protein solvent Hyamine has been developed by which all exposed organic material including marrow can be dissolved from bone. The removal of the organic portion of the bone with its associated plutonium does not remove the radionuclide, that is deposited in the hard bone. Mice were injected with 2.7 or 1.6 uCi/kg of Pu 238 and sacrificed after three days. Marrow from a segment of the shaft of the tibia was extracted by saline irrigation, and a similar segment was extracted using three changes of Hyamine over a period of 2 weeks. Since Hyamine solutions cannot be easily ashed, the plutonium extracted must be measured indirectly by subtracting the amount of radioactivity in a bone sample treated with Hyamine from that in a comparable untreated sample. Results with Hyamine extraction did not differ significantly from those with saline irrigation. This should be a valuable technique in the quantitative differentiation between the plutonium in marrow and that in cortical bone or on trabecular and other bone surfaces, especially in skeletal areas in which physical removal of the marrow is not possible. (BBM)

<188>
Russell, E.R., H. Delaney, E. Motta, J. Muntz, E.S.G. Barron, E.E. Painter, R. Edwards, O. France, C.W. Hagen, and S. Schwartz, University of Chicago, Chicago, IL. 1945

Effects of Product Upon Dogs. CN-2786; Part of Health Problems Relating to Product for Month of March 1945, (p. 18-28), 35 p.

Dogs were injected intravenously (0.286 mg/kg) and intramuscularly (0.404 mg/kg) with plutonium(+6) citrate and the excretion and blood levels of plutonium were studied. Total excretions at two weeks were 15.3% of the injected dose in the intramuscularly injected dog and 24.4% in the intravenously injected dog. These values were compared with those of a previous study in which a dog was injected with the nitrate. Equilibrium blood levels were about 0.01 ug Pu/ml blood. Most of the plutonium in the blood was attached to beta globulins. Both dogs showed marked reduction in cellular components of the blood. White blood cell count was minimal on the 13th day postinjection, but the neutrophil count showed some recovery after that time. The intravenously injected dog suffered from radiation sickness from 10 to 16 days after injection; the distribution of plasma proteins was altered and there was an increase in urine urobilinogen. Both dogs excreted more plutonium than had the nitrate injected dog. (Auth)(ST)

<189>
Rysina, T.N., V.K. Lemberg, and I.A. Tseveleva, Not given. 1971

Biochemical and Morphological Changes in the Lungs of Rats Accompanying Multiple Inhalation of a Plutonium Citrate Aerosol. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 364-370), 574 p.

Female rats of the Wistar line were administered a solution of Pu 239 citrate (activity 9 uCi/ml) by inhalation for a

<189> CONT.
period of 10 minutes three times a week for 80 days to study the latent effects and biochemical and morphological changes produced in the lungs. With the maximum number of inhalations, there was an average accumulation of 0.0727 uCi of Pu 239 in the lungs. Animals were sacrificed during the inhalation period and up to the tenth month after inhalation had ended. Moisture, total nitrogen, lipid, nucleic acid, hydroxyproline, and hexosamine content of the lungs were determined. Immediately following inhalation, alpha tracks were distributed relatively uniformly in the lungs. By the twentieth day and up to the sixth month, dense stars corresponding to macrophages and alveolar cells were evident. By 8-10 months a moderately expressed pneumosclerosis was present. Early morphological indicators of damage were the mobilization and destruction of alveolar macrophages and an increase in the number of mast cells. After 40-80 days there was an increase in the number of cells in the alveolar septa at the expense of alveolar cells and histio-lymphocytic elements with an admixture of segmentonuclear leukocytes. Beginning with six months there were indicators of an intensification of fibrilogenesis. An increase in the total content of protein and hexosamine were the earliest and most clearly expressed biochemical changes in the lungs. An increase in the quantity of nucleic acids was observed during the period of collagen formation. The level of lipids increased to a lesser degree than the content of the other studied compounds. (ST)

<190>
Sanders, C.L., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Metabolism of Soluble Plutonium 238 from Crushed Plutonium 238 PuO2 Microspheres Following Intratracheal or Intraabdominal Injection. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 254-262), 313 p.

Soluble Pu 283, prepared by crushing plutonium 238 PuO2 microspheres, was administered to rats by intraabdominal injection (1980 nCi) or intratracheal instillation (720 uCi). A large fraction of Pu 238 was excreted in the urine; urinary excretion of Pu 283 was markedly increased when DTPA was given with Pu 238. Within hours, Pu 238 was translocated to the blood and concentrated in the skeleton. About 20% of intraabdominally injected Pu 238 was initially deposited in the liver and mostly cleared during the first 40 days. Fecal excretion of Pu 238 was predominant following intraabdominal injection whereas urinary excretion was greater following intratracheal instillation. About 70% of intratracheally instilled Pu 238 was cleared from the lung during the first day and an additional 20% during the next 40 days after instillation. (Auth)

<191>
Sanders, C.L., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Carcinogenicity of Plutonium Dioxide, Asbestos, and Benzpyrene in the Abdominal Cavity of Rats. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 139-145), 313 p.

Pu 238 PuO2 chrysotile asbestos, and benzypyrene were effective in inducing a large number of abdominal sarcomas and mesotheliomas. The Pu 238 PuO2 induced tumors originated mostly in the omental region in a dose-dependent manner at radiation doses of from 34,000 rads (65% incidence), 6,3000 rads (32% incidence), and 770 rads (17% incidence) delivered to omental tissues. Pu 238 PuO2 did not induce any mesotheliomas and only 15% and 4% incidence of sarcomas at radiaton doses of 31,000 rads and 10,000 rads, respectively, delivered to omental tissues. Pu 238 PuO2 was spread more evenly throughout the omentum whereas Pu 239 PuO2 was concentrated within a few "hot spots" of intense alpha activity in omental tissue. Both asbestos and benzypyrene acted in an additive manner when injected with Pu 239 PuO2 the combination of agents inducing as many sarcomas or mesotheliomas as was obtained by adding tumor incidence from the agents given singly. (Auth)

<192>
Sanders, C.L., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Carcinogenicity of Inhaled Plutonium 239 from Crushed Microspheres. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 262-271), 313 p.

An estimated 99% of inhaled "soluble" Pu 239 derived from crushed microspheres was cleared from the lungs of rats by 200-300 days after inhalation. About 50% of terminal Pu 238 was found in the skeleton. The highly toxic nature of Pu 238 was shown by increased mortality and tumor formation following initial lung depositions of 5, 18, or 207 nCi. To date 13-23% of animals exposed to Pu 238 and 1% of controls have developed nonmammary, mostly epithelial, tumors; 44% of nonmammary tumors were found in the lung following estimated cumulative radiation doses to the lung of 10 to 375 rads. Further interpretation awaits autopsy of remaining animals. (Auth)

Table 1 gives the tissue and organ distribution of inhaled Pu 238 in rats.

<193>
Sanders, C.L., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Carcinogenicity of Inhaled Plutonium 238 from Crushed Microspheres. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 28-31), 103 p.

Three groups of 70-day-old female rats were exposed to an aerosol of "soluble" Pu 238 (ultrafilterability 72%, CMD 0.02, GSD 2.1) derived from crushed Pu 238 PuO2 microspheres suspended in physiological saline for 2 to 3 months prior to the animal exposures. Following inhalation, 12 to 25% of the initial alveolar lung burden remained in the body 1 to 2 yr after exposure; 0.3 to 1% of this was in the lungs and 50% in the skeleton. The lung tumor incidence was 6.6, 23.3, and 25% for initial lung deposition of 5, 18, and 230 nCi, and average radiation doses of 9, 32, and 375 rads, respectively. There was a 1.1% incidence of lung tumors in controls. The incidence of all tumors other than mammary tumors was 4.3% in the unexposed controls and in the Pu 238-exposed rats,

<193>

BIOLOGICAL ASPECTS

<193> CONT.
26.7, 36.6, and 46.8%. (Auth) (FNM)

<194>
Sanders, C.L., Jr., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, December

Carcinogenicity of Inhaled Plutonium 238 in the Rat. Radiation Research, 56(3), 540-553

Three groups of female albino rats were exposed to an aerosol of soluble Pu 238 derived from crushed Pu 238 PuO2 microspheres suspended in physiological saline. Initial alveolar burdens of Pu 238 were 5 nCi (Group 1), 18 nCi (Group 2), and 207 nCi (Group 3). Only 1% of the initial alveolar lung burden remained in the lung at 1 year, decreasing to 0.3% by 600 days after exposure. The Pu 238 body burden was 25% of initial alveolar burden at 1 year, decreasing to 12% by 1000 days after exposure; about half of the body burden was found in the skeleton at these times. The cumulative radiation doses to the lung at 2 years after exposure were 9 rads (1), 32 rads (2), and 375 rads (3). Unexposed controls exhibited a median survival time of 825 days as compared to experimental survival times of 650 days (1), 675 days (2), and 550 days (3). The incidence of lung tumors in controls was 1.1% as compared to incidences in Pu 238 exposed rats of 6.6% (1), 20.0% (2), and 25.0% (3). The incidence of all tumors, other than mammary tumors, was 4.3% in unexposed controls, and in Pu 238 exposed rats, 26.7% (1), 36.6% (2), and 46.8% (3). (Auth)

<195>
Sedina, N.S., Not given. 1971

Effect of Uranium Fission Products on the Functional State of the Central Nervous System. AEC-tr-7387; Part of Moskalev, Yu.I. (Ed.), Remote Aftereffects of Radiation Damage, (p. 246-252), 574 p.

Changes in the functional state of the central nervous system of rats were studied following administration of uranium fission products. Doses were 2 and 20 mCi/kg introduced by stomach probe and from 0.08 plus or minus 0.01 to 1.17 plus or minus 0.08 mCi/kg administered by inhalation. Conditioned reflex activity was investigated by the motor reaction-food method. Chronaxie of the tibial nerve was measured to study shifts in subcortical nerve centers. Regardless of dose and administration method, the observed changes could be divided into two distinct phases. The first phase lasted two days and was characterized by an increase in the latent period of the reflex, a decrease in the degree of the conditioned reflexes, and a marked weakening of the conditioned inhibition. The second phase lasted five or six months during which there were no marked deviations from normalcy in animal behavior, but impairment in the conditioned inhibitation process was exhibited. Both phases transpired differently for the different methods of contamination. Almost all of the animals died by the twelvth month. Dystrophic changes in both groups preceding death are discussed. Impairment of higher nervous activity accompanying internal radiation was a progressive weakening of conditioned inhibition and an intensification of unconditioned inhibition during the entire course of the disease. (ST)

<196>
Seidel, A., Kernforschungszentrum Karlsruhe, Institut für Strahlenbiologie, Karlsruhe, German Federal Republic. 1972

Distribution of Plutonium 239 Related to Different Methods of Preparation of a Citrate Injection Solution. International Journal of Applied Radiation and Isotopes, 23, 195-196

Citrate solutions of Pu 239 prepared by three different methods were injected intravenously into female albino rats of the Heiligenberg strain. The rats were sacrificed by exsanguination seven days after injection of 0.5 or 0.005 uCi/kg doses. With all preparation techniques and pH values tested, the resulting distribution of Pu 239 corresponded to that ascribed to monomeric Pu 239. With one exception, all preparation procedures applied yielded identical results for the distribution of Pu 239 soon after its intravenous injection into the rat. Solution preparation methods are described. (ST)

<197>
Seidel, A., Kernforschungszentrum Karlsruhe, Institut für Strahlenbiolo Karlsruhe, German Federal Republic. 1973

Retention of Americium 241 by Some Endocrine Organs of the Rat and Its Response to DTPA Treatment. International Journal of Radiation Biology, 23(4), 415-416

Female albino rats were injected intravenously with 0.3-0.6 uCi Am 241 citrate (pH 7.5-8.5) to study the retention of americium by some endocrine organs and its response to DTPA treatment. Treated rats received 12 intraperitoneal injections of Ca or Zn DTPA (30 uM/kg) from 1.5 minutes to 71 days or from 4 to 81 days following americium administration. There was no significant elimination of americium from the thyroid, ovaries, or adrenals of the control animals after the fifteenth day. Both chelates were equally effective in reducing the Am 241 content of the organs and their effectiveness depended on the time of administration. The mobilization of Am 241 from the thryoid was higher than from the ovaries. The concentrations of Am 241 in the endocrine organs were compared with those of the liver and skeleton and the effect on the ovaries due to its long time retention, non-uniform distribution, and poor response to treatment is discussed. (ST)

<198>
Seidel, A., Kernforschungszentrum Karlsruhe, Institut für Strahlenbiologie, Karlsurhe, German Federal Republic. 1973, May

Comparison of the Effectiveness of Calcium DTPA and Zinc DTPA in Removing Americium 241 from the Rat. Radiation Research, 54(2), 304-315

Female albino rats were injected intravenously with 0.3 uCi Am 241 citrate followed by intraperitoneal injection of 2 to 200 micromoles of calcium DTPA or zinc DTPA to study the mobilization of internally deposited Am 241 as dependent on time and dosage of the chelates. The effect of both chelates was sustained over several days and decreased with increasing time interval between injection of Am 241 and chelate. The removal of Am 241 from the liver was markedly higher than from other organs. In case of immediate or early treatment calcium DTPA was found to be more effective than zinc DTPA.

<198> CONT.
There was no difference in effect in the case of delayed treatment. All dose-effect curves were linear. The theoretical and practical implications of the results are discussed. (Auth) (ST)

<199>
Seidel, A., Kernforschungszentrum Karlsruhe, Institut fur Strahlenbiologie, Karlsruhe, German Federal Republic. 1973

Distribution of Americium 241 in the Rat as Influenced by Dose and the pH of the Injection Solution. International Journal of Applied Radiation and Isotopes, 24, 362-363

Adult female rats of the Heiligenberg strain were injected intravenously with 0.03 to 3.0 uCi/kg Am 241 in citrate solution to determine whether dose influences distribution and retention in the skeleton, liver, and kidneys. The effect of pH (2.7, 7.4, and 9.4) on distribution was also studied. The alpha activity of the tissue samples was assayed by liquid scintillation counting. There was no systematic and statistically significant influence of the pH on the distribution pattern. An increase of dose from 0.03 to 3.0 uCi/kg had no influence on Am 241 retention by the liver and skeleton. A slightly higher Am content in the kidneys was present with the higher dose. (ST)

<200>
Seidel, A., Kernforschungszentrum Karlsruhe, Institut fur Strahlenbiologie, Karlsruhe, German Federal Republic. 1973

A Multivariate Analysis of Calcium DTPA Effectiveness in Removing Americium 241 from the Rat. Zeitschrift fur Naturforschung, 28C(5-6), 316-318

The dependence on time of the dose-effect relationship was studied for the removal of Am 241 from the skeleton and liver of the rat by Ca DTPA. Due to the linearity of the dose-effect-curves (in a log-log scale) as well as to the linear dependence of the slope on the logarithm of time, simple equations were derived which describe the mobilization of Am 241 as influenced by DTPA-dosage and time of treatment. (Auth)

<201>
Seidel, A., and V. Volf, Kernforschungszentrum Karlsruhe, Institut fur Strahlenbiologie, Karlsruhe, German Federal Republic. 1972, December

Effect of DTPA on the Americium 241 Content of Different Bones of Rats. Naturwissenschaften, 59(12), 652 (German)

Americium citrate was injected intravenously into female rats followed by the injection of Ca DTPA or Zn DTPA after 90 min or 4 days. Alpha activity of the bones was determined 7 days after DTPA injection. Americium 241 concentration in the femur, parietal os, mandibles, teeth and ribs were not uniform, but it was concluded that the Am 241 activity of the femur presented a reasonably accurate picture of its distribution in the skeleton. There was no significant difference in either Ca or Zn chelate effectiveness. (RAF)

<202>
Sikov, M.R., and D.D. Mahlum, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Cross-Placental Passage of Actinides in the Rat. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 42-43), 207 p.

Pregnant rats were intravenously injected with doses of approximately 50 uCi of Pu 239 (ionic or colloidal), 3 uCi of Np 237 (ionic), or 4 uCi of U 233 (ionic). Injection of each solution was made after 15 or 19 days of gestation and the rats killed 24 hr later. Only small amounts of activity were found in the fetus following the administration of the radionuclides although substantial concentrations were measured in the placenta and fetal membranes. The partition of these materials among the fetal tissues was often dissimilar to that found in the corresponding maternal tissues. (Auth) (FMM)

Table 1 shows the distribution of actinides in tissues, 24 hr after injection in pregnant rats.

<203>
Sikov, M.R., and D.D. Mahlum, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Effect of Age and Physicochemical Form on Plutonium Toxicity and Metabolism in the Rat. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 5.8-5.14), 253 p.

The distribution and toxic effects of monomeric and polymeric plutonium in neonatal, weanling, and adult rats injected intravenously with a dose of 6-90 uCi/kg body weight in citrate or nitrate solution were compared. The parameters studied included radionuclide distribution and retention, growth, acute and chronic toxicity, and damaging effects on several specific organs. The polymer was more toxic to weanlings and adults than was the monomer, but there was little difference between the two forms in newborn rats. Weight gains were suppressed in animals of all age groups. Monomeric plutonium was deposited in the skeleton to a greater extent than in the liver; with the polymer, liver deposition predominated. Gross and histological damage was noted in the livers, particularly in animals receiving the polymer. The changes were most severe in those exposed as weanlings. There was a general tendency toward a dose dependent increase in the susceptibility to audiogenic seizures after exposure of the weanlings to the monomer. The weights of several organs, in relation to total body weight, were altered by exposure to plutonium. It was concluded that differences in acute lethality related to marked age dependent differences in distribution of the two forms, which also led to age dependent alterations in organs such as liver, spleen, and skeleton. (Auth) (ST)

Table 1 gives the acute lethal effect of Pu 239 administered as monomer or polymer to rats of different ages.

<204>
Sikov, M.R., and D.D. Mahlum, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Distribution of Einsteinium 253 in the Fetoplacental Unit of the Rat. BNWL-1650 (Part

<204>

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<204> CONT.
1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 85-87), 313 p.

The cross-placental transfer and distribution of Es 253 in the fetoplacental unit of the rat was determined 24 hr after injection at 15 or 19 days of gestation. The fraction entering the fetus was much lower than that observed with other heavy metals previously studied. The concentration in the membranes relative to that in the placenta was likewise much lower although the distribution within the membranes was similar to that previously found with Pu 239. (Auth)

<205>
Smith, V.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

The Biological Disposition of Einsteinium Nitrate in Rats After Intravenous, Intramuscular, Subcutaneous, and Transcutaneous Administration. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 279-283), 313 p.

Regardless of the injection route, Es(NO3)3 was retained preponderantly in the skeleton up to 24 days after intravenous (IV), intramuscular (IM), or subcutaneous (SC) administration. The liver burden decreased from 26% of the initial Es administered IV at 4 hours to 14% at 1 day and < 2% at 24 days. The skeletal content increased to about 70% on day 7 and decreased to about 56% by day 24. The liver and skeleton retention at 24 days from the SC and IM injections was slightly less than from the IV route. Injection site retention was greater for the SC route, 16%, than for the IM route, 8%. Skin absorption was very high, about 4% of the available Es (2.5 uCi/cm2 pH 2 nitrate solution) being absorbed in 30 minutes. (Auth)

<206>
Smith, V.H., Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Interactions in the Metabolism of Plutonium 239 and Neptunium 239. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 73-75), 242 p.

Female rats weighing approximately 250 g each were injected via the tail vein with Pu 239(+4) and Np 239(+4) as the pH 4 citrate complex. They received 0.03 mmoles (118 mg) of Na3H2 DTPA plus 1 cc of 10% w/v calcium glucoheptonate intraperitoneally one hour after the isotope administration. The whole tissues were counted in a 256-channel gamma analyzer to obtain the Np 239 content, and then, after Np 239 decay, were wet combusted with HNO3, plated, and the Pu 239 content measured in proportional flow counters. The results show that deposition of Np 239 in the liver is very significanly increased by the simultaneous administration of Pu 239. It is postulated that Pu 239, because of its relatively much greater mass, tends to "carry" the Np 239. DTPA is considerably less effective in removing Np 239 from the liver than in removing Pu 239 from the liver; and is totally ineffective in removing Np 239 from femurs. (Auth) (FMM)

Table 2 shows percent of Np 239 and Pu 239 doses remaining in tissues and excretion five days after administration.

<207>
Smith, V.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Prompt and Delayed Chelation Therapy for the Decorporation of Einsteinium 253 from Rats Using Zinc and Calcium DTPA. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 284-286), 313 p.

When chelation therapy was commenced 7 days after the intravenous adminstration of einsteinium 253 Es(NO3)3, the soft tissue retention was 2 to 5 times greater than when treatment was given after 1 hr. Skeletal retention was doubled from 35% to 77% of that retained by the control rats by delaying the treatment. The relatively short physical half-life and the predominate deposition in skeleton makes prompt treatment imperative if irradiation of the skeleton is to be effectively reduced. Directly injecting Zn DTPA near the site of intramuscular deposits of Es reduced local Es retention more than twofold compared to treatments remote from the deposit. Zn DTPA appears to be as effective in decorporating Es from rats as Ca DTPA and, since it is less toxic, is recommended for that purpose. Generally, Es is more susceptible to DTPA therapy than Pu. (Auth)

<208>
Smith, V.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Interaction of Plutonium and Cesium During Chelation Therapy in Rats. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 274-276), 313 p.

In rats, during the early phases of deposition and decorporation by chelate therapy, an excess of stable cerium citrate had little effect on Pu 238 retention or removal by Zn DTPA. On the other hand, an excess of Pu 238 relative to Ce 144 increased Ce 144 retention in the liver. Stable Ce administered as the DTPA chelate caused increased retention of Ce 144 in the soft tissues and was less effective in the removal of Pu 238 or Ce 144 than Zn DTPA. (Auth)

<209>
Smith, V.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

The Solubility of Plutonium 238 Dioxide Microspheres in Simulated Gastric Juice. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 4.18-4.19), 253 p.

In simulated gastric juice, plutonium 238 PuO2 microspheres exhibit an early rapid rate of dissolution followed after 1-2 hr by a constant and relatively slower rate. Assuming the stomach would normally empty within 1-4 hr, the faster early solution rate would dominate hazard conditions. The values reported are valid only for the particular microspheres employed and should not be considered to represent the solubility of an average SNAP fuel particle. Solubility may be expected to vary widely, depending on the production conditions, surface variation, cleaning procedure, and the general past history of the microsphere. (Auth) (RAF)

<210>
Smith, V.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Physics and Instrumentation Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1974, August

Toxicity of Inhaled DTPA. BNWL-1850 (Part 1); Part of Thompson, R.C., et al, Annual Report for 1973, (p. 111-112), 162 p.

No significant gastrointestinal pathology was seen in rats, during or following inhalation of Ca DTPA at daily dose levels up to 20 times those normally taken by man and for up to 20 consecutive days. Even at these high levels the inhalation route seems unable to maintain systemic levels of DTPA sufficiently high to produce the gastrointestinal syndrome seen following continuous infusion. A transient vesicular emphysema was produced that generally was not present 3 weeks after cessation of treatment. None of the fibrotic changes observed with intratracheally injected Ca DTPA at high dose levels were noted. (Auth) (RAF)

<211>
Smith, V.H., and J.L. Beamer, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Absorption of Plutonium 238 PuO2 from the Gastrointestinal Tract of Swine. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 91-92), 207 p.

Nine Hanford Miniature Swine were given large numbers of Pu 238 PuO2 microspheres by gavage. After 14 days the amount absorbed to tissues and urine was less than 10(E-6) of the dose. Absorption as a function of surface area of the microspheres was less than 2 mCi/m2. (Auth)

Table 1 shows Pu 238 content in tissues of swine administered Pu 238 PuO2 microspheres by gavage.

<212>
Smith, V.H., and H.A. Ragan, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Chelates as Contrast Media: Uranium-DTPA. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 105-106), 207 p.

The diethylenetriaminepentaacetic acid (DTPA) chelate of uranium produced useful angiograms when used in swine; however, acute toxicity, manifested by cardiac arrest, contraindicates its use in angiography. (Auth)

<213>
Smith, V.H., H.A. Ragan, and J.L. Beamer, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Passage Time and Pathology Following Feeding of Plutonium 238 PuO2 Microspheres to Swine. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 88-90), 207 p.

The passage time of Pu 238 PuO2 ceramic submillimeter particles administered intragastrically to nine Hanford Miniature Swine averaged 10.5 days for the excretion of 99% of the dose and 5.6 days for 50% of the dose. The passage of 0.18 to 1.1 Ci of Pu 238 elicited only a mild, inflammatory response. Two cases of particle retention at the ileo-cecal junction produced local inflammation and small regions of necrotic tissue surrounding the particles. (Auth)

<214>
Stevens, W., D.R. Atherton, B.J. Stover, and F.W. Bruenger, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

The Effect of the Physical-Chemical State of Plutonium 239 on Its Early Retention in Plasma and Selected Soft Tissues of Beagles. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 137-147), 380 p.

The early distribution and retention of Pu 239(+4) in plasma, kidney, spleen, and other selected soft tissues was studied in beagles after injection of the strictly monomeric Pu-transferrin complex (Pu-T sub 1), Pu(+4) in citrate buffer of pH 3.5 (Pu-M), and polymeric plutonium (Pu-P) prepared by differential precipitation from a purified solution of plutonium nitrate. It was given ata pH of approximately 6. Pu-T sub 1 was removed from the circulation at a rate slower than Pu-M, whereas, Pu-P initially left the blood at a very rapid rate. At 15 min after injection 87%, 64%, and <2% of the three forms of plutonium were circulating in plasma respectivley; 100% of Pu-T sub 1 and the larger fraction of Pu-M was protein bound. No protein binding fo Pu-P was seen. At two weeks after injection, the concentration of plutonium in most soft tissues was quite similar for Pu-T sub 1 and Pu-M. Compared to Pu-M, kidney retention was less by a factor of 20, whereas, spleen retention was elevated by a factor of 10 in the Pu-P injected animal. The concentration of Pu-P in the spleen was 1.6 times greater than the concentration in the liver. Following differential centrifugation of tissue homogenates from Pu-P injected animals, the percentage of plutonium in the soluble fraction was greatly reduced in spleen but not in similar fractions of kidney when compared to Pu-T sub 1 and Pu-M injected dogs. Most of the nuclide in the kidney was found in the fraction rich in mitochondria. In the case of Pu-P, a large concentration of plutonium also was found in the nuclear fraction of spleen homogenates. The concentration of plutonium in thyroid, adrenal, pituitary, duranater, subcutaneous loose connective tissue and other soft tissues are compared. (Auth)

<215>
Stover, B.J., D.R. Atherton, F.W. Bruenger, and W. Stevens, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Comparison of Skeletal and Hepatic Dose Rates from Plutonium 239 in the Beagle as a Function of Dose Level. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 167-192), 380 p.

The total skeletal retention was measured in four beagles that were injected intravenously with 0.0059 uCi Pu 239(+4)/kg in 0.08 M citrate buffer, pH 3.5. The dogs were young

<215>

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<215> CONT.
adults at the time of injection and they were sacrificed at 1648 to 2546 days after injection at which times the removal of plutonium from trabecular surfaces by remodeling had decreased significantly. Retention of plutonium in 8 humeri and 8 third lumbar vertebrae was measured in dogs at low dose levels which were sacrificed at 35 to 4375 days after injection. These results are combined with previous data on early deposition and retention in the skeleton, and early and long term data on retention in the humerus and third lumbar vertebra, to obtain a set of four skeletal retention equations applicable to at least seven dose levels. From measurements of the defleshed skeletons of 18 beagles, the indicated wet skeletal weight was 7.5 plus or minus 0.9% of the weight of the dog at injection, a value lower than the previously assumed 10%. Using the set of skeletal equations, and the measured skeletal weight, the cumulative rads doses to the skeleton and the liver are compared. The average dose to the liver exceeds that to the skeleton except at the 2.8 uCi/kg dose level after 1300 days. (Auth)

Table 5 shows average values of some measurements of weight and Pu 239 retention on beagle skeletons.

<216>
Stover, B.J., and D.R. Atherton, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Concentration of Plutonium 239(+4) in the Blood Plasma of the Beagle. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 161-166), 380 p.

The concentration of plutonium in plasma has been measured from 1 minute to 12.5 years following injection of the young adult beagle with Pu 239 (+4) in 0.08 M citrate buffer, pH 3.5. The following sum of exponentials has been fit to the data: $P = 0.116(E-1.05t) + 0.017(E-0.47t) + 0.0015(E-0.080t) + 0.00016(E-0.00089t)$ where P is the percent of injected Pu 239/g of plasma and t is days. Samples were obtained from dogs at 6 dose levels, and from well, ill, and terminal dogs. Thus, because of the known effect of dose level on hepatic and skeletal retention and the unknown effect of the disease state of the animal, metabolic interpretation of the equation must be limited to the observation that, on the average, there is a continuous decrease in the concentration of Pu 239 in plasma with time. An effect on the fourth term of P was observed at the highest dose level only. (Auth)

<217>
Stover, B.J., and H. Eyring, University of Utah, Radiobiology Division, Department of Anatomy, Salt Lake City, UT; University of Utah, Radiobiology Division, Department of Chemistry, Salt Lake City, UT. 1970, July

The Dynamics of Life. 3. Mechanisms of Nonsurvival and the Relation of Dose Size. Proceedings of the National Academy of Sciences, 65(3), 672-676

From the steady state theory of mutation rates, we have the probability, g, of the occurrence of a critical change at some site in a cell that leads to genetic alteration, and the probability, p equals 1-g, that the site either is not changed or that it has been repaired. In this paper, the formal theory is extended to include survival of biological systems, in particular, the survival curves of beagle dogs whose deaths resulted from aging, cancer, epilepsy and internal radiation from Pu 239 or Ra 226. Single and multiple mechanisms of nonsurvival, and multiple factors acting on a single mechansim, are considered. The number of sites that must be altered to lead to nonsurvival is examined and found to be greater than one. The effect of independent action on separate sets of sites, and the relationship between dose size and survival time are given. (Auth) (RAF)

<218>
Stover, B.J., G.N. Taylor, and D.R. Atherton, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1963, September 30

Completion of the Injection Phase of the Basic Toxicity Experiment. COO-228; Part of Dougherty, T.F., Research in Radiobiology, Semiannual Report of Work in Progress on the Chronic Toxicity Program, (p. 61-65), 185 p.

The 444 young adult beagles planned for the long-term study of the effects of Ra 226, Pu 239, Ra 228, Th 228, and Sr 90 have received their single intravenous injections. Injection of the toxicity dogs began in December 1952 and was concluded in July 1963. Thus nearly 11 years were required to introduce this number of dogs into the experiment. As of September 30, 1963, there are 268 of the 444 dogs (60.5%) still living. Osteosarcomas have been found in 112 of the 176 dead dogs (63.7%). Of the 176 dead dogs, 9 lived 10.0 years or more. (Auth) (FMM)

<219>
Stuart, B.O., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Acute Lethality of Inhaled Plutonium 238 PuO_2 and Plutonium 239 PuO_2 in Rats. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 66), 207 p.

The oxides of Pu 238 and Pu 239 were calcined at 350 degrees C and ground to a particle size of 0.1 u (count median diameter). Groups of 12 rats were exposed to one of eight different aerosol concentrations of each of the two isotopes. Acute mortality curves were drawn using estimates of the quantity of plutonium initially deposited in the alveoli as determined from whole-body counts and analyses of lung tissue. Preliminary results suggest that inhaled Pu 239 PuO_2 is somewhat more effective than Pu 238 PuO_2 in causing acute mortality in rats. (Auth) (FMM)

Table 1 shows LD 50 for inhaled PuO_2 in rats.

<220>
Stuart, B.O., E.B. Howard, P.L. Clary, and D.K. Craig, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1970, August

Chronic Exposure of Hamsters to Simulated Uranium Mine Atmospheres. BNWL-1306 (Part 1); Part of Thompson, R.C. (Ed.), Annual, Report for 1969, (p. 58-60), 90 p.

<220> CONT.
Four groups of hamsters received daily, 6-hr exposures to 30 WL and 600 WL radon daughters with and without simultaneous exposure to aerosols of carnotite ore dust (15 mg/m3). Bimonthly hematological sampling of selected hamsters from each group has shown no significant differences in peripheral blood parameters. After the first 6 months of daily exposures to 30 WL, the lungs of sacrificed animals showed some congestion and edema, with slight thickening and early hyalinization of the interalveolar septa. After 6 months and longer of daily exposures to 600 WL, edema was associated with the alveolar septa; areas of peripheral emphysema were found, with a moderate inflammatory reaction involving mononuclear and polymorphonuclear cells. Lungs of animals exposed to 600 WL plus carnotite ore dust showed areas of alveolar septal breakdown with emphysema plus dilation and congestion of the pulmonary vasculature. A severe generalized pneumonitis was also observed in many animals of this group. (PWM)

<221>
Stuart, B.O., F.F. Palmer, and R.H. Busch, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Biological Effects of Life Span Inhalation Exposures of Hamsters to Radon Daughters, Uranium Ore Dust, and Diesel Exhaust Fumes. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 232-238), 313 p.

Six groups, each consisting of 102 male hamsters, began one year ago to receive daily 6-hr inhalation exposures to laboratory air (controls), 1200 WL radon daughters, 1200 WL radon daughters with uranium ore dust, uranium ore dust alone, diesel engine exhaust (50 ppm CO), or 1200 WL radon daughters with uranium ore dust plus diesel engine exhaust. Sacrificed hamsters have shown respiratory tract lesions covering a spectrum ranging from normal lungs in control hamsters to metaplasia of bronchiolar-alveolar epithelium (cubiodal metaplasia or bronchiolization) in hamsters in the experimental groups. Accumulation of particulate-laden macrophages about small bronchioles and vessels appeared within a few months in almost all of the hamsters exposed to diesel engine exhaust alone or with radon daughters and uranium ore dust; and, after more than 5 months of exposure, in about 50% of the hamsters exposed to uranium ore alone or with 1200 WL radon daughters. Where such particle deposits were heaviest, they were frequently accompanied by septal cell hyperplasia. Cases of metaplasia in groups receiving 1200 WL radon daughters with uranium ore dust, uranium ore dust alone, or 1200 WL radon daughters with uranium ore dust plus diesel exhaust, began to appear after 5 to 6 months of exposures, increasing sharply therafter; adenomatous lesions began to appear after 6 months. (Auth)

<222>
Stuart, B.O., P.W. Perkins, and T.M. Beasley, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Preliminary Studies of Inhaled Uranium Ore. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 50-54), 242 p.

Preliminary studies of inhaled uranium ore in rats indicate that daughter radionuclides deposited in the lungs do not remain in secular equilibrium. Thorium 230 to U 238 ratios increased from 1.0 to more than 2 or 3 within eight weeks after exposure. (Auth)

<223>
Stuart, B.O., D.H. Willard, R.H. Busch, H.A. Ragan, and P.L. Hackett, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Biological Effects of Life-Span Inhalation Exposures of Beagle Dogs to Radon Daughters, Uranium Ore Dust, and Cigarette Smoke. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 242-246), 313 p.

Sixty beagle dogs are continuing to receive daily inhalation exposures to 600 WL radon daughters with uranium ore dust and/or cigarette smoking (10 cigarettes/day, 7 days/week). After 2 years of exposure, respiration rates and volumes and body weights have shown no sustained differences between the exposure groups and controls. Total white blood cell counts and segmented neutrophil levels rose significantly during the last 6 months in the group receiving 600 WL radon daughters with ore plus cigarette smoking. Lung lavage samples from dogs in this group and in the group receiving 600 WL radon daughters with ore dust show large macrophages with incresased numbers of neutrophils and occasional lymphocytes. The lungs of four dogs (one per group) sacrificed 6 months after beginning exposures showed no abnormalities in the control dog but perivascular and peribronchiolar accumulations of macrophages in the dog inhaling cigarette smoke. The dogs receiving 600 WL radon daughters with ore dust, with and without cigarette smoking, showed peribronchiolitis, perivasculitis, fibrosis, vesicular emphysema, and hyperplastic and metaplastic lesions of the bronchiolar epithelium. (Auth)

<224>
Stuart, B.O., D.H. Willard, E.B. Howard, P.L. Clary, and D.K. Craig, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1970, August

Chronic Exposure of Dogs to Simulated Uranium Mine Atmospheres. BNWL-1306 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1969, (p. 60-61), 90 p.

Twenty beagle dogs were exposed daily to 600 WL of radon daughters plus carnotite ore dust. An additional 20 dogs were similarly exposed, but in addition smoked 10 cigarettes per day. No significant differences in respiratory rate, minute volume, tidal volume, thoracic radiographs, hematology, or clinical chemistry, have been observed between groups at 2 months after beginning daily exposures. Two dogs were sacrificed 15 months after conclusion of 1/2 hr, twice daily exposures to pitchblende U ore dust (0.1 mg/liter). Radiochemical analysis revealed nonequilibrium ratios of U 234, Th 230, Pb 210, and Po 210 in the lungs, tracheobronchial lymph nodes, kidney, liver, spleen, and skeleton, with Th 230/U 234 ratios ranging from 2 to 10. Po 210/U 234 ratios in the lungs and tracheobronchial lymph nodes varied from 5 to 20. The highest concentrations of Th 230 were found in the

<224>

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<224> CONT.
lungs, skeleton, and tracheobronchial lymph nodes. (FWM)

<225>
Sullivan, M.F., and J.L. Beamer, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

The Hanford Miniature Swine as an Animal Model for Intracavitary Irradiation by Radium 226 and Californium 252. BNWL-1650 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1971, (p. 32-35), 313 p.

Techniques have been developed using Hanford Miniature Swine that will allow a comparison of the effects of Ra 226 capsules implanted in the uterine cervix with those resulting from implanted Cf 252 afterloading capsules. These methods should allow calculation of radiobiological effectiveness (RBE) for this neutron emitter. The organs evidencing most severe damage from intracervical placement for either Ra 226 or Cf 252 afterloading capsules were the rectum, bladder, and the uterine cervix. Results suggest that the swine is a useful animal model for evaluating the effects of an intracervical treatment with Cf 252. (Auth) (RAF)

<226>
Sullivan, M.F., J.L. Beamer, and A.C. Case, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Californium Studies. BNWL-1750 (Part 1); Part of Thompson, R.C. (Ed.), Annual Report for 1972, (p. 11-12), 103 p.

Hanford Miniature Swine, exposed to Cf 252 irradiation, were studied to determine the amount of sodium activation. It was found that a maximum of 2 nCi per ml was excreted in the urine following exposures that delivered from 2500 to 4000 rads to a point 2 cm lateral to tandem applicators containing four 12 ug Cf 252 sources. The amount excreted was markedly influenced by the health of the animals; an animal in poor health retained Na regardless of the length of exposure to a neutron source. (Auth) (RAF)

<227>
Taylor, D.M., and A.R. Chipperfield, Institute of Cancer Research, Department of Biophysics, Sutton, Surrey, England. 1970

The Mode of Fixation of Plutonium 239 and Americium 241 in Bone: A Possible Explanation of Their Different Carcinogenicity. CONF-680435; Part of Jelliffe, A. M. and Strickland, B. (Eds.), Proceedings of the Ossium Symposium held in London, England, April 4-6, 1968, (p. 215-217), 340 p.

The results of some studies on the comparative binding of plutonium and americium by bone mineral and by the sialoprotein isolated from the organic matrix are discussed and a tentative hypothesis to explain the different carcinogenicity of the two elements is proposed. The relative affinity of bone mineral for plutonium and americium was compared by measuring the uptake of Pu 239 or Am 241 on ashed bovine cortical bone as a function of the concentration of citrate in the suspending medium. The results showed that with increasing citrate concentration up to two hundred times that found under biological conditions, the proportion of plutonium bound by the bone ash decreased, but americium was bound firmly over a wide range of concentrations. Results of gel filtration studies of the binding of americium and plutonium to bone sialoprotein and human transferrin in vitro suggested that plutonium is bound much more strongly than americium by sialoprotein and that both elements are bound more strongly by sialoprotein than by transferrin. Thus following administration of equal microcurie amounts of Pu 239 and Am 241, both nuclides are deposited in bone mainly by surface absorption on the mineral phase, but preferential cellular binding of Pu 239 to sialoprotein would result in a greater radiation dose being delivered to bone cells those producing a greater risk of carcinogenic transformation. (ST)

<228>
Taylor, G.N., W.S.S. Jee, J. Williams, and L. Shabestari, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Anatomic Distribution of Monomeric and Polymeric Plutonium 239. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 106-125) 380 p.

Polymeric Pu 239 given intravenously to beagles was retained principally in the reticuloendothelial cells (RE) of the liver and the spleen. Retention in the skeleton was limited to the RE cells of the bone marrow with very little, if any, uptake in the bone proper. Except in the lung, where some mechanical filtration of larger particles may have occurred, the retention of polymeric Pu 239 was principally governed by phagocytic factors which was not the case with monomeric Pu 239. Monomeric Pu in the initial deposition was principally in the hepatic epithelium with little, if any retention in the RE cells. Approximately 0.5% of the injected dose was initially retained in the kidney. Retention of monomeric Pu in the spleen was more uniformly distributed. Like the polymeric form it appeared principally in the RE cells. The retention of monomeric Pu 239 in the lymph nodes was low. Retention within the skeletal tissues was mainly on the bone surfaces. (Auth) (RAF)

Figures 1-12 show electron micrographs and autoradiograms of Pu-containing tissues of beagles.

<229>
Taylor, G.N., W.S.S. Jee, R.B. Dell, C.W. Mays, J.L. Williams, and L. Shabestari, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1971, March 31

Distribution of Californium 249 and Berkelium 249 in the Soft Tissues of Beagles. COO-119-244; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 126-146), 424 p.

The microscopic distribution pattern of Cf 249 and Bk 249 in the soft tissues of beagles, at one to three weeks following a single intravenous injection of a citrate solution, was very similar to Am 241. Relatively high concentrations occurred in the hepatic cells of the liver, the glomeruli of the kidney, the interfollicular region of

<229> CONT.
the thyroid, the cartilaginous tissues of the lung, and media of the smaller arterioles of most organs. Very intense, but sparsely scattered "hot spots" were also present in the renal papillae and in the submucosa of the bronchioles. Lesser sites of localization were the endocardium of the heart valves@of the atrioventricular valves, the glassy membranes of the larger hairs of the coat, the zona pellucida of the Graafian follicles and the zona arcuata of the adrenal cortex. With the exception of the liver, where the radionuclide was principally within the hepatic cells, most of the deposition sites were extracellular, within or adjacent to connective tissue which gave a positive periodic acid-Schiff reaction. (Auth)

Thirteen autoradiograms of soft tissues following Cf 249 or Bk 249 injections are presented.

<230>
Taylor, G.N., C.E. Rehfeld, W.R. Christensen, and W.S.S. Jee, University of Utah, College of Medicine, Department of Anatomy, Salt Lake City, UT. 1969, September-October

Influence of Radium 226 and Plutonium 239 on the Dental Root Canal of the Dog. Journal of Dental Research, 48(5), 924-927

Sixteen month old beagle dogs were given a single intravenous injection of plutonium 239 (3 uCi/kg), radium 226 (10 uCi/kg), or radium 224 (10 uCi/kg) in a citrate buffer solution and the influence of these radionuclides on the rate of narrowing of the dental root canal was studied by periodic radiograms. No significant change in the rate of decrease in diameter of the pulp chambers occurred as the result of irradiation. The influence of age on the findings was discussed. (ST)

<231>
Taysum, D.H., and G.N. Taylor, University of Utah, College of Medicine, Radiobiology Division, Department of Anatomy, Salt Lake City, UT. 1972, March 31

Californium 252, Californium 249, Plutonium 239 and Radium 226 Toxicity Studies in Mice. COO-119-246; Part of Dougherty, T.F., Research in Radiobiology, Annual Report of Work in Progress in the Internal Irradiation Program, (p. 284-286), 380 p.

A proposal for a pilot study to provide experimental evidence for cancer induction by Cf 252 is presented. The objectives are to establish the toxicity of fission fragment emitting Cf 252 relative to the alpha emitting Cf 249, Pu 239, and Ra 226, and to examine the shape of the dose response curve for each of these nuclides. The experimental design calls for 24 toxicity mice (male and female) at each dose level (6) for each nuclide (4). Radionuclides in a citrate solution will be injected intraperitoneally into young adults at about 10 plus or minus 1 weeks of age. This pilot study should require about 5 years to complete. (Auth) (RAF)

<232>
Thompson, R.C. (Ed.), Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1973, April

Annual Report for 1972 to the USAEC Division of Biological and Environmental Research, Volume 1: Life Sciences, Part 1: Biological Sciences. BNWL-1750 (Part 1); 103 p.

This report covers work in the biological sciences during calendar year 1972. Subject categories researched were the toxicity of ingested, injected, inhaled, and topically applied radionuclides including plutonium and the transplutonics; inhalation hazards to uranium miners; removal of radionuclides; nuclear-powered prostheses and other human applications; and mechanisms of radiation effects. Parameters studied included toxicity, metabolism, age effects, dose-effect, long-term effects, carcinogenicity, cocarcinogenicity, detection, inhalation hazards, and chelate effects. Also studied were the effects of intracorporeal radioisotope heat sources, development of blood irradiators, and the role of viruses in radionuclide induced malignancies. Laboratory animals used in the studies were rats, mice, dogs, hamsters, and miniature swine. (ST)

<233>
Thompson, R.C. (Ed.), Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1972, September

Annual Report for 1971 to the USAEC Division of Biology and Medicine, Volume 1: Life Sciences, Part 1: Biological Sciences. BNWL-1650 (Part 1); 313 p.

This part of the progress report covers work in the biological sciences. Reports are grouped into sections covering a wide range of topics including radiation effects, cellular regulatory mechanisms, metabolism of radionuclides, carcinogenesis, decontamination, temperature effects, evaluation of blood irradiators, and biological effects of internal radioisotope heat sources. Laboratory animals including mice, rats, hamsters, beagle dogs, and pigs were used to study the effects of Ra 226, Cf 252, I 131, Es 253, Bk 249, Sr 90, Sm 145, Pm 143, U, Pu 239, Pu 238, Ce 144, and radon daughters. Twenty-one individual papers, primarily concerning Pu 239, PuO2, and radon daughters and uranium ore dusts, were abstracted separately for the data base. These papers involved studies of absorption and retention, skin irradiation, age factors, carcinogenesis, administration routes, decontamination, instrumentation, deposition following inhalation, effects of chelates, and internal heat sources. (ST)

<234>
Thurman, G.B., C.W. Mays, G.N. Taylor, A.T. Keane, and H.A. Sissons, University of Utah, Radiobiology Division, Anatomy Department, Salt Lake City, UT; Argonne National Laboratory, Radiological Physics Division, Argonne, IL; Institute of Orthopedics, Department of Morbid Anatomy, London, England. 1973, July

Skeletal Location of Radiation Induced and Naturally Occurring Osteosarcomas in Man and Dog. Cancer Research, 33, 1604-1607

Data from six major studies were used to compare the type and distribution of naturally occurring bone tumors in man and dog, the type and distribution of bone tumors induced in man and dog by bone-seeking radionuclides, and the skeletal distribution of osteosarcomas. Osteosarcoma was the most frequent type of bone sarcoma observed. The

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<234> CONT.
skeletal distribution of osteosarcomas induced by bone-seeking radionuclides (Ra 226, Pu 239, Th 228, Ra 228, Sr 90, and Ra 224) in man and dogs was different from the distribution of naturally occurring osteosarcomas. The major skeletal site of naturally occurring osteosarcomas in humans is near the knee (approximately 50%); dogs have an extremely high frequency of these tumors in the radius (28%) and ulna (6%). Osteosarcomas induced in humans and beagle dogs differed mainly in the fact that beagles had a high frequency of vertebral tumors (26%) whereas man had a high frequency in the femur (21-24%) and pelvis (20-29%). (ST)

<235>
Trnovec, T., A. Pleskova, and V.H. Smith (Ed.), Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1971

Mechanisms of Hepatic Uptake of Hepatotropic Radionuclides. BNWL-tr-71; 20 p.; Pracovni Lekarstvi, 23(5), 175-181

A survey concerning the mechanism of the uptake of radionuclides in the liver has been presented. The mechanism of hepatic uptake of polymerizable radionuclides depends markedly on the physicochemical condition in which they exist in the blood. Both principal types of liver cells, i.e., parenchymal and Kupffer cells, take part during uptake of the radionuclides of rare earths and transuranium elements into the liver. Data concerning Pu uptake in the liver of various animals has been obtained by means of the autoradiographic method and are discussed. Further investigation of the mechanism of hepatic uptake of polymerizable radionuclides must begin with the latest discoveries concerning the morphology and physiology of the liver tissue. Such discoveries, from a point of view of association between these radionuclides and plasma proteins are, for example, findings concerning the metabolism of isologous proteins in the liver cells. Also, the movement of these radionuclides in the liver tissue should be investigated with respect to the cytosis process and the mechanism of utilization of exogenous substances in the liver cells making use of the lysosome concept. (Auth)

<236>
Tsarapkin, S.P., and Z.G. Sych, Not given. 1961

Effects of Plutonium 239 and Strontium 89, 90 on Albino Rat Marrow. AEC-tr-7512; Part of Lebedinskii, A.V. and Moskalev, Yu.I., Distribution, Biological Effects, and Migration of Radioactive Isotopes, (p. 332-338), 408 p.

Experiments were done on albino rats ranging in age from 2.5 to 3 months and weighing 85 to 129 grams. A mixture of strontium 90 and strontium 89 in a ratio of 5:1 was used. Strontium 90 was in balance with its daughter product, yttrium 90. Plutonium 239 was administered in the form of a citrate complex. Both isotopes were injected intraperitoneally in doses of 1.5 uCi/gram for strontium 89, 90 and 0.0035 uCi/gm for plutonium 239. These doses constitute the subacute effective level (LD 50/30). The results show certain features in common in bone marrow reactions to equieffective quantities of strontium 89, 90 (1.5 uCi/gram) and plutonium 239 (0.0035 uCi/g), namely: greater sensitivity of cells of the erythropoietic class, as compared to the granulopoietic class, presence of an initial hyporegenerative phase, increased number of degenerative cells and pathological mitoses. Unlike strontium, the reaction of bone marrow to plutonium is characterized by suppression of the hyperregenerative phase and injury to reticuloendothelial and histiocytic cells. (Auth) (FMM)

<237>
Tseveleva, I.A., and R.A. Yerokhin, Not given. 1969

Behavior of Americium 241 in the Body of Rats Under Intraperitoneal and Intratracheal Administration. AEC-tr-7195; Part of Moskalev, Yu.I. (Ed.), Radioactive Isotopes and the Body, (p. 161-167), 458 p.

Experiments were conducted on rats of the Wistar Strain with an initial weight of 160-180 g. Americium was administered in the form of a nitric acid solution at pH 3.8 with an activity of 1 uCi in a volume of 1 ml for intraperitoneal administration and 0.3 ml in the case of intratracheal administration. After sacrifice, the Am content was determined in the liver, thigh, kidneys, spleen, and lungs of the rats. The results show that with intraperitoneal administration of Am nitrate, the liver and skeleton are the basic organis of deposition. The maximum content of Am in the liver(64.8%) was observed after 1 day and after 30 days in the skeleton (14.6% of the administered dose). Ninety-five and six tenths percent of Am is eliminated with T 1/2=14.4 days from the liver. The Am content in the skeleton decreases with T 1/2=406 days. One hour after intratracheal administration of Am nitrate about 70% of the radioelement is observed in the lungs. Elimination of Am from this organ occurred with 3 effective half-lives: 22.4 hours (40% of the radioelement), 5.9 days (55%) and 195 days (3%). By the 15th day after intratracheal administration, a considerable quantity of Am was deposited in the liver (19%) and skeleton (26.5%). Ninety-three percent of the isotope was eliminated from the liver with T 1/2=8.66 days. The period for the elimination of Am from the skeleton was equal to 298 days. A comparison was made of tissue doses in odgans of rats following administration of Pu nitrate at the same levels of activity as the Am used in the experiments. It was seen that under intraperitoneal administration of Am the ionization dose in the skeleton, i.e., in the critical organ for this method of administration, was lower than the dose produced by Pu by a factor of 2-2 1/2. Under entry of Am into the respiratory tracks the lungs receive a dose that is 2 1/2-3 1/2 times lower as compared with the dose which this organ receives in the case of Pu administration. (FMM)

Table 4 gives a comparison of tissue doses in organs of rats following a single administration of 1 uCi of Am 241 or Pu 239 in the form of a nitrate.

<238>
Van Cleave, C.D., University of North Carolina, School of Medicine, Chapel Hill, NC. 1963, March

Irradiation and the Nervous System. Bowman and Littlefield, Inc., New York, New York; 424 p.

This book attempts to give a comprehensive survey of the effects of ionizing radiation on the functional, behavioral, and morphological responses of the central

<238> CONT.
nervous system. A large amount of information is covered. The bibliography includes work done in the United States and also other countries, including the USSR. Most of the chapters are devoted to morphologic information, but a compilation of physiological and psychological studies relating to the effects of ionizing radiation is also presented. For example, the effects of ionizing radiation on learning in a wide range of animal species, especially monkeys, are summarized. Chapters on the effects of radiation on sensory receptors and behavioral response are included. (ST)

<239>
Vaughan, J., B. Bleaney, and D.M. Taylor, Churchill Hospital, Bone Research Laboratory, Oxford, England; Institute of Cancer Research, Royal Cancer Hospital, Sutton, Surrey, England. 1973

Distribution, Excretion and Effects of Plutonium as a Bone-Seeker. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 10. Springer-Verlag, New York, New York, (p. 349-502), 995 p.

The biological behavior of plutonium in man and various laboratory animals is reviewed under the following headings: The metabolism of Pu 239 with special reference to the skeleton, other plutonium isotopes, the pattern of Pu 239 distribution in the skeleton, the binding of plutonium in bone, theory and technique of alpha dosimetry with particular reference to the skeleton, radiation dose measurements from deposition of Pu 239 in the skeleton, effects of Pu 239 deposition in the skeleton, and removal of internally deposited Pu from the skeleton. Aspects of plutonium metabolism studied were species and age differences; effect of route of entry on skeletal metabolism; effects of chelating agents; differences in the behavior of Pu 239, 238, and 237; tumorigenesis; plasma transport and clearance; excretion; retention; skeletal burden; microdistribution in bone and bone marrow; binding in bone; theory and techniques of measuring radiation from alpha particles; dose rates to the skeleton; and radiation effects. (ST)

<240>
Volf, V., Kernforschungszentrum Karlsruhe, Institut fuer Strahlenbiologie, Karlsruhe, German Federal Republic. 1974, July

Combined Effect of DTPA and Citrate on an Intramuscular Plutonium 239 Deposit in Rats. Health Physics, 27, 152-153

Male rats were injected intramuscularally with 0.5 uCi Pu 239 in 10 ml 3N HNO3. One hour later, 0.2 M solutions of Ca DTPA and/or sodium citrate were injected into the Pu deposit. The rats were sacrificed 24 hr after administration of Pu and assayed for alpha activity. Results show that absorption of Pu from the injection site is increased by DTPA to a markedly higher extent than by citrate. The combined administration of the half doses of each agent, however, is clearly more effective than DTPA alone, although the uptake of Pu by bone and liver is reduced by DTPA irrespective whether given alone or with citrate. Citrate, on the other hand, produces a strikingly increased retention of Pu. The synergistic action of DTPA and citrate might be explained by the formation of a mixed ternary complex. (RAP)

<241>
Vorwald, A.J., A.L. Reeves, and E.C.J. Urban, Wayne State University, School of Medicine, Department of Occupational and Environmental Health, Detroit, MI. 1966

Experimental Beryllium Toxicology. Part of Stockinger, H.E. (Ed.), Beryllium: Its Industrial Hygiene Aspects, Chapter 7. Academic Press, New York, New York, (p. 201-234), 394 p.

Experimental studies concerning the toxicity of various beryllium compounds following inhalation or intratracheal injection and utilizing a variety of laboratory animals are reviewed. Efforts to produce experimentally acute beryllium pneumonitis met with early success. In addition it was found that certain beryllium compounds have an affinity for bone and produce osteosarcoma. Pulmonary cancer was produced in rats and monkeys following inhalation or lung deposition. Therapeutic studies showed that aurintricarboxylic acid (ATA) is an effective chelator of beryllium. Results of studies on the biological activity, transport, storage, elimination, and systemic effect of beryllium are also briefly reviewed. (ST)

<242>
Wallace, A., University of California, Soil Science and Agricultural Engineering, Riverside, CA. 1972, May 15

Effect of Steam Sterilization of Soil on Response of Two Desert Plant Species. UCLA-34-P-51-35; Part of Behavior of Certain Synthetic Chelating Agents in Biological Soil Systems, Annual Progress Report, (p. 27-30), 99 p.

FRANSERIA DUMOSA and HILARIA RIGIDA seedlings were grown in potted soil which was collected at the Nevada Test Site near Mercury, Nevada. The soil represented areas under shrubs and also areas between shrubs. Soil was either steam sterilized or not steam sterilized. The sterilization greatly decreased yields possible because of induced phosphorus deficiency. It was suggested that symbiotic mycorrhizae necessary for P absorption for the species involved might have been eliminated. There was an interaction in that plants did not grow well in soil from under shrubs regardless of steaming indicating possible allelopathic effects. Sterilization increased both Mn and Zn in plants. (Auth)

<243>
Wallace, A., A.M. Abou-Zamzam, G. Alexander, F. Brinkerhoff, C.R. Carmack, A. ElGazzar, E.F. Frolich, V.Q. Hale, C. Joven, H.H. Young, E. Motoyama, R.T. Mueller, E.M. Romney, and S.M. Suffi, University of California, Los Angeles, CA. 1971

Regulation of the Micronutrient Status of Plants by Chelating Agents and Other Factors. UCLA-34-P-51-33; Edwards Brothers, Inc., Ann Arbor, Michigan; 309 p.

The major part of the book contains progress reports of the use of chelating agents in plant nutrition and of the micronutrient status of plants. The rest of the book contains a list of reports on chelating agents in plant nutrition covering the past decade (up to 1971) and partial reviews of several other aspects of micronutrient nutrition of plants. Significant phenomena and newly developed concepts, the current

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status of the use of metal chelates in plant nutrition, metal chelation and mechanisms of metal function in biological systems, the status of general rules concerning plant nutrients and general conclusions concerning chelating agents in plant nutrition are discussed. Three articlesthat discuss the uptake of Am 241 in plants were separately entered in the data base. (RAF) (CTS)

<244>
Wallace, A., A.M. Abou-Zamzam, G. Alexander, F. Brinkerhoff, C.R. Carmack, A. ElGazzar, E.F. Frolich, V.Q. Hale, C. Joven, H.H. Young, E. Motoyama, R.T. Mueller, E.M. Romney, and S.M. Suffi, University of California, Los Angeles, CA 90024. 1971

Effect of Citrus Rootstock and Chelating Agent on Specifc Activity of Iron and Zinc in Shoots of Grafted Plants and on Iron 59, Zinc 65, Lead 210, and Americium 241 Contents in the Shoots. UCLA-34-P-51-33; Part of Wallace, A., et al, Regulation of the Micronutrient Status of Plants by Chelating Agents and Other Factors. Edwards Brothers, Inc., Ann Arbor, Michigan, (p. 168-172), 309 p.

Valencia orange scions were grafted to rough lemon or trifoliate orange rootstocks and grown for 119 days with and without chelating agents in calcareous Hacienda loam soil to which high specific activity Fe 59, Zn 65, Pb 210 or Am 241 had been mixed. Mineral analyses were determined after 85 days in leaves and stems of suckers growing from the rootstocks and also in new and old leaves and stems of the scions after 119 days. The chelating agents had little effect on Fe content of the plants but they increased considerably the specific activity of the Fe in the shoots. PA 157 increased it more than DTPA did and the effects were much more pronounced with rough lemon rootstock than with trifoliate orange. DTPA increased the Zn 65 contents but with rough lemon more so than with trifoliate orange. It did not consistently increase Zn content. No effects were noted for contents of Pb 210 in shoots; virtually none was present. DTPA did increase the contents of Am 241 in shoots of both rootstock-scion combinations. (Auth)

<245>
Wallace, A., A.M. Abou-Zamzam, G. Alexander, F. Brinkerhoff, C.R. Carmack, A. ElGazzar, E.F. Frolich, V.Q. Hale, C. Joven, H.H. Young, E. Motoyama, R.T. Mueller, E.M. Romney, and S.M. Suffi, University of California, Los Angeles, CA. 1971

Retranslocation of Americium 241 in Bush Beans. UCLA-34-P-51-33; Part of Wallace, A., et al, Regulation of the Micronutrient Status of Plants by Chelating Agents and Other Factors. Edwards Brothers, Inc., Ann Arbor, Michigan, (p. 96-97), 309 p.

Since the chelating agent DTPA has been shown to increase Am 241 uptake by plants, this study was made to determine if DTPA had any effect on retranslocation of Am 241 once it was accumulated in plants. Plants were allowed to accumulate Am 241 and then the Am 241 was removed and plants were allowed to grow to maturity with and without DTPA. Am 241 initially after absorption was largely located in leaves of plants. During a subsequent growth period some of the Am 241 was transported from the old leaves to the new leaves and to new roots. The chelating agent DTPA had no effect on the retranslocation. (Auth) (RAF)

<246>
Wallace, A., A.M. Abou-Zamzam, G. Alexander, F. Brinkerhoff, C.R. Carmack, A. ElGazzar, E.F. Frolich, V.Q. Hale, C. Joven, H.H. Young, E. Motoyama, R.T. Mueller, E.M. Romney, and S.M. Suffi, University of California, Los Angeles, CA. 1971

Effects of Micronutrient and DTPA Applications on Americium 241 and Micronutrient Contents of PI54619-5-1 Soybeans Grown in Calcareous Hacienda Loam Soil. UCLA-34-P-51-33; Part of Wallace, A., et al, Regulation of the Micronutrient Status of Plants by Chelating Agents and Other Factors. Edwards Brothers, Inc., Ann Arbor, Michigan, (p. 8-9), 309 p.

PI54619-5-1 soybeans which are susceptible to lime-induced chlorosis were grown in calcareous Hacienda loam soil with micronutrient and chelate additions. Am 241 which had been mixed with the soil was greatly increased in plants to which iron DTPA had been added to the soil. Applications of high levels of Zn or Mn decreased Am 241 content of plants only slightly. The Fe DTPA was of slight value only in correcting the lime-induced chlorosis. The 4 pounds per acre of Fe as DTPA increased Zn contents of leaves as much as did 100 pounds per acre of added Zn. Manganese increased Mn contents of leaves; 200 pounds Mn per acre doubled the Mn content. (Auth)

<247>
Wildung, R.E., and T.R. Garland, Battelle Memorial Institute, Pacific Northwest Laboratories,, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1973, March

Development of Methods for Measurement of Plutonium Complexation in Soil and Uptake by Plants. BNWL-1750 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1972, (p. 2.7-2.8), 105 p.

Basic procedures for the assessment of the potential entrance of Pu into the food chain at the soil-plant level are presented. Studies were undertaken to determine 1) the effects of Pu on the soil microbial population and on soil microbial processes, 2) the potential for formation of Pu complexes in soil and the role of the soil microflora in this process, 3) the extent of plant uptake and translocation of Pu or its complexes, and 4) the bond types and chemical forms of metabolites in microbial and plant tissues and soils. (RAF)

<248>
Wildung, R.E., T.R. Garland, and H. Drucker, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1974, January

Potential Role of the Soil Microbiota in the Solubilization of Plutonium in Soil. BNWL-1850 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1973, (p. 21-22), 200 p.

To provide a preliminary assessment of the potential for microbial alteration of Pu solubility in soil under aerobic conditions, soils, sterilized by gamma irradiation were treated and incubated. The soil respiration rate was measured. Sterile and non-sterile soils during a 30-day incubation period

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containing 10 uCi/g of soil, were subsampled and suspended in 1 liter of distilled water and filtered after a 4 hr equilibration period through 5, 0.5 and 0.05 u millipore filters. The Pu in the 0.5 and 0.1 u filtrates was designated water soluble. Plutonium solubility in the non-sterile soil, while initially lower, increased by a factor of 3 with incubation time to 14 days and remained significantly higher than the sterile soil during the incubation period. The increase generally followed the accumulation carbon dioxide curve, and maximum solubility occurred at the end of logarithmic growth for all classes of organisms. (Auth) (PAF)

<249>
Wildung, R.E., and T.R. Garland, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1974, January

Influence of Soil Microbial Activity on the Uptake and Distribution of Plutonium in the Shoots and Roots of Barley. BNWL-1850 (Part 2); Part of Vaughan, B.F., et al, Annual Report for 1973, (p. 22-24), 200 p.

In order to determine the distribution of Pu in the structural components of plants grown on Pu containing soil and to determine if the increased Pu solubility on incubation resulted in increased Pu uptake by plants, the soil were incubated, planted to barley and cultured using a split-root technique which allowed measurement of the uptake, sites of deposition and chemical form of Pu in plant shoots and roots. The results were compared to the results of similar plant studies in which the soils had not been incubated. The concentration of Pu in barley shoots and roots decreased with decreased soil Pu concentration regardless of the culture method employed. The Pu levels in barley roots differed markedly from the shoots with levels of Pu exceeding the shoots by factors of 3 to 8, depending on soil Pu concentration. In the shoots Pu was concentrated near the crown; in the roots Pu was distributed over the entire length of the root. Findings suggest that the Pu in the roots originated from the soil and was translocated downward from the soil in the root system. Implications of these findings in terms of evaluation of Pu hazards in the environment are discussed. (Auth) (RAF)

<250>
Willard, D.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1967, July

Retention of Plutonium Oxide Microspheres in Beagle Dog Lungs. BNWL-480; Part of Thompson, R.C. and Swezea, E.G. (Eds.), Annual Report for 1966, (p. 87-88), 207 p.

Beagle dogs were exposed to 50 u Pu 238 PuO2 microspheres dispersed in air or given single 120 u Pu 238 PuO2 microspheres by pulmonary intubation. Whole-body scanning techniques were used to follow the course of the particles in the dog. It was found that alveolar deposition was minimal in dogs that inhaled 50 u Pu 238 PuO2 microspheres only one particle being found in the lung of a dog sacrificed immediately after exposure. Two dogs retained single 120 u microspheres for more than 6 months. The only biological effect observed in dogs which retained particles for 6 months was a possible reduction of circulating lymphocytes. (Auth) (FMM)

<251>
Willard, D.H., and B.O. Stuart, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Pulmonary Deposition and Retention of Plutonium 238 Dioxide Microspheres in Beagles. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 4.3-4.6), 253 p.

Two series of experiments were performed. The first involved inhalation of 50 u Pu 238 PuO2 microspheres dispersed in air; the second involved pulmonary intubation of 50, 120, or 300 u microspheres under sodium pentothal anesthesia. Whole-body longitudinal scanning techniques were used to follow the course of the particles in the dogs. The results show that none of the 50 u Pu 238 PuO2 particles were deposited or retained in the lower respiratory tract of the dogs. Two dogs have retained single 120 to 300 u Pu 238 PuO2 particles in the lung over 1 year after deposition by pulmonary intubation. Such deposited microspheres are much less effective in producing a reduction in circulating lympocytes than would be an equivalent quantity of Pu distributed more uniformly throughout the lung. (Auth) (FMM)

<252>
Wilson, D.O., and J.F. Cline, Hanford Atomic Products Operation, Biology Laboratory, Richland, WA. 1964, January 15

Removal of Plutonium 239, Tungsten 185, and Lead 210 from Soil by Plants and Ion Extracting Solutions. HW-80500; Part of Kornberg, H.A. and Swezea, E.G. (Eds.), Hanford Biology Research Annual Report for 1963, (p. 187-190), 242 p.

The uptake of Pb 210 by barley was studied using a modified Neubauer technique. The uptake of W 185 and Pu 239 was studied by growing beans and barley in metal cans containing 1600 g of soil. The isotopes were added to the soil as K_2WO_4, $PbCl_2$, and $Pu(NO_3)_4$. Two soil types, Cinebar and Ephrata, were used in the Pb 210 studies and these, combined with a third soil type, Willville, comprised the soil types used in the W 185 and Pu 239 studies. It was found that leaf-to-soil ratios ranged from <0.000015 to 0.00026 for Pu 239, from 0.002 to 0.005 for Pb 210 and from 0.009 to 0.28 for W 185. All extracting agents removed greater quantities of Pu 239 and W 195 than did plants. A 200:1 molar excess of DTPA caused 28% of the Pu 239 to remain in the equilibrium solution of the Cinebar soil. (Auth) (FMM)

Table 2 shows uptake of W 185 and Pu 239 by plants grown in cans containing three different soil types. Table 3 shows removal of Pu 239 and W 185 from soils using different extractants.

<253>
Balabukha, V.S., L.I. Tikhonova, L.M. Razbitnaya, D.D. Smolin, N.O. Razumovskii, and O.L. Torchinskaya, Not given. 1966

Physicochemical Approach to the Selection of Organic Compounds Designed to Eliminate Radioactive Substances from the Organism. AEC-tr-6944 (Rev.); Part of Moskalev, Yu.I., Distribution and Biological Effects of Radioactive Isotopes, (p. 581-591), 718 p.

A physiochemical approach to finding effective organic complex forming agents that can eliminate radioactive isotopes from the organism was emphasized. The dependence of complex formation of nine chelating compounds with strontium, yttrium, cerium, zirconium, uranium, and ruthenium on the physiochemical properties of the element concerned, the selectivity of the isotope with respect to specific atoms of the organic complex former, and the formation of highly stable complexes is discussed. (ST)

<254>
Benck, R.F., C. Crisco, A.W. Runquist, and E.F. Holdsworth, U.S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, Aberdeen, MD; Northwestern University, Department of Chemistry, Evanston, IL; Arizona State University, Department of Geology, Tempe, AZ. 1973, August

Characterization of Fallout Particles from Electron Microprobe X-Ray Analyses. Health Physics, 25, 188-191

The association of radioactivity of fallout particle with specific elemental distribution within the particle was studied. Samples of this study originated from 5 U.S. nuclear detonations (2 in the Pacific, 3 in Nevada). Qualitative compositions of 33 particles were determined by electron microprobe analysis of numerous areas. Fallout particles are generally a heterogeneous mixture of various elements indigenous to the detonation location. In general, matrices of particles formed in the Pacific were rich in Ca and Mg. Matrices of Nevada formed particles were generally an aluminum silicate with traces of Fe, Ca and K. In addition to these particles, small, clear, fused, glassy, highly radioactive spheres were common to all detonations. Such spheres were usually fused silica, containing varying amounts of homogeneously distributed Fe, Al and K. In a majority of fallout particles studied, radionuclides were concentrated in specific areas rich in Fe, relative to the bulk particle. The only fallout particles that were homogenous in elemental composition and radioactivity distribution were from the Pacific detonations. (Auth) (RAF)

Additional details of fallout particles analyses are given in two companion reports, BRLR-1470 and BRLR-1611.

<255>
Bishop, C.T., M.M. Bolton, M.L. Curtis, J.O. Erve, R.K. Gillette, and E.B. Nunn, Mound Laboratory, Miamisburg, OH. 1971, November 15

Determination of Plutonium in Soil. MLM-1815; Part of Mound Laboratory Chemistry and Physics Progress Report, January-March, 1971, (p. 18-28), 28 p.

Progress is reported on a method for the determination of plutonium in soil by a fusion technique. Several blank determinations were made to examine the possibility of contamination of the reagents or glassware. A plutonium 236 tracer was added to all the blanks and carried through the entire procedure as a check on percent recovery. Four soil samples and two standard plutonium samples were analyzed. (ST)

<256>
Bojanowski, R., H.D. Livingston, D.L. Schneider, and D.R. Mann, Woods Hole Oceanographic Institution, Woods Hole, MA. 1973

A Procedure for Analysis of Americium in Marine Environmental Samples. COO-3563-8; Part of IAEA Technical Report Series on Reference Methods for Marine Radioactivity Studies. 2. Ruthenium, Iodine, Silver and the Transuranic Elements, (9 p.)

A method is described for the measurement of americium in marine environmental samples. An alpha-emitting radiotracer, Am 243, is used to measure the radiochemical yield of Am 241 separated from a sample. A lanthanide carrier is used in preliminary concentration of americium from sample matrix elements. Various combinations of hydroxide and oxalate precipitations are used. After the concentration steps, the lanthanide/americium fraction is radiochemically purified by ion exchange from alpha-emitting isotopes of the natural radioactive series. Following purification the Am is electroplated for alpha-spectrometry. The activity of Am 241 and of the Am 243 yield-monitor are measured using a high resolution surface barrier detector. Some data are presented to show the method is capable of acceptable accuracy and precision. An extensive series of notes discusses the rationale for various steps in the procedure. (Auth) (FMM)

<257>
Buldakov, L.A., E.R. Lyubchanskii, Yu.I. Moskalev, A.P. Nifatov, A.A. Horvath (Translator), and R.G. Thomas (Ed.), Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1970, June

Physical and Chemical Properties of Plutonium 239. LF-tr-41; Part of Buldakov, L.A., et al, Problems of Plutonium Toxicology, (p. 3-5), 225 p.

The chemical and physical properties of plutonium are reviewed. The dependence of distribution of plutonium in the human body, its biological effect, and fate on chemical properties is discussed. (ST)

<258>
Carpenter, B.S., and C.H. Cheek, National Bureau of Standards, Institute for Materials Research, Washington, DC; Howard University, Department of Chemistry, Washington, DC. 1970, January

Trace Determination of Uranium in Biological Material by Fission Tract Counting. Analytical Chemistry, 42(1), 121-123

A nuclear track technique for determining trace amounts of uranium in biological materials is described. Samples of human whole blood and plasma were placed on a Lexan slide and irradiated and the resultant etched fission tracks were counted with the aid of an optical microscope. The determinations of uranium in human whole blood and plasma are given in tabular form. (ST)

<259>

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<259>
Casarett, A.P., Cornell University, New State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Chemistry. Part of Radiation Biology, Chapter 4. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 57-89), 368 p.

The principles of general radiation chemistry are reviewed and in particular the chapter deals with the ionization of molecules, changes produced in them and the changes they produce, secondarily, in other atoms and molecules. The effects of radiation on water (ionization and production of free radicals) and simple aqueous inorganic and organic solutions are discussed. The last part of the chapter considers the radiation induced changes in the molecules which are of particular importance to the structure and function of a living cell. Effects on proteins, enzymes, nucleic acids, lipids, and carbohydrates are discussed. (ST)

<260>
Clanet, F., J. Ballada, J. Lucas, and C. Gil, Faculte de Pharmacie, Laboratoire de Chimie Minerale et d'Hydrologie, 37-Tours, France; Commissariat a l'Energie Atomique, Department de Protection, Fontenay-aux-Roses, France. 1973, July; 1972

Determination of Urinary Plutonium by Radiochemical Analysis on Ion Exchange Filters. LA-tr-73-39; 6 p.; Health Physics, 23, 245-247

A new method for determination of urinary plutonium is described. Known amounts of Pu 239(+4) were added to human urine collected in concentrated hydrochloric acid. The plutonium was purified and fixed on Amberlite SB-2 filters. Following elution and evaporation the radioactivity of the residue was measured. The detection limit was 1 pCi Pu 239/l of urine. The average recovery yield was 80%. This method reduced analysis time by one-half when compared to the classic method using columns of ion exchange resins. (ST)

Translated by Kanner Associates, Redwood City, California for Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

<261>
Cole, A., D.J. Simmons, H. Cummins, F.J. Congel, and J. Kastner, Argonne National Laboratory, Radiological Physics Division, Argonne, IL. 1970, July

Application of Cellulose Nitrate Films for Alpha Autoradiography of Bone. Health Physics, 19, 55-56

High resolution autoradiographs of bone containing Pu 239 were prepared by coating sections with cellulose nitrate detector films that are selectively sensitive to alpha particles. The radiation damaged sites in the polymer were developed by etching with NaOH. The cellulose nitrate method provides an alternative to autoradiography with nuclear emulsions. It does not require darkroom facilities. The films are very stable and will not fog during long exposures at room temperature. (Auth) (ST)

<262>
Darrall, K.G., G.C.M. Hammond, and J.F. Tyler, Laboratory of the Government Chemist, Department of Trade and Industry, London, England. 1973, May

The Determination of Plutonium 241 in Effluents. Analyst, 98, 358-363

A method is described for the simultaneous determination of plutonium 241 and plutonium alpha-activity. The plutonium is isolated by coprecipitation on barium sulphate followed by extraction into di(2-ethylhexyl)-phosphoric acid, which is incorporated in a liquid scintillator for counting in a liquid scintillation spectrometer. Interferences from alpha and beta emitting radionuclides are studied together with interferences from non-radioactive elements. The lower limit of detection is in the region of 1 pCi. (Auth)

<263>
Gindler, J.E., Argonne National Laboratory, Argonne, IL. 1973

Physical and Chemical Properties of Uranium. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 2. Springer-Verlag, New York, New York, (p. 69-164), 995 p.

The physical and chemical properties of uranium are reviewed. Physical properties are discussed under the headings extra-nuclear properties and nuclear (isotopes and nuclear fission) properties. The chemistry of uranium is discussed under the headings: metallic uranium; compounds of uranium and non-metallic elements; uranium salts, hydrated oxides, uranates, and peruranates; and uranium in solution. The preparation and properties of metallic uranium, chemical preparation and reactions of primarily binary and a few mixed uranium compounds, and the preparation and properties of a few uranium (+4) and (+6) salts important to uranium technology are discussed. (ST)

<264>
Higgins, G.H., Lawrence Radiation Laboratory, Livermore, CA. 1960, October 25

The Radiochemistry of the Transcurium Elements. NAS-NS-3031; 35 p.

The volume deals with the radiochemistry of the transcurium elements and is of use to the radiochemist and research workers in the fields of physics, biochemistry, or medicine. Included is a review of the nuclear and chemical features of particular interest to the radiochemist, a discussion of problems of dissolution of a sample and counting techniques, and a collection of radiochemical procedures for the element as found in the literature. (ST)

<265>
Jackson, D.D., J.E. Rein, and G.R. Waterbury, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973

Chemical Assay of Plutonium for Safeguards. LA-UR-73-1585; CONF-731101; Part of Proceedings of the Joint Meeting of the American Nuclear Society and the Atomic Industrial Forum and Nuclear Energy Exhibition held in San Francisco, California, November 11-15, 1973, (18 p.); Transactions of the American Nuclear Society, 17, 303-304

An analytical methodology used for Pu assay for various nuclear fuel cycle materials with emphasis on LASL practices is presented.

<265> CONT.
When selecting an analytical method, the interplay of desired precision and accuracy levels, selectivity, and time consumption must be considred. For the assay of relatively pure product materials, generally with high Pu content, very reliable methods are required. For pure product materials, highly selective methods are not required. Generally, titrimetric methods are favored using techniques of potentiometry, visual-indicator end-point detection, amperometry, coulometry, and calorimetry. As these highly precise methods are complex, time consuming, and require highly skilled analysts, automation is needed. Less reliable methods are acceptable for heterogenerous scrap-type materials with low Pu contents. An alternate type of assay for scrap-type materials is being developed. This assay involves high-temperature, high pressure acid attack to solubilize 90% or more of the Pu, analysis of the low-Pu residue by a gamma-ray assay, and analysis of the Pu-rich soluble fraction with an automated spectrophotometer. The gamma-ray assay system emphasizes simplicity of operation and low-cost apparatus with an operational goal of 10% precision for the analysis of 10% or less of the total Pu. The automated BROMUS sp.; TRAGOPOGON sp.; LACTUCA SCARIOLA; THOMOMYS TALPOIDES; PEROMYSCUS method for measuring 0.5 to 12 mg of Pu in a sample volume of 0.5 ml or less. The relative standard deviation is 1% or less for measuring more than 1 mg of Pu. The instrument takes up to 24 samples with a throughput rate of 5 min/sample. For Pu isotopic abundance measurement, thermal ionization mass spectrometers are used almost universally. Samples are subjected to chemical separation procedures to obtain a pure Pu fraction which then is placed in the mass spectrometer where the relative abundances of the 238 through 242 masses are measured. The status of Pu physical standards is discussed. (Auth)(RAF)

<266>
Kahn, B., National Environmental Research Center, Radiochemistry and Nuclear Engineering Research Division, Cincinnati, OH. 1973

Determination of Radioactive Nuclides in Water. Part of Ciaccio, L.L. (Ed.), Water and Water Pollution Handbook, Volume 4, Chapter 25. Marcel Dekker, Inc., New York, New York, (p. 1357-1388)

This chapter summarizes the techniques of analytical radiochemistry with special consideration given to the analysis of water samples. Radionuclides in water are first discussed in terms of permissible and actual concentrations. The two components of analytical radiochemistry--chemical separation and radiation detection--are then described, and a typical analysis is presented step by step. Finally, instrumental calibration, some important variant procedures, and specific analytical problems are considered. (ST)

<267>
Keenan, R.G., U.S. Public Health Service, Division of Occupational Health, Physical and Chemical Analysis Section, Cincinnati, OH. 1966

Analytic Determination of Beryllium. Part of Stokinger, H.E. (Ed.), Beryllium: Its Industrial Hygiene Aspects, Chapter 5. Academic Press, New York, New York, (p. 133-165), 394 p.

Analytical methods for the determination of submicrogram quantities of beryllium in atmospheric samples and biologic substances are reviewed. A critical examination of the ashing procedures for biologic materials, the fusion methods for the decomposition of beryllium ores and refractory forms of beryllium oxide, the physical and chemical separation procedures, and the chemical, fluorometric, and spectrographic methods for the determination of beryllium is presented. The special precautions peculiar to each preparatory and determinative type of method are emphasized. A tabulation of the chemical methods along with their individual applications is provided as a guide to the chemist or technician who must use these procedures. Two spectrographic methods, a highly sensitive and specific fluorometric method for all types of samples, and a simplified morin method for air samples are recommended. In addition, two rapid and direct spectrographic methods for the analysis of beryllium in air samples are included. (ST)

<268>
Keough, R.F., and G.J. Power, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1970, March

Determination of Plutonium in Biological Materials by Extraction and Liquid Scintillation Counting. Analytical Chemistry, 42(3), 419-421

A method for the determination of plutonium in biological materials is described. The method utilizes the direct extraction of plutonium from the acidic solution of sample ash into a toluene solution of di(2-ethylhexyl) phosphoric acid (D2EHPA) and scintillators. Extraction is carried out in the counting vial. Liquid scintillation counting is done with both phases present in the vial. Counting efficiencies of 100% were obtained in scintillator solutions containing as high as 1.7 M D2EHPA. The effect of various ions on recovery of plutonium from nitric acid are listed. Detection limit depends on a number of factors, but one disintegration/min-gram of wet sample can be measured with a five minute count. The technique can be extended to the determination of other alpha and beta emitters by the proper selection of extractants, solvents, and aqueous phases. (ST)

<269>
Koide, M., and E.D. Goldberg, Scripps Institution of Oceanography, La Jolla, CA. 1965

Uranium 234/Uranium 238 Ratios in Seawater. Part of Progress in Oceanography, Vol. 3. Pergamon Press, Oxford, England, (p. 173-177)

The importance of radioactive disequilibrium within the natural uranium 238 series in various natural systems, has steadily gained importance especially in geochronological and geochemical studies. Recently, Russian workers have shown that the parent member, U 238, and the daughter, U 234, in groundwaters do not exist in radioactive equilibrium concentrations. It has been postulated that while U 238 exists in crystal rocks primarily in the +4 state, as a result of the radioactive decays producing the daughter U 234, electrons are lost from the nucleus such that a part of the U 234 ends up in the +6 state. The latter form is preferentially brought into solution by weathering waters due to the formation of the strong complexes

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<269> CONT.
formed between uranyl and carbonate ions. Thus, the activity ratio A(U 234)/A(U 238) often exceeds one in surface waters. Experimentally determined values of the activity ratio in surface and deep seawaters from the Atlantic and Pacific Oceans and the Mediterranean Sea are uniform with a value of 1.14 plus or minus 0.014. The error arises from the counting statistics in the radioactive assay of the alpha particles emitted by these two isotopes of uranium. This constancy in the ratio is consistent with the long residence time of uranium and relative lack of reactivity in seawaters. (Auth)

<270>
Kressin, I.K., W.D. Moss, E.E. Campbell, and H.F. Schulte, Los Alamos Scientific Laboratory, Health Division, Industrial Hygiene Group, Bioanalytical and Chemical Section, Los Alamos, NM. 1974; 1975, January

Plutonium 242 vs Plutonium 236 as an Analytical Tracer. LA-UR-74-180; 17 p.; Health Physics, 28, 41-47

Plutonium 242 was compared to Pu 236 as a tracer isotope in the analysis of very low levels of Pu 238 and Pu 239, and it was found that the Pu 236 tracer, because of its daughters, contributes to the background level for Pu 238. This increased background becomes intolerable at the higher levels of the Pu 236 tracer because of the large variation in the background values. In contrast, the background values for Pu 238 and Pu 239 remain constant when the Pu 242 is used as a tracer isotope in the analysis. Plutonium 242 solutions show no ingrowth of daughters whereas Pu 236 solutions require periodic purification and standardization to remove the U 232 and Th 228 daughters which interfere in the alpha spectrometry. (Auth)

<271>
Levine, H., and A. Lamanna, U.S. Department of Health, Education and Welfare, Public Health Service, Division of Radiological Health, Radiochemistry Support Laboratory, Washington, DC. 1965, March

Radiochemical Determination of Uranium in Environmental Media by Electrodeposition. PHS-999-RH-11; 21 p.

Uranium is isolated by either of two techniques: adsorbing on a strongly basic ion-exchange resin pretreated with 6N HCl, washing with 9N HCl to remove interfering ions, and eluting with 1N HCl; or salting with aluminum nitrate, followed by extracting with ethyl acetate and stripping with water. It is then electrodeposited on a nickel-plated copper disc from a dilute ammonium oxalate solution. Electroplating efficiencies are about 85 to 95 percent. A regulated power source connected in parallel permits several electroplating operations to proceed simultaneously. The procedure has been applied to a series of spiked solutions with reproducible results. Maximum deviation is less than 5 percent for any one determination. Beer's law is followed over a range of 10(E-5) to 5.0 g. uranium. The method is applicable to samples of biological materials as well as to environmental media. (Auth)

<272>
Livingston, H.D., D.R. Mann, and V.T. Bowen, Woods Hole Oceanographic Institution, Woods Hole, MA. 1972

Double Tracer Studies to Optimize Conditions for the Radiochemical Separation of Plutonium from Large Volume Seawater Samples. COO-3563-12; CONF-7210109; Part of Proceedings of a Symposium on Reference Methods for Marine Radioactivity Studies: Determination of Transuranic Elements, Radioruthenium and Other Radionuclides in Marine Environmental Samples held in Vienna, Austria, October 30-November 3, 1972, (11 p.)

By using two tracers of a single element as yield-monitors, adding one at late steps in a sequential procedure, it is possible straightforwardly to examine the conditions affecting efficiency at each step. In the analyses described, Pu 242 (about 2 disintegrations per minute) was added to seawater samples (50 to 60 liters), along with various carriers, and was used to determine the overall recovery of plutonium separated from the sample. Then recovery of Pu 242 at any chosen point in the procedure was measured by the addition of a similar amount of Pu 236 at that point and the percentage of Pu 236 finally recovered was used to calculate the Pu 242 recovery at the time of Pu 236 addition. The experience gleaned from these double tracer experiments has permitted improvements in the ability to recover plutonium from 50 liter seawater samples for L-spectrometric analysis of Pu 239/240 and, in some cases, Pu 238. Plutonium recoveries in excess of 50% have been recently routine, rather than exceptions as was the case prior to this study of the sources of losses during concentration and purification. (FNM)

<273>
Low-Beer, A. deG., Lawrence Livermore Laboratory, Livermore, CA. 1973

Bioassay of Plutonium. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 13. Springer-Verlag, New York, New York, (p. 593-611), 995 p.

The principles on which bioassay programs are based were reviewed and related to recommendations of the International Commission for Radiological Protection (ICRP). The general considerations that underlie a bioassay program for any of the transuranium elements are set forth. These include protocols for routine monitoring and for accidental exposures, methods of preparation of samples for radiochemical analysis, and instrumentation for detection of alpha radioactivity and low energy photons. Radiochemical procedures designed to isolate plutonium when it is the only nuclide of interest, but not when it is one of several actinide isotopes in a sample, are included in this chapter. Interpretation of bioassay results is discussed and equations relating excretion rates to body burden are presented. (ST)

<274>
Low-Beer, A. deG., Lawrence Livermore Laboratory, Livermore, CA. 1973

Bioassay of Transplutonium Elements. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 20. Springer-Verlag, New York, New York, (p. 909-928), 995 p.

<274> CONT.
The chapter is concerned with radiochemical and detection methods that have been designed to take advantage of the chemical and physical properties of the transplutonium elements that differ from those of plutonium. These relate to the predominantly trivalent state of the transplutonium elements and to the emission of abundant high energy gamma rays by many of them. Chemical procedures used for the separation of transplutonium elements are reviewed and modified methods designed to overcome the problems encountered in dealing with biological materials are presented. Characteristic alpha energies in addition to gamma emissions of characteristic energy and low energy photon spectra are used for detection and identification of individual radionuclides. Presently the interpretation of bioassay results depends on models that have been developed to describe the metabolic behavior of plutonium. However, data from recent investigations indicate that the transplutonium elements may have greater mobility and are excreted more rapidly than plutonium. (ST)

<275>
Lyon, W.S. (Ed.), and I. Brogden, Oak Ridge National Laboratory, Oak Ridge, TN. 1974, January

Radioanalysis of Environmental Materials. ORNL-4930; Part of Analytical Chemistry Division Annual Progress Report for Period Ending September 30, 1973, (p. 39-40), 87 p.

Analytical and general radiochemical studies related to programs of the Environmental Sciences Division are in progress. An investigation of methodology for determination of actinides in environmental materials such as soil, water, and biological matter has begun. Plutonium is the element of primary interest at this time because of its radiological significance in the LMFBR and radioisotope-source programs. It was suggested that the National Bureau of Standards supply calibrated solutions of Pu 236 to be used for simultaneous evaluation of recovery and counting efficiency in plutonium analysis. However, NBS and the AEC Health and Safety Laboratory (HASL) have chosen to use Pu 242 for this purpose. Soils and vegetable table matter of known plutonium content are being obtained from the International Atomic Energy Agency (IAEA) and from C.W. Sill (AEC, Idaho), and ASTM D-19 is planning a "round robin" on plutonium in water. It was desired to have a substitute for plutonium to permit exploratory work outside containment. A review of the radiochemical behavior of similar elements led to the suggestion that thorium would probably be best, and Th 234 is a satisfactory tracer. Plutonium 237 is a useful isotopic tracer and emits x and gamma radiations, thus avoiding complexities of alpha counting and permitting in situ measurements. Its properties and methods of production have been reviewed in anticipation of obtaining a supply. (FMM)

<276>
Major, W.J., R.J. Peters, R.A. Wessman, R.D. Szidon, and K. Lee, Trapelo/West, Richmond, CA. 1968

Determination of Americium 241 in Urine by Curium 244 Tracer. TWL-6011; CONF-680607; Part of Proceedings of the 13th Annual Health Physics Society Symposium held in Denver, Colorado, June 16-20, 1968, (16 p.)

A method has been developed for tracing Am 241 in urine samples with Cm 244. The chemical procedure consists of: wet ashing the sample with fuming HNO_3 and $HClO_4$, in the presence of Cm 244 tracer, extraction with HDEHP, purification and isolation with ion-exchange resins, and electrodeposition of platinum. The Am 241 content is measured by isotope dilution using alpha pulse-height analysis. Limits of detection are approximately 0.05 dis/min. for a thousand minute count. A typical chemical recovery is 65% and counting precision is within 3 per cent. Experiments to determine the feasibility of using Cm 244 for tracing Am 241 in urine samples showed statistically identical Am 241-Cm 244 ratios for electrodeposited standards and processed samples, indicating fractionation of Am-Cm did not occur. The advantages of the method are: a high degree of sensitivity; accuracy and freedom from other alpha emitters is obtained; no measurable residual activity from the tracer ever appears in spectra of the Am 241 energy region (as sometimes happens when Am 243 is used for tracing); and recoveries are precise and estimated yields are avoided. (Auth)

<277>
Martell, C.J., Los Alamos Scientific Laboratory, Los Alamos, NM. 1974, February

The Effect of Particle Size on the Carrier-Distillation Analysis of Plutonium Dioxide. LA-5454; 6 p.

Sample particle size is one of the parameters that must be controlled to ensure the similarity of samples and standards necessary for reliable spectrochemical analysis. In spectrochemical carrier-distillation analysis of PuO_2, significantly greater intensities are obtained from the impurity elements when the particle size of the PuO_2 is 45 um or less. Large PuO_2 particles, when present, reduce the intensities of the impurities and of cobalt, the internal standard. Because these intensity changes are not the same for each element, accurate spectrochemical values cannot be obtained when large PuO_2 particles are present. Proper preparation of the PuO_2 can be done easily by mortar grinding and mechanical mixing. (Auth)

<278>
McDowell, W.J., D.T. Farrar, and M.R. Billings, Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN; Tennessee Technological University, Department of Chemistry, Cookeville, TN. 1974

Plutonium and Uranium Analysis in Environmental Samples: A Combined Solvent Extraction-Liquid Scintillation Method. Talanta, 21, 1231-1245

A method for the analytical determination of uranium and/or plutonium by a combined high-resolution liquid scintillation--solvent extraction method is presented. Assuming a sample count equal to background count to be the detection limit, the lower detection limit for these and other alpha-emitting nuclides is 1.0 dpm with a Pyrex sample tube, 0.3 dpm with a quartz sample tube using present detector shielding or 0.02 dpm with pulse-shape discrimination. Alpha counting efficiency is 100%. Identification and quantitative determination of a specific alpha emitter independent of chemical separation are possible in this method. The separation procedure allows greater than 98%

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recovery of uranium and/or plutonium from solution samples containing large amounts of iron and other interfering substances. In most cases uranium, even when present in 10(E+8) fold mole excess, may be quantitatively separated from plutonium without loss of the plutonium. Special problems associated with the analysis of plutonium in soil and water samples are mentioned such as the question of whether a particular leaching, dissolution or fusion procedure places all of the Pu in a sample in solution. The availability of plutonium in the environment to milder leaching agents such as carbonic or acetic acids is a pertinent question relevant to the hazard that environmental plutonium presents to man and biota, and that the techniques presented are easily adapted to the assay of plutonium (or other alpha emitters) in such solutions. (Auth) (FMM)

<279>
Nomura, T., K. Sumazaki, S. Motoyama, and N. Suzuki, Tokai Works, Power Reactor and Nuclear Fuel Development Corporation, Tokai, Ibaraki, Japan. 1973, December

Rapid Determination of Plutonium in Bioassay Samples. PNCT-831-73-02; Part of Tokai Works, Semiannual Progress Report, January-June, 1973, (5 p.), 122 p.

A new modified procedure is described for the rapid determination of Pu in bioassay samples. The procedure has two characteristic points: the adoption of solvent extraction technique using tri-n-octyl amine (TOA) as the organic phase, and the use of Pu 236 tracer to correct the recovery of plutonium. Following separation, the purified Pu is electrodeposited into stainless steel discs and the Pu is determined by alpha spectrometry. Thirteen fecal samples and four urinary samples were tested using the procedure mentioned above. The average recoveries of plutonium were 82.4% and 70.9% for feces and urine, respectively. The recoveries range from 76.0% to 94.7% for feces, from 67.5% to 74.1% for urine. (FMM)

<280>
Not given, Philippine Atomic Energy Commission, Classification and Information Branch, Herran, Manila, Philippines. 1972, January

Cobalt 60: A Literature Search. PAEC(A)-727; 241 p.

This bibliography of 1,411 entries was prepared for scientists and researchers interested in the study of Co 60. Entries are listed under the following headings: chemistry, earth sciences; engineering; instrumentation; life sciences; metals, ceramics and other materials; physics (general); physics (high energy); physics (nuclear); and reactor technology. These references appear in Nuclear Sciences Abstracts (NSA) covering the period July 1955 to July 1970. The entries are arranged alphabetically by titles under their respective subject headings. Personal author and corporate author indexes are provided to facilitate prompt retrieval of the particular research information. (ST)

<281>
Not given, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1968, January 1

Health Physics and Safety Bioassay Procedures. ORNL-CF-68-1-67; 49 p.

The manual contains the analytical methods that are currently used in the Health Physics Division at ORNL for the analysis of urine for alpha and beta emitting radionuclides. The gamma emitting radionuclides in both urine and fecal samples are determined by counting the sample with the use of a NaI(Th) crystal and a gamma spectrum analyzer. Only procedures for the most hazardous radionuclides are included in the report. Among these are Pa, U, Np, Pu and trans-Pu actinides, Pa 233, Pu 241, Po, radiostrontium, Co, tritium and cesium. Since the rate of excretion of some of the more hazardous radionuclides is so low, it is necessary that a large volume of urine be taken so that a reliable radiochemical determination can be made. In practice, the analytical procedures are designed for a 24-hour urine sample. Some shorter radiochemical procedures are also included under "Rapid Analysis for Transuranium Actinides" and "Total Rare Earth Beta Activity". (FMM)

<282>
Penneman, R.A., and T.K. Keenan, Los Alamos Scientific Laboratory, Los Alamos, NM. 1960, January

The Radiochemistry of Americium and Curium. NAS-NS-3006; 62 p.

The volume deals with the radiochemistry of americium and curium and is one of a series of monographs on radiochemistry of the elements. There is included a review of the nuclear and chemical features of particular interest to the radiochemist, a discussion of problems of dissolution of a sample and counting techniques, and a collection of radiochemical procedures for the elements as found in the literature. (ST)

<283>
Raabe, O.G., G.M. Kanapilly, and H.A. Boyd, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

Studies of the In Vitro Solubiliity of Respirable Particles of Plutonium 238 and Plutonium 239 Oxides and an Accidentally Released Aerosol Containing Plutonium 239. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 24-30), 342 p.

The objectives of this study were to measure the in vitro dissolution rates of samples of monodisperse particles of Pu 238 PuO2 and Pu 239 PuO2 in a chemical simulant of lung fluid at 37 C and to test the usefulness of the in vitro dissolution system in predicting the in vivo dissolution of inhaled aerosols containing plutonium. In the system a continuously flowing stream of a chemical simulant of blood serum passes a sample of particles which are sealed between membrane filters. Dissolved plutonium is carried off in the stream and measured to determine the dissolution rate and the rate constant of specific solubility. Monodisperse particles of both oxides were found to be relatively insoluble; however Pu 238 PuO2 was observed to dissolve about two orders of magnitude faster than Pu 239 PuO2. At 37 C the average value of the rate constant was 6.5 x 10(E-11)

<283> CONT.
g/cm2 day for Pu 239 PuO2 and 1.2 x 10(E-8) g/cm2 day for Pu 238 PuO2. To demonstrate the potential usefulness of in vitro dissolution studies for hazard evaluation, a sample containing Pu 239 aerosol accidentally released at another laboratory and involved in human exposures was studied using the same dissolution system. Applications of in vitro dissolution data in the evaluation of lung burden from urinary excretion data and on the efficacy of DTPA therapy are discussed. (Auth) (ST)

<284>
Silker, W.B., Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1974, January

Measurements of Plutonium in Seawater. BNWL-1850 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1973, (p. 114-115), 200 p.

Analytical efforts in the oceanographic field were extended to include measurements of plutonium isotopes concentrated by the aluminum oxide and filters employed in field sampling. Recovery rates ranged from 60 to 80%. Plutonium analysis of samples previously analyzed for other radionuclides are given in tabular form. Soluble Pu 239 concentrations in the Sargasso Sea at various depths were measured and measurements of Pu 239 and Pu 238 in surface water collected in the South Pacific were also made. Plutonium concentrations in the Atlantic Ocean were consistent with those of other investigators. Pu 238/239 ratios are given for the northern and southern hemispheres. Smaller ratios at the 75 and 100 m depths in the northern hemispheres suggested that the plutonium was injected prior to the interhemispheric transfer to the northern latitudes of Pu 238 from the failure of the SNAP-9A device in 1964. (ST)

<285>
Sill, C.W., and F.D. Hindman, U.S. Atomic Energy Commission, Health Services Laboratory, Idaho Falls, ID. 1974, January

Preparation and Testing of Standard Soils Containing Known Quantities of Radionuclides. Analytical Chemistry, 46(1), 113-118

A general procedure for preparation of standard soils containing a known quantity of any given radionuclide is described. Four separate standards have been prepared from three different soils using Pu 239 to demonstrate the reproducibility and reliability of the procedure. Extensive analyses using Pu 236 tracer show that the standards contain the exact concentration calculated to have been added, that they are not detectably inhomogeneous on samples as small as 1 gram, and that homogeneous standards of lower concentrations can be prepared exactly by weight dilutions with the unspiked soils. Of a total of 56 determinations made on 1 and 10 g aliquots of the four individually spiked standards and two others made by dilution, only four determinations showed distinct signs of inhomogeneity with the particular method of preparation and sample size employed. Of the remaining 52 measurements, all agreed with the calculated value within three standard deviations of the determination, and 42 were within two standard deviations. The dramatic effect of heat treatment on the leachability of the plutonium is demonstrated. Also, an alternative method for preparation of solid standards for members of the natural uranium and thorium series is suggested. (Auth)

<286>
Silver, G.L., Mound Laboratory, Miamisburg, OH. 1973, November 21

Plutonium in Environmental Waters. MLM-2099; Part of Mound Laboratory Isotopic Power Fuels Programs, July-September, 1973, (21-23), 40 p.

A theoretical discussion of how much plutonium may dissolve in natural waters and in what form it might be, is presented. At pH 6 the concentration of pentavalent plutonium in equilibrium with typical hydrous plutonium oxides may have a value of almost 10(E-5) M. Factors that may increase or decrease this value in natural waters--the solution potential and complexing agents--are discussed. (ST)

<287>
Taylor, D.M., Institute of Cancer Research, Royal Cancer Hospital, Sutton, Surrey, England. 1973

Chemical and Physical Properties of the Transplutonium Elements. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 17. Springer-Verlag, New York, New York, (p. 717-738), 995 p.

The chemistry of americium, curium, berkelium, and californium is reviewed with special reference to those properties which may be important in determining their biological behavior. The elements einsteinium, fermium, mendelevium, nobelium, and lawrencium are included, although little is known about their chemistry. Compound and complex formation and solution chemistry of the transplutonium elements are discussed in some detail. Hydrolysis and complex formation play important roles in determining the metabolic behavior of americium and curium, and may be expected to be similarly important in relation to the higher transplutonic elements. The interactions of americium and curium with plasma proteins, and binding to ferritin, bone proteins, and other substances is discussed. (ST)

<288>
Taylor, D.M., Institute of Cancer Research, Royal Cancer Hospital, Sutton, Surrey, England. 1973

Chemical and Physical Properties of Plutonium. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 9. Springer-Verlag, New York, New York, (p. 323-347), 995 p.

The chapter reviews those aspects of plutonium chemistry which are germane to an understanding of the biological behavior and toxicity of plutonium. Metallurgical chemistry of plutonium receives brief attention; solution chemistry and complex formation are discussed in some detail. The plutonium compounds discussed are those which have important technological uses either as reactor fuels or in the chemical processing of plutonium. These compounds together with a few complex compounds discussed represent the range of compounds which are most likely to be encountered in cases of accidental contamination. The (+4) oxidation state is the most important in compound formation.

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<288> CONT.
Finally, the interaction of plutonium with proteins and other substances of biological importance is reviewed. (ST)

<289>
Thomas, C.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Program, Richland, WA. 1973, April

Sequential Procedure for Measuring Plutonium 239, Plutonium 238, Americium 241, Strontium 90 and Iron 55 in Air Samples. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 143-144), 152 p.; BNWL-1751 (Part 2); Part of Nielsen, J.M., et al, Annual Report for 1972, (p. 66-67), 116 p.

A method was developed for the sequential removal of Pu 239, Pu 238, Am 241, Sr 90 and Fe 55 from a large membrane filter. The filter specimen, after addition of Pu 236, Sr 85 and Am 243 tracers and a Sr carrier, was evaporated to dryness with acetone, charred and fused at 900 C. The melt was dissolved in conc. HNO3; fuming HNO3 was used to precipitate Sr as the insoluble nitrate. The filtrate is passed through a Dowex 1-X8, Cl form that has been equilibrated with 7.7 NHNO3. The resulting eluate contains Am and Fe. Plutonium is eluted from the column with 6 M HCl containing 0.024% HI. Hydrochloric acid and iodic acid are removed from the eluate containing Pu by evaporating to near dryness with conc. NHNO3. The residue is dissolved in H2SO4 and NH4OH is added to the acid end point of thymol blue. Plutonium is electrodeposited onto stainless steel or Pt discs from this solution at 1.1 amps for 2 hours. The Pu isotopes are then measured using alpha energy analysis. Analytical yields for Sr 90, Pu 238-239, Fe 55 and Am 241 measured on 70 samples were 77 plus or minus 12%, 73 plus or minus 17%, 85 plus or minus 10%, and 65 plus or minus 20%, respectively. (RAF)

<290>
Thompson, G.H., Savannah River Plant, Aiken, SC. 1972, June 10

Ion Exchange Separation of Curium 242 from Plutonium, Americium, and Fission Products. Radiochemical Radioanalytical Letters, 10(4), 223-230

Curium 242 was separated from Pu by anion exchange and from Am and fission products by pressurized cation exchange in a high flow system. It was demonstrated that excellent anion exchange separation of Pu from 1 Ci/ml solutions can be obtained, if radiolytically formed NO2--is eliminated prior to and during valence adjustment of plutonium. The maximum amount of Cm 242 processed in a single cation exchange process run was 0.6 g. (Auth) (RAF)

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<291>
Beatley, J.C., University of California, School of Medicine, Laboratory of Nuclear Medicine and Radiation Biology, Department of Biophysics and Nuclear Medicine, Los Angeles, CA. 1965, April

Ecology of the Nevada Test Site. 1. Geographic and Ecologic Distributions of the Vascular Flora (Annotated Checklist). UCLA-12-553; 69 p.

The list is a revision of the first on vascular plants of the Nevada Test Site and an expanded effort to bring together what is known to date, from field and herbarium records, of the occurrence and distributions of the vascular species of the large reservation. Included in the list are 526 taxa (of sub-generic rank), belonging to 67 families, 239 genera, and 488 species. Relative abundance, vegetation types with which the taxa are associated, geographic distributions, and flowering times are given. The major areas in which the vegetative types are represented are indicated on a map. (FMM)

<292>
Beatley, J.C., University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1974, Early Spring

Effects of Rainfall and Temperature on the Distribution and Behavior of LARREA TRIDENTATA (Creosote Bush) in the Mojave Desert of Nevada. Ecology, 55(2), 245-261

The effects of rainfall and temperature on the distribution and certain behavioral characteristics of LARREA TRIDENTATA (Creosote-bush) at and near its northern limits in the northern Mojave desert of southern Nevada, were investigated at 30 sites with LARREA and 20 sites without LARREA in eight drainage basins at elevations of 915-1,770 m over a 2,600-km3 area of the Nevada Test Site. Data used were (1) rainfall records for 9 yr (1963-71) for each site; (2) maximum and minimum air temperature records for each site, November 1962-February 1972; (3) percentage cover by all shrub species and by LARREA; (4) height and density data for LARREA; and (5) percentage of germinable seeds from 29 of the LARREA populations for three seasons (1963-65) in relation to the seasonal rainfall for each site. Total percentage cover by all shrub species is highly correlated with mean annual rainfall, less well correlated with elevation. In general, in undisturbed communities, the taller the LARREA plants the fewer there are of them, but the relationship is not strictly linear. Using height as an index to plant volume, numbers of LARREA plants are highly correlated with total plant volume. Mean height is not strongly correlated with mean annual rainfall or temperature parameters, but is well correlated with the ratio of mean precipitation mean temperature. The prevailing low minimum air temperatures and their extremes in the lowlands of enclosed drainage basins are inferred to be the primary cause of the absence of LARREA in three discrete vegetation zones. Average extreme minimum air temperatures on all LARREA sites were above 1 degree F; the absolute minimum was -8 degree F. Upper altitudinal limits of LARREA apparently are not determined by minimum temperatures. There is no pattern of relationship between maximum temperatures and the distribution of LARREA although the highest extreme maxima usually occur on non-LARREA sites in the lowlands of Frenchman Flat. Mean annual rainfall on the LARREA sites ranged from 118 to 183 mm. Altitudinal and latitudinal limits of LARREA coincide with a maximum mean rainfall of 183 mm. Mean annual rainfall of 160-183 mm appears to be critical to the behavior of LARREA. Germination trials support the inference of a deleterious effect of high rainfall on LARREA populations through time: there were high correlation coefficients (negative or positive, depending on the year) between the rainfall of the effective rainfall season and the percentage of germinable seeds; highest mean germination percentages (20%-60%) occurred with 80-150 mm of seasonal rain, and either lower or higher seasonal rainfall resulted in lower percentages of germinable seeds (0%-20%). (Auth)

<293>
Davy, D.R., Australian Atomic Energy Commission, Research Establishment, Health Physics Research Section, Lucas Heights, Australia. 1973, April

Environmental Studies for Uranium Provinces, Aims and Methods. AAEC/E-272; CONF-711227; Part of Proceedings of the AAEC Symposium on Environmental and Radiological Safety Aspects of the Mining and Processing of Uranium held in Lucas Heights, December 9-10, 1971, (23 p.)

The general approach to the environmental studies for the Northern Territory uranium province is given. The environmental characteristics are described such as the black soil plains, sedge meadows, freshwater systems, grass growth in the wet season. The range of habitats likely to be influenced by mining operations and their relative sensitivities to the range of potential pollutants are investigated. The tolerance of significant habitats to heavy metal, chemical or radiological pollution is measured and an investigation is made on the significance of potential radioactive or chemical pollutants with emphasis on items of food or food processing and possible exposure routes to man, both in relation to food collection by aborigines and present water usage and in relation to the development of mining towns. (FMM)

Table 8 gives the content of U, Cu, Pb and Co in biological samples. Table 6 gives apparent concentration factors for U, Ra, Pb and Cu in grazing animals. Other tables give elements found for soil and water analyses.

<294>
Federov, E.A., B.S. Prister, G.N. Romanov, and N.I. Burov, et al, State Atomic Energy Committee, USSR. 1972

The Biological Effect and Behavior of Radioactive Fission Products in Agricultural Chains. CONF-710901; STI/PUB/300; A/CONF-49/P-686; Part of Proceedings of the 4th International Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 6-16, 1971, Vol. 11, (p. 663-674) (Russian, English Abstract)

A discussion is presented of the agricultural aspects of the radiation situation that can arise through contamination of the environment by a mixture of nuclear fission products of different ages and products resulting from neutron activation of the soil. Experimental data obtained in work carried out under natural conditions on experimental plots are quoted. Relationships are established between the density of the radioactive contamination

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produced on agricultural land by a fresh mixture of fission products, the accumulation of radionuclides in agricultural crops contaminated at different stages of their growth, the gamma doses and contact beta doses to plants and the resulting radiation injury to the latter. Coefficients of proportionality are established between the intensity of precipitation (single event or continuous) of radioactive fission products and their concentration in crops, as a function of the composition of the radionuclide mixture, the stage of growth at the time of precipitation, and the period elapsing after the plants are contaminated. Field experiments were carried out with a view to deriving coefficients of proportionality relating the density of soil contamination by radioactive fission products, neutron activation products and fissile materials to their degree of accumulation, as a function of the soil properties and the biological nature of the plants. The part played by soil and foliar uptake of radionuclides in the contamination of crops by radioactive fission products and neutron activation products is discussed. In other experiments, in which a fresh mixture of uranium 235 fission products was introduced into milch cows, a study was made of the accumulation and elimination of radionuclides of iodine, tellurium, molybdenum, barium, etc., and coefficients were obtained for the proportionality between the uptake of the mixture by the animal and the radionuclide content of the animal products. A relationship was established between the uptake of a mixture of fission products by cows via the feed, the dose burdens to the critical organs and the degree of radiation injury. The results obtained are used to calculate the lowest density of radioactive contamination of agricultural crops, meadows and pastures by radioactive fission products of different ages that will cause radiation injury to pasture animals and plants. (Auth)

<295>
Koval'skiy, V.V., and I.Ye. Vorotnitskaya, V.I. Vernadskiy Institute of Geochemistry and Analytical Chemistry, Moscow, USSR. 1966

Regularities in the Biogenic Migration of Uranium. PFP-Trans-141; 7 p.; Ukrainskii Biokhimichnii Zhurnal, 4, 419-424

Biogenic migration of chemical elements in the biosphere depends not only on their concentration in the environment, but also on the demand for them, and on the nature of the organisms, i.e., it is determined by the character of the biogeochemical food chains. The article deals with a study of the U biogeochemical provinces of Kirgiz SSR, and a partial comparison of them with regions with normal U content. The biogenic migration of U under dry-land conditions was studied in a soil-plant-animal system. The accumulation of U by plants growing on soils with elevated U content was on the average of 5-85 times greater (from 5.3 x 10(E-6)% to 1.5 x 10(E-4)% U dry weight) than in plants from unenriched regions. Plants from the Kurskiy chernozem reservation contain from 1.0 x 10(E-6)% to 4.0 x 10(E-6)% U dry weight. It is shown that a non-uniform amount of U enters sheep (through the food chain) from the different zones studied. The daily ration of sheep raised in the U provinces of the Issyk-Kul basin contains on the average up to 1300 mg of U while the daily ration of sheep from the Tula Oblast contains from 50-100 mg of U. The U entering sheep is deposited primarily in bones, wool, hooves and horn. The biogenic migration of U under aquatic conditions was studied in water and mud systems, with algae, with benthos and plankton, and with fish. Of the marine vegetation, charophyte algae (Charophyta) accumulate the most U, in terms of dry weight. The algae contain 700-1000 times more U than does lake water and 1.5 times more than is in the underlying muds. Benthic organisms accumulate U on the average at a rate less than algae by a factor of six and fish accumulate it to an even lesser degree than benthic organisms. Thus U content and its accumulation gradient with respect to water are reduced as U passes through the food chain. It is thought that the biogenic migration of U in Lake Issyk-Kul occurs mainly in the form of uranyl carbonate compounds. (FMM)

<296>
Leavitt, V.D., National Environmental Research Center, Monitoring Systems Research and Development Laboratory, Las Vegas, NV. 1974, March

Soil Surveys of Five Plutonium Contaminated Areas on the Test Range Complex in Nevada. NERC-LV-539-28; 77 p.

Soils in five areas located on the Test Range Complex, Nye County, Nevada, are discussed. All of the areas have at one time been sites of above-ground nuclear safety tests. The areas are contaminated with Pu and are, therefore, the object of investigations regarding the movement of Pu in the environment. Most of the surface soils in the five areas have a gravelly texture and are typically classified as gravelly sandy loam. The majority of the surveyed land is either flood-plain or alluvial fan with deep soils having well-developed profiles and platy structure. All of the soils are alkaline ranging in pH from 7.0 to 9.0. The vegetation is clasified in two general categories, low and high desert shrub. The low desert shrubs are predominantly creosote-bush (LARREA DIVARICATA), and white bursage (FRANSERIA DUMOSA). The high desert shrubs are mostly fourwing saltbush (ATRIPLEX CANESCENS), winterfat (EUROTIA LANATA), and bud sagebrush (ARTEMISIA SPINESCENS). (Auth)

<297>
Marshall, J.S., D.N. Edgington, S.A. Spigarelli, and M.A. Wahlgren, Argonne National Laboratory, Argonne, IL. 1972

Great Lakes Radioecology: Introduction and Description of the Present Program. ANL-7960 (Part 3); Part of Radiological and Environmental Research Division Annual Report, (p. 1-6), 163 p.

The ultimate objective of the Great Lakes Radioecology Program is an understanding of the biogeochemical behavior and pathways to man of radionuclides and toxic trace elements in the Great Lakes, and the capability of predicting the transport and fate of artificial radionuclides introduced into the Great Lakes from any source. Cycling of the radionuclides Pu 239, Cs 137, and Sr 90 within the Lake Michigan ecosystem is being studied through representative sampling of trophic system organisms, sediment, and water from various locations, including existing and known future nuclear sites. Water, sediment, and plankton samples for radionuclide analysis were taken at 25 stations throughout Lake Michigan during the

<297> CONT.
June 1972 cruise of the University of Michigan's R/V Inland Seas. Biological samples consisted of representative fish species (appropriate size ranges), MYSIS RELICTA, PONTOPOREIA AFFINIS, and plankton. Three hundred and eighty fish samples (alewife, smelt, sculpin, whitefish, coho salmon, chinook salmon, rainbow trout, lake trout, perch, and other species) have been obtained from sampling stations. By measuring the vertical distributions of Pu 239, Cs 137, and Sr 90 in selected areas of Lake Michigan, it is possible to improve estimates of the inventory of these long-lived radionuclides in the lake. Comparisons of inshore and offshore concentrations, and those of the southern and northern regions of Lake Michigan, can yield useful information on vertical mixing, water mass residence times, and sedimentation characteristics of various lake regions. (FMM)

<298>
Medica, P.A., F.B. Turner, and D.D. Smith, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1972; 1973

Effects of Radiation on a Fenced Population of Horned Lizards (PHRYNOSOMA PLATYRHINOS) in Southern Nevada. UCLA-12-886; 21 p.; Journal of Herpetology, 7(2), 79-85

Between 1964 and 1966 minimum spring densities of horned lizards ranged from 1.0-2.5/hectare (ha) in 3 8ha enclosures in Rock Valley, Nevada. Minimal survival of hatchling horned lizards to the age of 8 months was about 26-38 per cent. Annual minimal survival of older lizards was 50-60 per cent. Female horned lizards usually laid one clutch of eggs per year, but multiple clutches were observed in 1969. Conversely, no reproduction was observed in 1970. The maximum life span of horned lizards is at least 94 months. One of the enclosures was subjected to continuous gamma irradiation from a centrally located source of Cs 137. Between 1964 and 1966 numbers of horned lizards declined in all 3 plots. Between 1967 and 1970 numbers of horned lizards increased in the two control areas, but continued to decline in the irradiated plot. Female sterility owing to regression of ovaries is judged to be the cause of the population decline. Similar radiation effects have previously been observed among leopard lizards (CROTAPHYTUS WISLIZENII), whiptail lizards (CNEMIDOPHORUS TIGRIS), and side-blotched lizards (UTA STANSBURIANA). (Auth)

<299>
Not given, International Atomic Energy Agency, Vienna, Austria. 1973

Radioactive Contamination of the Marine Environment. CONF-720708; Proceedings of a Symposium on the Interaction of Radioactive Contaminants with the Consitutents of the Marine Environment held in Seattle, Washington, July 10-14, 1972, 786 p.

At the symposium forty-eight papers were presented, five of which have been abstracted separately for the data base. The meeting covered four main topics: physical and chemical forms of radioactive contaminants in the marine environment; interaction of radionuclides with marine biota; evaluation of hazards to the health and safety of man; and study of radiologically labeled environments. The papers give results of recent research on many aspects of the topics mentioned and should serve as a guide not only for those interested in marine radioactivity studies but also in the whole subject of oceanography. (FMM)

<300>
Not given, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1973

Annual Progress Report for the Period Ending June 30, 1973. UCLA-12-919; 142 p.

Research activities of the six divisions of the laboratory for the year June 1972-June 1973 are reported. Activities encompass the discipline areas of health, environmental, biological, and physical and analytical studies; but are focused primarily on medical and environmental problems. Research in biological systemswill contribute to an understanding of radiation effects on biological systems or to fundamental biological processes. Environmental studies at the Nevada Test Site are characterized by research in physiological ecology and studies on the uptake and transport of radionculides. Some of the individual studies are: analysis and modeling of a desert ecosystem; behavior, diet and reproduction in a desert lizard; partitioning of photosynthetically fixed C 14 in perennial plants of the northern Mojave Desert; plant root and stem relationships; vertical root profiles of perennial plants; comparative photosynthetic production in shrubs; contribution of salts to the water potential of woody shoots; revegetation in areas damaged by close-in fallout from nuclear detonations; some characteristics of soil and perennial vegetation; some correlations between soil characteristics and plant ecology; effect of shrubs on native fertility; and sodium relations in desert plants. The program in radiation measurement attacks the problems of detection and measurement and applies systems to the solution of environmental, medical, and biological problems. Progress is reported on fabrication and use of an *esophageal probe to measure (in vivo)* deposits of Pu translocated to lymph nodes. Tests with a NaI(Tl) crystal coupled to a low noise photomultiplier in a human thorax phantom indicate a detection limit of about 1 nCi. (ST)

<301>
Not given, University of California, Laboratory of Nuclear Medicine and Radiation Ecology, Los Angeles, CA. 1972

Annual Progress Report for the Period Ending June 30, 1972. UCLA-12-858; 103 p.

Progress is reported on the major projects of the several divisions of the Laboratory. Studies of nutrient and radionuclide cycling and plant ecology were conducted primarily at the Nevada Test Site. Some of these studies included revegatation problems; creosote-bush (LARREA TRIDENTATA) ecotone lines; persistence of radionuclides in soils, plants, and small mammals; increased uptake of Am 241 by plants caused by the chelating agent DTPA; ecological aspects of plutonium dissemination in terrestrial environments; vegetative propagation of woody shrub species; density of biomass of plants in the Rock Valley Site; and effects of rainfall and temperature on the behavior and distribution of creosote-bush. Transplanting of shrubs

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<301> CONT.
appears to be a practical means of shortening the vegetative recovery time of disturbed areas. (ST)

<302>
Price, K.P., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1973, January-March

A Review of Transuranic Elements in Soils, Plants and Animals. Journal of Environmental Quality, 2(1), 62-66

Published information concerning the distribution and fate of neptunium, plutonium, americium, and curium in terrestrial ecosystems is reviewed, and areas needing further study are identified. In the final analysis of environmental quality, radionuclides with very long half lives will become increasingly important to man as they continually constitute a greater proportion of environmental radioactivity. The transuranic elements have been identified as the most hazardous radionuclide by-products of nuclear reactor operations. The relatively few studies conducted indicate that transuranic elements do not remain in solution in soils, plants, or animals, but organic complexes and chelation greatly enhance mobility. The elucidation of natural organic complexes and chelating agents has not been attempted. Oxidation state also influences mobility, but possible biological mechanisms permitting oxidation or reduction remain uninvestigated. Ingestion is the most important transfer mechanism in ecosystems, but assimilation of transuranics from natural food sources is mostly unknown. Evidence in the literature suggests three possible mechanisms leading to the observed increase in plant uptake with time: the formation of organic complexes or chelates, a buildup of radionuclide concentration at root surface, or the slow but continual uptake by perennial plants. Each of these mechanisms deserves further study. (Auth)

<303>
Price, K.R., Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Department, Richland, WA. 1974, January

The Behavior of Waste Radionuclides in Soil-Plant Systems. BNWL-1850 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1973, (p. 38-41), 200 p.

Soil-plant interactions with nuclear wastes under field and laboratory conditions for plants and soils characteristic of Hanford waste storage sites were investigated. Special attention was given to the behavior and fate of long-lived radionuclides, especially the transuranium elements. Basic information relevant to environmental waste management has been provided from the following studies: 1) The effect of transuranic chemical form on plant uptake. Tumbleweed and cheatgrass were grown on soils treated with transuranic-chelate solutions, harvested after 2 months, and analyzed for transuranic uptake. In case of Pu, chelation apparently not only increased plant uptake from soil but also may facilitate transport from root to shoot. 2) The influence of depth of waste burial on plant uptake and redistribution within the soil. Transuranic nitrate and oxalate solutions were added at mid-depth to large pots. Tumbleweed and cheatgrass shoot and root tissues were harvested after a 2-month growth period. Roots were harvested separately from soil above and below the placement zone. In all cases, except Np 237, uptake into root tissue was detected only below the radioactive layer and not above it. 3) The relationship between plant age and uptake of transuranium elements from soil. Tumbleweed and cheatgrass plants were harvested periodically for 16 weeks. Initial plant uptake was very high but decreased with time through about 6 to 10 weeks and then levelled off. Fertilizers, such as ammonium sulfate can result in increased Pu uptake by more than a factor of two. Without complexation or chelation, transuranium elements (except Np) were distributed unevenly throughout soybean plants with highest concentrations occurring in older tissues. There are several environmental waste management implications of these results: are (1) environmental monitoring samples should consist of seedlings or older tissues collected near the base of the plant, (2) young and succulent plants attractive to foraging animals likely will contain the greatest concentrations per gram of tissue and would foster maximum plant-to-animal transfers, (3) plant root systems provide a mechanism whereby radioactivity can be spread from a layer buried beneath the soil surface and may extend several meters deep under field conditions. Complexing or chelating agents present in environmental waste storage sites would be expected to enhance plant uptake of plutonium. (Auth) (RAF)

<304>
Romney, E.M., A. Wallace, R.O. Gilbert, S.A. Bamberg, J.D. Childress, J.E. Kinnear, and T.L. Ackerman, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1973, November; 1974, July

Some Ecological Attributes and Plutonium Contents of Perennial Vegetation in Area 13. UCLA-12-937; NVO-142; CONF-731048; Part of Dunaway, P.B. and White, M.G. (Eds.), The Dynamics of Plutonium in Desert Environments, Proceedings of the NAEG Plutonium Environmental Studies Program Symposium held in Las Vegas, Nevada, October 2-3, 1973, (p. 91-106), 369 p.

This is an interim progress report of work conducted at the Nevada Test Site under the auspices of the Nevada Applied Ecology Group, Office of Effects Evaluation, USAEC Nevada Operations Office, Las Vegas, Nevada. Included are data on some ecological attributes of the vegetation within the fenced portion of the Project 57 fallout pattern in Area 13. Also included are some preliminary data on the Pu 239-240 and Am 241 in samples of vegetation collected in conjunction with the soil sampling program. Prominent shrub and grass species in the fallout pattern of Area 13 include ARTEMISIA SPINESCENS, ATRIPLEX CANESCENS; ATRIPLEX CONFERTIFOLIA, EUROTIA LANATA, GRAYIA SPINOSA, KOCHIA AMERICANA, LYCIUM ANDERSONII, and ORYZOPSIS HYMENOIDES. Individual or co-dominant species distinguished local association patterns of varied size within the fenced study area. Vegetation cover estimates in sample study plots ranged from 12.8 to 28.3%. Shrub densities ranged from 11.2 X 10(E+3) the standing shrub biomass ranged from 1592 to 4285 kilograms per hectare (0.7 to 1.9 tons per acre). Preliminary results showed rather uniform distributions of Pu 239-240 and Am 241 among individual samples of the same plant species collected within an intensive study plot. However, there was considerable variation in

<304> CONT.
the contamination levels between different species, presumably from superficial entrapment of resuspended particulate material. Concentrations in EUROTIA LANATA were three to five times higher than in other species sampled from the same study site. The Pu 239-240 and Am 241 generally tended to decrease in samples of vegetation collected at increasing distances from ground zero, but there were poor correlations between vegetation and soil Pu 239-240 concentrations in isopleth strata within the fenced grazing area. Results showed inconsistencies in the Pu/Am ratios for vegetation and soil. Lower ratios found in vegetation samples indicate that preferential uptake and concentration of Am 241 through plant roots might have occurred in the Project 57 fallout area. (Auth)

<305>
Romney, E.M., A. Wallace, and J.D. Childress, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1971

Revegetation Problems Following Nuclear Testing Activities at the Nevada Test Site. CONF-710501; Part of Nelson, D.J. (Ed.), Radionuclides in Ecosystems, Proceedings of the 3rd National Symposium on Radioecology held in Oak Ridge, Tennessee, May 10-12, 1971, Vol. 2, (p. 1015-1022), 1268 p.

Wherever vegetation has been destroyed at the Nevada Test Site as the result of nuclear activities, the SALSOLA species and native annual species and grasses have grown abundantly in subsequent years on those areas. Experience indicates, however, that decades of time are necessary for the perennial shrub vegetation on a disturbed site to return to its original state. In disturbed areas on Pahute Mesa, the germination and survival of native shrub seedlings have been in abundance in recent years and sufficient to return that portion of the southern Great Basin Desert to its original condition. After severe drought periods many new seedlings have disappeared not directly because of drought but because of browsing animal activity. In the Mojave Desert portions of the Nevada Test Site, the germination and survival of shrub seedlings have been much slower on disturbed sites than of Pahute Mesa. Animals have destroyed virtually all shrubs which we have transplanted into disturbed areas. Nevertheless, transplanting has been successful when protected from browsing animals, and this appears to be a practical means of shortening the vegetational recovery time for these disturbed areas. (Auth)

<306>
Smigel, B.W., and M.L. Rosenzweig, State University of New York, Department of Biological Sciences, Albany, NY; University of New Mexico, Department of Biology, Albuquerque, NM. 1974, Early Spring

Seed Selection in DIPODOMYS MERRIAMI and PEROGNATHUS PENICILLATUS. Ecology, 55(2), 329-339

Theories of resources allocation in sympatric heteromyids have often been based on the idea that body size is a key factor in determining the size of resource packages an animal takes. Considerable field data have supported this idea. In this study, however, two coexisting heteromyid species of different sizes are shown to be selecting the same set of seed sizes. These findings and other conflicting data show a need for a new theoretical basis for the correlation of body size with seed size in heteromyids. Both species tested take a more specialized diet at high seed densities than low. This supports the hypothesis that these seed eaters are in some sense adaptively, flexibly selective. It also supports the notion that the selectivity is inversely proportional to the time required to find a seed. (Auth)

<307>
Smith, D.D., National Environmental Research Center, Monitoring Systems Research and Development Laboratory, Farm and Animal Investigation Branch, Las Vegas, NV. 1973, October

Observations on Wildlife and Domestic Animals Exposed to the Ground Motion Effects of Underground Nuclear Detonations. NERC-LV-539-24; 11 p.

Since 1963, several hundred cows, horses, deer, and elk have been stationed or observed in close proximity to surface Ground Zero at the time of underground nuclear detonations at the Nevada Test Site and at other test locations within the contiguous United States. This report gives subjective summaries of large animal involvement with specific nuclear events. Detonation size and seismic data (peak upward ground motions) for each event are included. No physical damage was noted from the ground motion the animals experienced. Recommendations are made for experimental verification of these subjective observations. (Auth)(ST)

<308>
Volchok, H.L., Health and Safety Laboratory, New York, NY. 1974, December

Transuranic Elements in the Marine Environment. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 155-168), 327 p.

In marine environments, transuranic elements have been introduced, in dispersed form, in four ways, namely, closein fallout from nuclear explosives testing, worldwide fallout from nuclear explosives testing, atmospheric burnup of Pu power supplies, and fluid wastes from chemical reprocessing and reactor operations. Profiles of Pu concentration as a function of depth in ocean water columns have been measured, and the relationship between Pu 239 in sediment and the overlying water has been studied. The accidental release of Pu 239 and Am 241 near Thule, Greenland showed that of the Pu measured, upwards of 95% went to the sediments; 1% found in the water columns was fine particles. Pu 239 and Am 241 from fallout have been found in marine organisms from a variety of places in both hemispheres, for example, Cm 242 has been found in Fucas from the Irish Sea and Np 237 in a variety of samples from Eneweta. Concentration factors of about 1000 have been indicated for Pu 239 in marine plants and this level often exceeded by marine benthos, zooplankton and the Atlantic Ocean species of pelagic Sargassum. In general it appears that marine invertebrates exhibit higher concentration of fallout Pu than do fish. The data show

<308>

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<308> CONT.
little evidence for trophic level enhancement of Pu 239 accumulation, although in one case studied, starfish showed consistently higher Pu 239 (fallout) than did the mussels on which they were feeding. A residence half-time of 3.5 yr was given for Pu 239 in albacore liver from the results of a study. (FMM)

<309>
Berger, R., R. Boucher, B. Jampsin, and C. Devillers, Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France. 1971, February

Plutonium 238 Sources for Cardiac Pacemakers. CONF-700930; EUR-4612 d-f-e; Part of Proceedings of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 115-141), 660 p.

The radiation protection and safety concepts for plutonium 238 capsules for cardiac pacemakers are described according to the following: dose rate equivalents, thermo-mechanical stresses, chemical corrosion. This survey is supplemented by experimental results obtained when carrying out the program undertaken under the sponsorship of the Delegation Generale a la Recherche Scientifique et Technique. (Auth)

<310>
Coffey, D.L., and K.F. Wylie, Mound Laboratory, Miamisburg, OH. 1966, February 14

Gamma Ray Dose Rates from Shielded Plutonium 238 Sources. MLM-1267; 10 p. (Declassified October 22, 1971)

Theoretical gamma ray dose rates from shielded, cylindrical plutonium 238 sources were computed and compared to measured dose rates. The measured and theoretical gamma ray dose rates agreed when suitable instrumentation and procedures were used and when certain theoretical effects were taken into consideration. The agreement between the values indicated that the published mass attenuation coefficients for plutonium and the elements used in the shielding materials are sufficiently accurate for computing dose rates. The agreement also validified self-absorption corrections which assumed a spherically distributed source; the corrections were valid when the length to diameter ratio of a cylindrical source was three or less. This method of computing dose rates could be applied to any gamma emitting source. (Auth)

<311>
Crandall, J.L., Savannah River Laboratory, Advanced Operational Planning, Aiken, SC. 1973, September 21

Applications of Transplutonium Elements. DP-MS-71-52; CONF-711078; Part of Proceedings of the 3rd International Transplutonium Element Symposium held in Argonne, Illinois, October 20-22, 1971, (20 p.)

The uses of the transplutonium elements as heat, alpha and gamma radiation, and neutron sources are reviewed. Alpha heat sources, powered primarily by Pu 238, are used as heat sources in space, pacemakers, and in powering artifical hearts, heart-assist devices, and kidneys. Americium 241 is widely used as an alpha and gamma radiation source. Applications include use in transmission (mass and thickness gages), backscatter, and x ray fluorescence measurements. Californium 252, Pu 238, Am 241, and Cm 244 are used as neutron radiation sources for cancer therapy, process control, oil and mineral exploration, and neutron radiography. (ST)

<312>
Crandall, J.L., Savannah River Laboratory, Aiken, SC. 1969, January

Survey of Applications for Californium 252. CONF-681032; Part of Barker, J.J. (Ed.), Proceedings of a Symposium on Californium 252 held in New York City, New York, October 22, 1968, (p. 225-256), 376 p.

Proposed uses of Cf 252 that stem from its unique properties are discussed. Cf 252 will always be relatively expensive; but because of its high average neutron yield per radioactive disintegration, it produces neutrons less expensively than any comparable radioisotope source and competitively with small nuclear reactors and accelerators. It thus has major potential in providing compact, portable, and reproducible neutron sources at intensities ranging from a few neutrons/second up to 10(E+14) neutrons/second. Such sources have unique applications as tissue implants for cancer therapy, as point sources for neutron radiography, and as portable tools for mineral exploration, as well as meeting more specialized purposes such as reactor physics measurements. Other uses of the Cf 252 sources are expected in such fields as activation analysis, short-lived radioisotope production, moisture gages, well logging, in-line process instrumentation; where the operating simplicity, minimal maintenance, and full predictable output of these sources should open many applications which are currently closed to the more conventional accelerator and reactor sources. Particular emphasis is being placed on industrial uses of the Cf 252 sources for in-line process control. A preliminary market survey by Savannah River of possible Cf 252 applications indicates a demand for 20-60 g of Cf 252 by 1975 with the probability of an exponentially increasing demand for some time thereafter. (Auth) (ST)

<313>
Huffman, F.N., F.A. Molokhia, and J.C. Norman, Thermo Electron Research and Development Center, Waltham, MA; Sears Surgical Research Laboratory, Boston, MA. 1971

Thermal and Radiation Effects of Plutonium 238 Fuel Capsules on Dogs and Primates. CONF-711009; Part of Proceedings of the American Nuclear Society Symposium held in Miami Beach, Florida, October 19, 1971. Published in Transactions of the American Nuclear Society, 14(2), 510-511

Heat and radiation effects of implanted radioisotope heat exchangers fueled with Pu 238 were evaluated. The design of the heat exchanger and its insertion into dogs and primates were discussed. Maximum dose rates of 16- and 24-watt capsules are approximately 1200 and 1800 mrem/hr, respectively. An extended series of hematologic studies performed for over two years on dogs bearing capsules did not reveal any adverse effects other than possible lymphocyte abnormalities and radiation effects within one centimeter of the sources. It appears that animals adjust their temperature regulation mechanisms to dissipate up to 24 watts of additional heat without significant elevations in core temperatures. The most significant results of these studies are the long-term survivals of animals (two years or more) with both Pu 238 and radiation equivalent source implants. In additional studies, calves implanted with circulatory assist systems tolerated thermal loads up to 36 watts. These levels of heat and radiation are over two orders of magnitude higher than

<313> CONT.
those associated with nuclear powered pacemakers. (ST)

<314>
Not given, U.S. Atomic Energy Commission, Division of Civilian Application, Washington, DC. 1957, March

Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants. A Study of Possible Consequences if Certain Assumed Accidents, Theoretically Possible but Highly Improbable, Were to Occur in Large Nuclear Power Plants. WASH-740; 105 p.

The study analyzes possible consequences of major reactor accidents and the likelihood of occurrence of such major accidents. The consequences of theoretical accidents started with the assumption of a typical power reactor, of 500,000 kilowatts thermal power, in a characteristic power reactor location. Accidents were postulated to occur after 180 days of operation, when essentially full fission product inventories had been built up. Three types of accidents which could cause serious public damages were assumed. Pessimistic (higher hazard) values were chosen for numerical estimates of many of the uncertain factors influencing the final magnitude of the estimated damages. For the three types of assumed accidents, the theoretical estimates indicated that personal damage might range from a lower limit of none injured or killed to an upper limit, in the worst case, of about 3400 killed and about 43,000 injured. Theoretical property damages ranged from a lower limit of about one half million dollars to an upper limit in the worst case of about seven billion dollars. This latter figure is largely due to assumed contamination of land with fission products. Under adverse combinations of the conditions considered, it was estimated that people could be killed at distances up to 15 miles, and injured at distances of about 45 miles. Land contamination could extend for greater distances. In the large majority of theoretical reactor accidents considered, the total assumed losses would not exceed a few hundred million dollars. Estimations of the probability of reactor accidents having major effects on the public ranged from a chance of one in 100,000 to one in a billion per year for each large reactor. However, whether numerically expressed or not, there was no disagreement in the opinion that the probability of major reactor accidents is exceedingly low. The appendices include articles on the nature and extent of a fission product release from a power reactor, a method for calculating the number of people that could be affected by a fission product release and the effects of fission product release on humans and land use. Values are given for the deposition of Pu 239 in man. (FMM)

<315>
Not given, International Atomic Energy Agency, Vienna, Austria. 1971

Environmental Aspects of Nuclear Power Stations. CONF-700810; STI/PUB/261; Proceedings of a Symposium held in New York, New York, August 10-14, 1970, 970 p.

At the symposium activities in the production of nuclear power that might have an impact on the environment were discussed and compared. About 350 participants from 25 countries and 9 international organizations heard 58 papers and took part in two panel discussions. The program started with a forecasting of the future needs for electrical power on a world-wide and national basis. The standards for control of effluents were discussed and, apart from the newly emerging thermal standards, the very wide acceptance internationally of the ICRP Recommendations was emphasized. The siting of power stations was also discussed in a number of papers. The effects of fuel transportation, aesthetic requirements, waste heat discharge, smoke and other non-nuclear pollutant emissions, and radioactivity emissions in connection with both nuclear and fossil-fuel power stations were compared. The part to be played by the public in participating in power plant siting studies or regulatory practices was emphasized. Finally it was suggested that the real problem facing mankind was that of reconciling inordinate growth of population with a limited quantity of resources. It was recognized that, if the standard of living in the world was to continue to rise, cheap energy must be made available and the conclusion was reached that nuclear power was the only feasible answer to world requirements in the immediate future. (FMM)

<316>
Prosser, D.C., and D.P. Kelly, Mound Laboratory, Miamisburg, OH. 1966, February 1

Fabrication, Testing and Evaluation of SNAP-15A Capsules. MLM-1258; M-3679 (49th Ed.); 36 p. (Declassified November 2, 1971)

Mound Laboratory fabricated and evaluated heat source capsules for the SNAP-15A milliwatt generator developed by the General Atomic Division of the General Dynamics Corporation. Each capsule contained sufficient plutonium 238 metal to provide approximately 1.6 watts of heat. Fabrication procedures and hazards evaluation including effects of high temperature burst, vibration, mechanical shock, temperature shock, corrosion tests, and shock overpressure for the sources are presented together with fuel properties and fabricated capsule parameters. Data for a simulated fire test at 1800 F performed with two fueled units are given. The evaluation program used for the SNAP-15A project has shown that the reproducibility of integral welds and fuel content can be achieved even when large numbers of capsules are involved. It is suggested that this inspection procedure be considered in preparing capsules for future SNAP programs. (Auth)

<317>
Robinson, E.L., B.O. Hannah, W.B. Bass, and E.L. Wills, University of Alabama, Radiation Biology Laboratory, Physics Department, Birmingham, AL. 1974, April

Neutron and Photon Flux from X Ray Fluorescent Thyroid Scanners. Health Physics, 26, 301-306

Systems using x ray fluorescence for in vivo organ studies, especially thyroid scanning, are now in use at several institutions. The most commonly used sources of gamma radiation for stimulating fluorescent I x-rays for thyroid scans are multicurie sources of Am 241. Alpha particles from the decay of Am produce nuclear reactions in the source matrix and give rise to a fast neutron flux and gamma rays. The neutron dose rate delivered to the eyes of a patient during a scan is less than 1 mrem/hr for a 5 Ci Am 241 source mounted inside a 1/2 in thick tungsten

<317> CONT.
alloy source-collimetor assembly and the gamma-ray dose rate delivered to the patient's eyes from this source during a scan is less than 0.1 mR/hr. A typical fluorescent scan requires 20-30 min. (Auth)

<318>
Warner, E.E., McDonnell Douglas Corporation, McDonnell Douglas Astronautics Company, Donald W. Douglas Laboratories, Richland, WA. 1972

Comparison of Plutonium and Promethium Containment for Medical Applications. CONF-720519; Part of Proceedings of the 2nd International Symposium on Power from Radioisotopes held in Madrid, Spain, May 29-June 1, 1972, (p. 875-891), 986 p.

Safety criteria developed for plutonium may require modification for beta-emitting isotopes such as promethium because of the absence of helium generation, differences in radiation characteristics, and relative biological hazards. Design approaches for plutonium capsules are compared with those for a promethium-fueled nuclear battery illustrating techniques which meet the critical cremation and mechanical loads. Safety test results are presented to demonstrate that both plutonium and promethium devices are suitable for widespread implantable medical applications. (Auth)

<319>
Cross, F.T., and J.C. Sheppard, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1973

In-Phantom Dosimetry of Prototype Plutonium Heat Sources for Circulation Support Systems. CONF-720411; STI/PUB/311; IAEA-SM-160/55; Part of Proceedings of a Symposium on Dosimetry Techniques Applied to Agriculture, Industry, Biology and Medicine held in Vienna, Austria, April 17-21, 1972, (p. 497-506), 685 p.

The dose rates from various implanted Pu 238 heat sources have been measured and calculated. The source material was encapsulated medical grade Pu metal and Pu dioxide of nominal 30 W strength. The latter material was placed in a prototype circulation-support subsystem. The tissue equivalent phantoms were a large homogeneous right-circular cylinder and a man-simulating REMAB phantom. Dose rates were calculated using a modified point-kernal code QAD-P5A. The calculations were in good agreement with the measurements, at least in the regions where the photons and neutrons make their greatest dose contribution for a source enclosed in a circulation-support system. Dose rates to various organs and regions, both internal and external to a man-simulating phantom, are presented. The values are derived from measurements and calculations. Neutron dose rates were measured with small tissue-equivalent proportional counters biased to exclude the photon contribution. Most of the neutron values were derived from measurements on Cf 252 which was used as a substitute for the Pu sources. Photon dose rates were measured with small thermoluminescent dosimeters (TLD-700) known to be insensitive to the neutrons from Cf and Pu. Integrated and average body dose rates were derived from the measurements in the large homogeneous tissue-equivalent phantom. These values are presented for an artificial heart power source with a ten year mission life and therefore include the 'growing-in' of the dose rates from the heat source impurities. These values will be compared with past radiologic experience and conclusions will be presented on the acceptability of an artificial heart device incorporating a medical grade Pu heat source. (Auth)

<320>
Auxier, J.A., D.J. Christian, T.D. Jones, G.D. Kerr, P.T. Perdue, W.H. Shinpaugh, and J.H. Thorngate, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1973, September

Contribution of Natural Terrestrial Sources to the Total Radiation Dose to Man. ORNL-TM-4323; Ph.D. Thesis, Georgia Institute of Technology; 160 p.

Investigations were done to determine the important parameters affecting radon emanation from radionuclides for typical concentrations in soil, to determine the possibility and practicability of using high resolution spectrometers to measure low levels of radioactive contamination due to human activities, and to evaluate major sources of external and internal human exposure due to the natural radiation environment. It was demonstrated that the most important parameter in controlling the emanation of radon from concrete is the free moisture content of the concrete. Radon concentrations in dwellings constructed of uranium bearing materials are often in the rang 1-5 pCi/l of air. These concentrations result in the irradiation of the basal cells of the lung bronchial epithelium near the first five bifurcations by the alpha emitting daughters of radon that often exceeds, sometimes by a large factor, the average whole body absorbed dose due to the gamma rays from the natural radiation environment. Further, the doses to these basal cells over a 50-year span may approach the levels at which the incidence of lung cancer in uranium miners is increased by a factor of two over the normal incidence in men of the same age. (Auth) (FMM)

Table 3 shows average concentration of U and Th in geologic formations. Table 4 shows geographical areas having soil concentrations of U and/or thorium to produce the dose increments indicated.

<321>
Cook, C.S., U.S. Naval Radiological Defense Laboratory, San Francisco, CA. 1968

Basic Characteristics of Nuclear Radiation from Fallout. 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. 65-83), 688 p.

This discussion provides a brief summary of currently available information about ionizing radiation from fallout. Fifty-eight references are attached to provide a basis for additional search of the literature. The review considers the following topics: Ionizing radiation resulting from a nuclear weapons detonation, comparison of fallout and fission product gamma ray spectra, aerodynamic effects, detonation conditions needed to form local fallout, fractionation, neutron induced activities in surrounding materials, gamma radiation from distributed sources, calculated radiation fields, and experiments using simulated sources and using real fallout fields. (BBM)

<322>
Dole, S.H., and R.A. Papetti, Rand, Santa Monica, CA. 1973, January

Environmental Factors in the Production and Use of Energy. R-992-RF; 77 p.

The major undesirable environmental effects of energy production and use, the available control techniques, and the costs of control, are summarized. The report is divided into sections dealing with the air, the water, and the land--each division indicating the sphere of man's natural environment that is most affected by human activities associated with energy production or use. The section on air includes discussions of air pollutants from or incidental to the combustion of fuels, air pollutants from nuclear power production, thermal inputs into the air, gaseous resources and acoustical noise. The section on water is concerned with chemical-physical factors such as oil spills and acid mine drainage, radiological factors such as tritium and other radioactivity from liquid effluents, uranium milling wastes and thermal inputs into water. The section on land deals with acid fallout from the air, mineral fallout from cooling towers, solid wastes, high-level radioactive wastes, land subsidence due to underground mining of coal, strip-mining of coal, land use in power production and transmission and hydroelectric dams. (FMM)

Table 8 gives a summary of releases of mixed fission and corrosion products from power reactors in liquid effluents in 1969.

<323>
Fey, F.L., Jr., Los Alamos Scientific Laboratory, Los Alamos, NM. 1967, June 16

Health Physics Survey of Trinity Site. LA-3719; 8 p.

More than 20 years after the first nuclear weapon test, a health physics survey of the Trinity site was made to determine whether it would be radiologically safe for the public to visit. The survey included monitoring of the entire site for whole-body exposure rates, monitoring of samples of trinitite carried away from the site for gamma-exposure rates, measurement of surface exposure rate from individual pieces of trinitite, calculation of deposition of radioactivity in the body from injested trinitite, analysis of soil samples, and analysis of air samples taken in the area. The whole-body gamma-exposure rate at Trinity Site varied from a high of 3 mR/h near ground zero to a low of 0.03 mR/h. The whole-body exposure rate received by a person visiting Trinity Site would average less than 1 mR/h. Trinitite also contained some unfissioned Pu 239 but the deposition of radioactivity in the body due to ingestion of trinitite cannot be considered a problem owing to the large amount it would be necessary to consume in order to deposit a maximum permissible body burden. Soil and air samples taken at Trinity Site revealed that all the activity is contained in pieces of trinitite. There appeared to be no activity associated with particles of respirable size. From the results, it does not appear that anyone could receive any radiation injury through a visit to Trinity Site. Gamma radiation at the Trinity Site comes from fission and activation products which were fused into the sand to form a green glossy substance called trinitite. Most of the gamma activity is caused by Cs 137, Eu 152 and Co 60. (FMM)

<324>
Frigerio, N.A., K.F. Eckerman, and R.S. Stowe, Argonne National Laboratory, Environmental Statement Project, Argonne, IL. 1973, September

<324>

ENVIRONMENTAL ASSESSMENT

<324> CONT.
The Argonne Radiological Impact Program (ARIP). Part 1. Carcinogenic Hazard from Low-Level, Low-Rate Radiation. ANL/ES-26 (Part 1); 35 p.

The entire Argonne Radiological Impact Program is briefly outlined, and part of the program dealing with radiation hazards from nuclear power plants is discussed in detail. Various models and predictions of carcinogenic hazard are examined and compared with actual experience in U.S. and foreign populations. All of the models predict a significant increment in malignant mortality with increasing background. Observation of the actual populations at risk shows not only no increment, but an actual decrement, so that these predictions are left quite without observational support. It is concluded that extrapolation of high-rate and usually high dose-level studies to low rates and low levels is probably invalid, and that radiation at such levels and rates does not constitute an environmental carcinogen of significance. (Auth)

<325>
Hakonson, T.E., L.J. Johnson, and W.D. Purtymun, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973

The Distribution of Plutonium in Liquid Waste Disposal Areas at Los Alamos. LA-UR-73-1309; CONF-730907; Part of Proceedings of the 3rd IRPA International Congress held in Washington, D.C., September 9-14, 1973, (6 p.)

An ecological investigation of plutonium in the Los Alamos Scientific Laboratory environs is described. Data are presented on the distribution of plutonium in the alluvial sediments, water, vegetation and rodents from Mortandad Canyon, an area which has been used for liquid waste disposal for 10 years. It was concluded that stream channel sediments were the major reservoir of the waste Pu. Levels of Pu 238 and Pu 239 increased from less than 0.5 pCi/g dry at the pre-outfall stations to over 300 pCi/g in post-outfall samples. Data on low growing grass species showed that the plutonium concentration ratios for plant/sediment are on the order of 3 x 10(E-2) to 8 x 10(E-2), which was about an order of magnitude higher than that reported by others for root uptake of plutonium from soils. There appeared to be a relationship between growth form and the plutonium content of the plant. Lower growth forms contained higher plutonium concentrations than higher growth forms. The highest mean Pu 238 and Pu 239 concentrations in the lung and hide of rodents from the canyon suggested that resuspension of sediment-bound plutonium may be a prime mechanism in the contamination of rodents. The appreciable variation in the plutonium data for rodent tissues indicated that the contamination of the small mammal populations living near the stream channel is heterogeneous, with many individuals receiving minute quantities of plutonium and others receiving relatively large amounts. The Pu 238/Pu 239 ratios calculated from the data provided assessment of the vertical and horizontal movement of the effluent-associated plutonium. (Auth) (PMM)

Table 2 shows the Pu 238/Pu 239 ratios in water, sediment, vegetation, and rodents from Mortandad Canyon in October 1972.

<326>
Hardy, E.P., Jr., Health and Safety Laboratory, New York, NY. 1974, December

Worldwide Distribution of Plutonium. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 115-128), 327 p.

Plutonium contamination of the environment on a global basis is primarily the result of atmospheric nuclear weapons testing. There arelocalized areas where Pu contamination has occurred through accidents or inadvertent releases from nuclear facilities. The total amounts released are on the order of curies as compared with hundreds of thousands of curies from nuclear tests. About 320 kilocuries of Pu 239 have deposited and about 4 kilocuries remaining in the stratosphere will reach the earth's surface. Measurements are being made of air concentrations at ground level and of the deposition rate. It is agreed that human exposure to Pu is primarily through inhalation. To assess the inhalation hazard, the fraction of the total concentration which may deposit in the nonciliated portion of the lung, must be known. Measurements of deposited Pu have made it possible to estimate the total amount on the earth's surface and to determine its distribution. Am 241, with a 25% activity level of that of Pu 239, shows a depth distribution in soil similar to Pu 239; further studies in this area are indicated. (RAF)

Figures 1-7 show stratospheric inventory of Pu 239, stratospheric inventory of SNAP-9A Pu 238, Pu 239 in surface air (New York), distribution of deposited Pu 239 and Pu 238 in the northern and southern hemisphere, cumulative deposit of Pu 239 in mCi/km(E+2) in the United States, and Pu 239 deposition rate in New York.

<327>
Hollingsworth, R.E., U.S. Atomic Energy Commission, Washington, DC. 1973, April

Environmental Statement, Underground Nuclear Testing Program, Nevada Test Site. WASH-1526; 60 p.

This environmental statement covers all underground nuclear tests and preparations for tests of one megaton or less at the Nevada Test Site during fiscal years 1974 and 1975. The probable impact on the environment due to continued underground nuclear testing at the NTS will small. The chief environmental impacts translate to costs in terms of subsidence craters, pockets of underground ratioactivity, and direct ground motion. The subsidence craters are depressions in the ground surface that occur as manifestations of ground settling above the detonation cavity. Once formed the subsidence craters do not constitute any particular hazard. Most of the radioactive materials which are created as a result of the nuclear explosion become trapped in molten rock as it solidifies, near the detonation point so that noble gases and tritium are the only major untrapped radioactive materials which are potentially available to migrate very slowly from the cavity. These do not reach the environment in levels of possible hazard. Fractions of the radionuclides strontium 90 and Cesium 137 are not trapped in the solidified melt; these are deposited on rock surfaces some distance up the explosion produced chimney. The

<327> CONT.
direct ground motions from larger tests can be felt but these are not large enough to damage the structural integrity of buildings offside. (BBM)

<328>
Kaplan, I.R., University of California, Los Angeles, CA. 1972

Biological Cycling of Elements and Stable Isotopes in Marine Environments, Progress Report April 1, 1971 to May 1, 1972. UCLA-34-P-134-6; 208 p.

A summary of projects in progress is given. The following studies are described: U 234/U 238 in recent corals and related carbonates; trace elements uptake by corals and sediments from New Caledonia; distribution of uranium in near shore marine sediment; a sediment squeezer for removal of pore waters without air contact; and mechanisms for marine iron sulfide formation. (Auth)

<329>
Kolodny, Y., and I.R. Kaplan, The Hebrew University, Department of Geology, Jerusalem, Israel; University of California, Institute of Geophysics and Planetary Physics, Los Angeles, CA. 1972

Deposition of Uranium in the Sediment and Interstitial Water of an Anoxic Fjord. CONF-700965; Part of Proceedings of an International Symposium on Hydrogeochemistry and Biogeochemistry held in Tokyo, Japan, September 10, 1970, (40 p.); UCLA-34-P-134-6; Part of Kaplan, I.R., Biological Cycling of Elements and Stable Isotopes in Marine Environments, Progress Report for April 1, 1971 to May 1, 1972, (40 p.), 208 p.

The distribution of uranium in the sediments of Saanich Inlet was determined using chemical fractionation methods to separate authigenic uranium from detrital uranium. U 234/U 238 activity ratios were found to be good indicators for determining the efficiency of the separation. Uranium concentration in the sediment shows a significant enrichment relative to deep sea sediment. Authigenic uranium correlates most strongly with the organic carbon content of the sediment, and is probably bound as organo-uranyl complexes. Approximately half the uranium in the sediment of the central fjord is organically complexed and the remainder is distributed among detrital minerals, authigenic tetravalent uranium and uranium adsorbed on organic matter. Uranium is highly enriched in interstitial water (both oxidizing and reducing waters with an Eh range of +380 mV to -140 mV) relative to its concentration in normal seawater. Its concentration appears to depend on the oxidation state and the organic content of the sediment. Concentration of uranium by the sediments was found to be very efficient in this environment. The residence time of uranium in the water column was found to be 3 or 4 orders of magnitude less than estimated for the open ocean. (FMM)

<330>
Liverman, J.L., U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC. 1974, December

Introductory Testimony. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 1-10), 327 p.

Public concern regarding the manufacture and use of transuranium elements is based on several facts. Increasing quantities of the transuranics are being produced, and the rate of production will increase substantially. Several radioisotopes of Pu and other transuranic elements have exceedingly long life-lives and, once released, will persist and accumulate in the environment for time periods extending over many human generations. These naturally occurring alpha-emitting radioisotopes are known to produce cancer of the lung, bone, and liver in humans as well as in experimental animals. Meaningful judgments on the adequacy of current standards and guidelines must be based in part on the knowledge and understanding acquired in the course of nuclear development including the research in the life sciences. There are several domestic and foreign organizations, independent of government, that have played a role in the development of standards, criteria and guidelines. It is essential to have adequate information on the biomedical and environmental behavior of Pu and other transuranics in order to assure safety in current and future activities and to identify specific areas where increased understanding is likely to have the greatest impact on specific developmental, operational, and regulatory decisions so that research may be focussed on these areas. The major research programs of the AEC on the biomedical and environmental aspects of the transuranics include experiments in inhalation of aerosolized transuranics, effects of "hot particles", the Transuranium Registry and behavior of transuranic elements dispersed globally by weapons testing. Increasingly, in anticipation of ERDA, research activities in the area of the transuranics is being integrated with research on the environmental behavior and potential health consequences of pollutants from alternative energy sources so that a better assessment of the bioenvironmental aspects of alternative energy technologies can be made, so as to help orchestrate their development, and to provide a sound basis for operating and regulating these technologies as they are installed. (FMM)

<331>
Mayer, R.A. (Comp.), A.W. Rudolph (Comp.), D.E. Bell (Comp.), and R.S. Davidson (Comp.), Battelle Columbus Laboratories, Columbus, OH. 1972, June 30

Bioenvironmental Effects Associated with Nuclear Power Plants: A Selected Bibliography. TID-26164; 292 p.

There are 446 abstracts contained in the bibliography. The sources used for the selection of references were Nuclear Science Abstracts, special bibliographies and review papers. The references contain authors, corporate authors, title, publication description, abstracts (in most cases) and keywords. Indexes on keywords, authors and report numbers are included. (HP) (LCW)

<332>
Wrenn, M.E., U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC. 1974, December

<332>

ENVIRONMENTAL ASSESSMENT

<332> CONT.
Environmental Levels of Plutonium and the Transplutonium Elements. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S Environmental Protection Agency Plutonium Standards Hearings on Plutonium and the Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 89-112), 327 p.

Information about the locations, amounts, origins, and distributions of Pu and transplutonium elements present in the environment, available for environmental transport, and not readily amenable for retrieval is summarized. Environmental Pu is described in two general categories, namely globally or locally distributed Pu. Globally distributed Pu emanates from two sources--nuclear weapons testing and space nuclear application. The global inventory is thought to be 460,100 curies, primarily of Pu 239 and Pu 240. Local sources fall in five general categories: nuclear weapons testing, nuclear weapons accidents, major AEC production and test sites, AEC contractor industrial type facilities, and purposeful release of wastes under controlled conditions. It was concluded that the major transuranic activity in the environment is composed of Pu and Am from weapons testing and that this material is detectable in surface soils around the world, although their presence raises the alpha background in surface soils generally less than 1%. The Pu and Am activity per gram near the surface will decrease slowly with time. Finally, local sources of Pu although much smaller in quantity than that from globally distributed weapons testing fallout can result in concentrations of Pu in soil exceedings the concentrations of the global level from weapons testing. (RAF)

Figures 1-7 show the yearly deposition of Pu 239 in New York since 1954 and its cumulative deposition, the distribution of Pu 239 between northern and southern hemisphere as of 1970/1971, Pu 238 and Pu 239 in surface air 45 degrees North, the distribution of Sr 90 with latitude, Pu 239 accumulation in mCi/km(E+2) at various locations in the United States and the vertical distribution of Pu 239, Sr 90 and Cs 137 in sandy loam soil samples from New England. Table 1-5 show estimates of globally distributed Pu, actinide concentrations in United States soil, representative concentrations of Pu 239 in various media (Circa 1971), preliminary estimates of local sources of Pu in the environment and concentrations of Pu in soil.

MEDICAL ASPECTS

<333>
Berton, M., Commissariat a l'Energie Atomique, Centre d'Etudes, Bruyeres-le-Chatel, France. 1972, August

Peaceful Applications of Nuclear Explosions Mines, Chemistry, Gas Extraction, Oil Extraction. CEA-BIB-129 (ADD 1), 279 p.

This bibliography is complementary to the bibliography CEA-BIB-129 written in 1968. It is comprised of 788 references covering principally the following domains: Nuclear Science Abstracts, Government Research Abstracts, Scientific Technical Aerospace Reports, le Bulletin Signaletique of the C.N.R.S., l'Index de la Litterature Nucleaire Francaise and reports and books of the Central Library of Saclay. The documents are presented in a number of chapters indicated in a subject index table. The main topics covered are: aspects of underground explosions such as contamination of underground water, environmental effects and radiological protection; mines; chemistry; petroleum; gas; radionuclides, including Pu 239 and Cf 252; and specific Plowshare projects. Several indexes appear at the end of the bibliography: authors index, index of reports, index of review articles, index of congresses, index of books, and a patents index. (Auth) (PMM)

<334>
Koranda, J.J., J.P. Martin, P. Wikkerink, and M. Stuart, Lawrence Radiation Laboratory, Biomedical Division, Livermore, CA. 1970, January 7

Postshot Distribution and Movement of Radionuclides in Nuclear Crater Ejecta. UCRL-71918; CONF-700101; Part of Proceedings of a Symposium on Engineering with Nuclear Explosives held in Las Vegas, Nevada, January 14-16, 1970, (33 p.)

The distribution and postshot movement of radionuclides in nuclear crater ejecta are discussed. Continuing studies of tritium movement in ejecta at Sedan crater demonstrate that variations in tritium concentration are correlated with seasonal rainfall and soil water movements. Losses of 27 mCi H3/ft2 are evident on Sedan crater lip at the end of a three year period of measurements in which an unusually large flux of rain was received. The distribution of gamma emitting radionuclides and tritium is described in the recently created SCHOONER crater ejecta field. The specific activity of radionuclides in the SCHOONER ejecta continuum is shown for ejecta collected from the crater lip to 17 miles fromGround Zero (GZ). The movement of W 181 and tritium into the sub-ejecta preshot soil is described at a site 3030 feet from GZ. (Auth)

<335>
Koranda, J.J., J.P. Martin, and P. Wikkerink, Lawrence Radiation Laboratory, Biomedical Division, Livermore, CA. 1967, December 7

Residual Tritium at Sedan Crater. Part 2. Soil and Ejecta Studies. UCRL-50360; 42 p.

Continuing studies of residual tritium in soil or ejecta deposited on the landscape around the Sedan crater, Nevada Test Site, are concerned with the spatial and temporal distribution of THO in the area from the crater lip to 5000 ft from ground zero. Seasonal variations in the concentrations of tritium in soil water occur mainly during the winter rainfall period. Dilution effects were observed to a depth of 3 ft during an unusually high rainfall period (1965-1966). Diluted tritium concentrations in the surface strata of soil (6 in. to 3 ft) increase to almost the predilution levels during the summer as a result of soil moisture movements. When Sedan ejecta occurs as a shallow layer overlying the preshot soil, maximum tritium concentrations are found in this soil, usually at the maximum depth of rainfall penetration, or approximately 3 ft. Maximum concentration of tritium in ejecta on the Sedan crater lip is found at a depth of 4 to 5 ft and is correlated with the depth of ejecta materials found around the crater lip. An inventory of tritium in the Sedan ejecta field was calculated, based upon collections of soil samples along transects of the ejecta-covered area, and to a depth of 6 ft at each site. The tritium inventory measurements are essentially of biologically available water in the soil system. When data are corrected to total soil-water tritium values, the current inventory of tritium outside the Sedan crater in 1967, five years postshot, is 5 to 6% of the estimated inventory of the residual tritium in the ejecta at shot time. (Auth)

<336>
Not given, Nevada Operations Office, Las Vegas, NV. 1973, January

Reports Available in the Alaskan Information Program. NVO-103 (Rev. 3); 17 p.

A bibliography has been compiled listing all documents available in the open file depositories in Alaska at which unclassified scientific and technical reports are available relating to the USAEC's Amchitka Island Activities. These reports provide facts of the test program and detail measures being taken to assure the safety of the public and test participants as well as protection of the environment--163 reports are cited. (BBM)

<337>
Not given, Nevada Operations Office, Las Vegas, NV. 1973, July

Reports Available in Plowshare Open File. NVO-86 (Rev. 3); 35 p.

A bibliographic listing of all open file publications concerning Projects Gasbuggy, Rulison, Rio Blanco and Wagon Wheel is provided. These projects are part of the USAEC's Plowshare Program to develop peaceful uses for nuclear explosives and use the energy of deeply buried nuclear explosives to increase the permeability and porosity of rock thereby stimulating the flow of natural gas. Reports include production testing data, on and offsite Rad-Safety data, and miscellaneous data. 240 references are cited. (BBM)

<338>
Bayer, K.C., National Oceanic and Atmospheric Administration, Earth Sciences Laboratories, Las Vegas, NV. 1973, May

A Preliminary Seismicity Study of the Southern Nevada Region Quarterly Report, January-March 1973. NOAA-TM-ERL-ESL-26; NVO-746-12; 109 p.

A cooperative (FSL, Sandia Laboratories, and USGS) network of 21 seismic velocity sensitive stations is operated in the southern Nevada area; the stations are monitored by the NOAA/ESL Nevada Special Projects Party, located in Las Vegas, Nevada. The most active area during this period was in the Ranger Mountains/Frenchman Lake area on and adjacent to the Nevada Test Site (NTS). Six monthly seismicity maps are included; three of the southern Nevada region and three of the seismicity on and adjacent to the Nevada Test Site. This is the initial quarterly seismic bulletin covering the southern Nevada region, as monitored by the Las Vegas, Nevada-based Special Projects Party. The seismic data ouput is listed in the Hypocenter Summaries and the station data is tabulated in the Seismological Bulletins. The analyses are the result of data scaled only from the local cooperative network and solutions determined by a local-epicenter program. A total of 365 epicenters is listed, over two-thirds associated with the Ranger Mountains sequence. (Auth)

<339>
Blankennagel, R.K., and J.E. Weir, Jr., U.S. Department of the Interior, Geological Survey, Washington, DC. 1973

Geohydrology of the Eastern Part of Pahute Mesa, Nevada Test Site, Nye County, Nevada. Geological Survey Professional Paper No. 712-B; 35 p.

A deep structural depression, the Silent Canyon caldera, underlies the eastern part of Pahute Mesa, Nye County, Nev. The caldera is elliptical in plan and measures about 11 by 14 miles; the greater axis trends in a north-northeastern direction. Exploratory drilling revealed a Tertiary volcanic section of ash-flow and ash-fall tuffs and rhyolitic lava flows which attained thicknesses in excess of 13,686 feet. Hydraulic tests made in deep drill holes indicated that these volcanic rocks are capable of transmitting water and that measurable permeability occurs at depths greater than 3,500 feet below the top of the saturated zone. Most movement of groundwater beneath the mesa occurs through interconnecting fault and joint systems. The yield of water to wells from intervals of ash-fall and nonwelded ash-flow tuffs, particularly those that are zeolitized or argillized, is low. Hence these rocks are considered the best media for mining of underground chambers in the saturated zone. In the Silent Canyon caldera, depth to water ranges from about 1,952 feet (alt. 4,164 ft) in the western part to 2,350 feet (alt. 4,685 ft) in the eastern part. In the extreme northwestern part of the Nevada Test Site, outside the caldera, the depth to water is about 850 feet (alt. 4,700 ft). Pumping tests indicate that transmissivities range from 1,400 to 140,000 gallons per day per foot. Water derived from drill holes at Pahute Mesa moves southwestward and southward toward the Amargosa Desert through Oasis Valley, Crater Flat, and western Jackass Flats. The flow, across a 15-mile underflow strip which extends from the hydraulic barrier on the west to the groundwater divide on the east, is estimated to be 8,000 acre-feet per year. Estimates of groundwater velocity vary as much as two orders of magnitude--5 to 250 feet per year. Based on the assumption that most groundwater movement occurs along interconnected fractures and that some movement occurs through interstices, a reasonable estimate of velocity is less than 15 feet per year. (Auth)

<340>
Cherdyntsev, V.V., and J. Schmovak (Translator), Geological Institute of the Academy of Sciences of the USSR, Dating Laboratory, Moscow, USSR; Kazakh University, Alma-Ata, USSR. 1971

Uranium 234. Keter Press, Jerusalem, Israel; 234 p.

A systematic account of the experimental data available on uranium 234 in nature is presented. The needs of specialists in the field of uranium, readers interested in science in general, and researchers in the fields of geology, physics, archeology, oceanology, and soil science are considered. Experimental data and literature references including foreign publications are exhaustive up to 1966. Chapter 1 deals with the physical principles of nuclear geochemistry. Succeeding chapters are devoted to fractionation of heavy radioactive elements in nature, fractionation of radioactive isotopes, U 234 in nuclear geochemistry, U 234 in uranium minerals, U 234 in continental waters and in Quaternary deposits, and U 234 in the ocean. Dating with U 234, particularly during the Quaternary, is extensively discussed. Attention is called to its use in the future as a tool of modern nuclear geochemistry. (ST)

This is a translation of URAN-234.

<341>
Claassen, H.C., U.S. Department of the Interior, Geological Survey, Federal Center, Lakewood, CO. 1973, January

Water Quality and Physical Characteristics of Nevada Test Site Water-Supply Wells. USGS-474-158; NTS-242; 152 p.

Chemical, radiochemical, and hydraulic data obtained by the U.S. Geological Survey from the water-supply wells at the Nevada Test Site are presented. Time variations in these parameters are discussed and evaluated. A diagrammatic representation of well construction and lithology penetrated is included for each well. (Auth)

<342>
Heard, H.C., B.P. Bonner, A.G. Duba, R.N. Schock, and D.R. Stephens, Lawrence Livermore Laboratory, Livermore, CA. 1973, May 22

High Pressure Mechanical Properties of Mt. Helen, Nevada, Tuff. UCID-16261; 41 p.

Pressure-volume, uniaxial stress, failure envelope, uniaxial strain, and acoustic velocity measurements have been made on the porous, fine grained Mt. Helen tuff. For each type of measurement, three levels of saturation were investigated: 0, 50 and 100%. Additional intermediate saturations were examined in the failure and acoustic velocity determinations. Hydrostatic compression to 40 kbar yield compactions ranging from 27% for 0% saturation to 23% for 100% saturations. Bulk moduli (K) as

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GEOLOGICAL ASPECTS

<342> CONT.
determined at low pressure in both pressure-volume and uniaxial stress loading yield values of approximately 30 kbar for both the dry and saturated tuff. The corresponding range of shear moduli (micro) from the uniaxial stress tests are approximately 15 to 30 kbar. Both K and micro determined for the 50% saturated tuff give anomalous results suggesting chemical interaction between the water and component minerals. Results from the acoustic velocity measurements also suggest chemical interactions. Shear strengths (pi) of the Mt. Helen tuff depend strongly on water content at all pressures. Values for pi in dry tuff range from 0.2 to 3.0 kbar over the pressure range of 1 bar to 7 kbar. In the fully saturated material, pi ranges from 0.1 to 0.35 kbar over the same pressure range. Ductile behavior is ubiquitous for all saturations at pressures less than 0.5 to 1.0 kbar. The path in uniaxial strain loading rises directly to the vicinity of the failure envelope and then closely parallels it to the highest pressures, independent of water content. (Auth)

<344>
Becker, K., and D.R. Johnson, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1970, March 5

Nonphotographic Alpha Autoradiography and Neutron-Induced Autoradiography. Science, 167, 1370-1372

With a new combination of two techniques, (1) alpha-particle or fission fragment registration in thin polymer foils by etching and (2) automatic counting and magnification of the etched perforations by local evaporation of a thin metal layer with an electric spark, the sensitivity of conventional photographic methods for determining quantity and spatial distribution of alpha emitters, fissile materials, and of elements undergoing (n, alpha) reactions can be drastically improved, without need for darkroom processing and microscopic evaluation. (Auth)

<345>
Casarett, A.P., Cornell University, New State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Detection and Dosimetry. Part of Radiation Biology, Chapter 3. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 31-56), 368 p.

This chapter deals with radiation detection, measurement, and dosimetry and with general techniques of irradiation. Radiation detection methods are reviewed and several types of dosimeters are described. Emphasis is placed on those detectors that are used in radiobiology for measuring radiation distribution and exposure. Techniques of measuring internal dose to tissues and factors which influence tissue dose are discussed. Descriptions of several experimental exposure set-ups are included in this section. (ST)

<346>
Clemente, G.F., Comitato Nazionale per l'Energia Nucleare, Environmental Radioactivity Laboratory, Rome, Italy. 1973

In Vivo Measurements of Plutonium 239 in Man. CONF-720503; Part of Buidoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 503-507), 655 p.

Three different sets of equipment were tested for use in making in vivo lung measurements of plutonium 239 of personnel at the Casaccia Nuclear Centre, Rome, Italy, where plutonium fuel elements are prepared. All measurements were made inside the shielded room of the Whole Body Counter of the Laboratory. A twin crystal composed of a 125 mm x 0.5 mm NaI(Tl) crystal optically coupled to a 125 mm x 50 mm CsI(Na) crystal used together with a pulse shape discrimination system yielded the necessary sensitivity of 4 nCi. Results obtained from the three sets of counting equipment are reported. (ST)

<347>
Davis, W., Jr., Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN. 1974, April

High-Efficiency Particulate Air Filters: State of the Art Summary Pertaining to Plutonia Aerosols. ORNL-TM-4463; 9 p.

High-efficiency particulate air (HEPA) filters now being manufactured commercially routinely exceed the specification of removing 99.97% of 0.3 u-diameter particles of a monodisperse dioctyl phthalate (DOP) aerosol. Laboratory tests indicate that when such filters are properly installed in series, at least up to three, each will perform at this same level with plutonia aerosols, leading to decontamination factors in excess of 3 x 10(E+10). Filter media that are resistant to serious degradation by hydrogen fluoride and fluorine are now in the process of assembly into filter units for testing. (Auth)

<348>
Light, M.E., A.J. Hulbert, and W.K. Johnson, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973, December

An Instrument for Realtime Determination of Concentrations of Aerosols of Alpha-Emitting Radionuclidse for Use in Animal Inhalation Studies. LF-46; Part of McClellan, R.O. and Ruporecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1972-1973, (p. 21-23), 342 p.

An aerosol concentration monitor has been designed and fabricated for the purpose of measuring aerosol concentrations of alpha-emitting radionuclides during exposures of experimental animals. Aerosol samples are drawn at flow rates of 200-500 cc/min from the exposure chamber and through a filter which is separated from a diffused-junction silicon radiation detector by approximately 1 cm. The face of the detector is covered by a light tight mylar cover. Amplified pulses from the detector are routed through a discriminator so that only particles above a threshold energy are counted. The counting circuitry computes and displays accumulated activity and the rate of accumulation. (Auth)

<349>
Parfyonov, V.A., N.V. Ryabov, and K.N. Stas, Union Research Institute of Instrumentation, State Committee for Utilization of Atomic Energy, Moscow, USSR. 1973

Personnel Monitoring of Respiratory Tract Overirradiation Hazard Due to Radon Decay Products. CONF-720503; Part of Buidoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 149-152), 655 p.

The known personnel monitoring techniques of radon short-lived decay products are reviewed and their advantages and disadvantages are discussed. Aspects of further development of monitoring apparatus are discussed. (Auth)

<350>
Poston, J.W., Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1971

A Detector for the Measurement of Dose Distributions at a Bone-Tissue Interface. CONF-701112; STI/PUB/269; Part of Proceedings of a Symposium on New Developments in Physical and Biological Radiation Detectors held in Vienna, Austria, November, 23-27, 1970, (p. 299-310), 742 p.

<350>

INSTRUMENTATION

<350> CONT.
Radiation detectors are described which facilitate the measurement of dose distributions at a bone-tissue interface. These small extrapolation-ionization chambers allow the measurements of dose distributions at depths in tissue-equivalent phantoms, a significant improvement over dosimeters of this general type. Such measurements allow a more accurate assessment of the importance of this interface in the establishment of external radiation exposure standards. Detectors characteristics, such as saturation voltage as a function of electrode spacing, directional response of the chambers, and effects of change in collecting electrode area, are discussed. A method for measuring ionization currents produced in these chambers at large distances from the point of measurement is presented. Results of measurements in a tissue-equivalent phantom are presented for neutrons from several isotopic sources, i.e., AmB, AmBe, and PuBe. Dose distribution from a 14 MeV neutron source are given also. The significance of these results in relation to theoretical studies and the present exposure standards is discussed. (Auth)

<351>
Raabe, O.G., G.J. Newton, J.A. Mewhinney, B.B. Boecker, L.E. Bowen, Lovelace Foundation for Medical Education and Research, Inhalation Toxicology Research Institute, Albuquerque, NM. 1973

An Improved System for Exposure of Beagle Dogs to Radioactive Aerosols. LF-46; Part of McClellan, R.O. and Rupprecht, F.C. (Eds.), Inhalation Toxicology Research Institute Annual Report, 1971-1973, (p. 10-15), 342 p.

A new apparatus is described for individually exposing beagle dogs to radioactive aerosols for periods up to two hours. The system utilizes a whole-body plethysmograph for measuring the dog's respiratory activity during the exposure. The dog is restrained in the plethysmograph and only the nose is exposed to the radioactive aerosol. Provision is made for aerosol generation, for heat treatment of the aerosol, if necessary, and for sampling for aerosol characterization with a cascade impactor, a filter, and an electrostatic precipitator. The primary improvements over previous equipment include: (1) use of stainless steel glove boxes with safety-glass viewing windows for housing the aerosol equipment, (2) simplified aerosol chamber and aerosol dilution system, (3) isolation of the high temperature heating column used for heat treatment of aerosols, (4) provision for obtaining duplicate and multiple aerosol samples, and (5) remote control and monitoring from a single control panel of all normal operations including sampling. Successive tests with monodisperse aerosols of Pu 239 PuO2 showed the reproducibility of aerosol concentrations and particle size distributions as measured with multiple samples. (Auth)

<352>
Watson, C.R., Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Radionuclide Scanning Facility for Dogs. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 315-317), 253 p.

A dog scanning apparatus, first operated in 1960, has been refined so that it allows simultaneous scanning for Pu 239 and Am 241. Beagle dogs were scanned following inhalation of Am 241-enriched Pu 239, to determine whether these inhaled radionuclides follow the same path within the body. (ST)

<353>
Atkins, H.L., Brookhaven National Laboratory, Medical Research Center, Upton, Long Island, NY. 1969, January

The Medical Use of Californium 252. BNL-12919; CONF-681032; Part of Barker, J.J. (Ed.), Proceedings of a Symposium on Californium 252 held in New York City, New York, October 22, 1968, (p. 285-302), 376 p.

Methods of treating radioresistant anoxic tumor cells are reviewed. The use of californium isotopes as implantable fission neutron sources, a variety of high linear energy transfer radiations, has been suggested. The advantages of using this isotope and its limitations are discussed. Results of studies with human tumor cells in culture showed that the relative biological effectiveness of californium with respect to protracted irradiation by radium is approximately 2.9. Studies are in progress to determine the oxygen enhancement ratio of californium. (ST)

<354>
Bair, W.J., and R.C. Thompson, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1974, February

Plutonium: Biomedical Research. Science, 183, 715-722

The biomedical literature on plutonium was reviewed in an effort to summarize the known toxic effects of this element and to evaluate the hazards to man. Because of the future role of plutonium in the production of power and in fueling breeder reactors, more information is needed on other radionuclides with which the toxicity of plutonium can be compared. The chemical and physical properties of plutonium are briefly summarized and a brief historical survey of biomedical studies in the United States is given. The Atomic Energy Commission now spends approximately $6 million on research on plutonium and the transuranic elements. Inhalation is the most probable route of entry into man during occupational exposure. Plutonium reaching man by way of environmental routes is more likely to be by uptake of resuspended particles than through food chains. From 0.3 to 0.5 million Curies of plutonium have been released as a result of atmospheric weapons tests. Autopsy results in the Boston area suggest that each human may accumulate 10(E-17) of this total amount. Results of beagle dog studies suggest that inhaled soluble plutonium may be largely cleared from the lungs within a year and translocated to bone and liver. Insoluble particles are retained in the lungs longer and are translocated primarily to regional lymph nodes. The influence of physical and chemical form and route of administration on speed of removal from the blood and translocation is discussed. Deposition sites within the liver and bone and metabolism and retention within these and other tissues is reviewed. Excretion studies by Langham (1956) cite the slow removal of injected plutonium. Animal studies show that the acute toxicity of injected plutonium is due to its destructive effects on the hematopoietic system. The most sensitive index of plutonium toxicity in bone is the induction of osteosarcoma. Beagle dog studies at the University of Utah showed that Pu 239 is five to ten times more toxic than Ra 226 (Mays, 1972). Other animal studies showed that the earliest response to inhaled plutonium is lymphopenia, but the most sensitive index is lung cancer. The safest and most effective decontamination measures used on man are discussed. Problems encountered in attempting to evaluate the hazardous effects of plutonium in man and to establish exposure limits are discussed. Present accepted ICRP permissible body burden for occupational exposure is 40 nCi. It is suggested that much more information on plutonium toxicity is needed so that reliable predictions can be made. (ST)

<355>
Barron, E.S.G., and J. Muntz, University of Chicago, Chicago, IL. 1945

Clinical Medicine and Medical Research: Studies on the Mechanism of Plutonium Intoxication. CN-2786; Part of Health Problems Relating to Product for Month of March 1945, (p. 4-7), 35 p.

Plutonium nitrate (0.0001 M) added to human blood serum and subjected to electrophoresis migrated with the beta-gamma globulin fraction. Upon ultrafiltration of plutonium serum and plutonium plasma mixtures, 24 and 15% of the plutonium was found in the ultrafiltrate. There was no difference between dialyzed and undialyzed samples, an indication that plutonium did not form firm complex compounds with the anions of blood plasma. (Auth)(ST)

<356>
Basson, J.K., C.H. Wyndman, A.J.A. Heyns, W.H. Keeley, I. Webster, C.P.S. Barnard, A.H. Munro, and I. Webster, National Nuclear Research Center, Pelindaba, South Africa; Chamber of Mines of South Africa, Johannesburg, South Africa; National Research Institute for Occupational Diseases, Johannesburg, South Africa. 1971

A Biostatistical Investigation of Lung Cancer Incidence in South African Gold/Uranium Miners. CONF-710901; A/CONF-49/P-659; STI/PUB/300; Part of Proceedings of the 4th International Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 6-16, 1971, Vol. 11, (p. 13-29)

The incidence of lung cancer among South African gold miners was investigated to determine whether, as a result of exposure to radon daughters, arising from the presence in the ore as mined of low concentrations (0.015 to 0.075% U308) of uranium, it is greater than for the male population as a whole. A random sample of 1100 men was drawn from the total of 227,000 white miners registered by the Chamber of Mines up to the end of 1967, and the cumulative exposure for each man was calculated as the product of the shifts worked underground and the relevant concentration of radon daughters. On the basis of surveys made in twelve typical mines, estimates of radon concentrations expressed in "working levels" were assigned to each of the 119 mines concerned. The average cumulative exposure over the period 1960-7 was 35.8 "working level months". From the number of deaths due to brochogenic carcinoma and the extimated population at risk (using an expansion factor (227,000/1100 equals 206) the crude death rates were calculated. The average annual death rate due to lung cancer among white gold miners in South Africa was found to be 2.96 per 10,000 (or 3.70 when corrected for all possible omissions) as compared with 3.12 for the general population of white South African males (or 3.67 when corrected for age distribution). It is concluded that the

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<356> CONT.
death rate from lung cancer among white South African miners has not been increased by the low radon exposure occurring in South African gold/uranium mines. Furthermore, although this investigation was undertaken as a pilot study, it appears that no improvel results would be obtained by increasing the sample size as the estimates of cumulative exposure of individuals are necessarily very crude and the spread of exposures very narrow. (Auth)

<357>
Bennett, B.G., Health and Safety Laboratory, New York, NY. 1974, December

Environmental Pathways of Transuranic Elements. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 131-155), 327 p.

Exposure of man to transuranic element contamination may occur by the inhalation or ingestion pathways. A discussion is given of the specific aspects of these pathways, such as resuspension of deposited activity, plant uptake, and physical and biological transfers in terrestrial and aquatic environments. In addition, the measurements of fallout Pu, tracing the course of this material in air and diet to man, provide some of the most directly appropriate data regarding the environmental pathways. It is generally recognized that for an initially airborne release, the inhalation pathway is the dominant contributor to the body burden in man. The low solubility of the transuranic elements inhibits plant uptake and absorption from the gastrointestinal tract and minimizes the importance of the ingestion pathway. For contamination which originates on the ground surface, such as leakages or spills, resuspension could be an important consideration. It is recognized thata number of parameters are involved in describing the resuspension process, icluding soil conditions, moisture, wind, vegetation cover and mechaical disturbances such as digging or traffic. The factors influencing plant uptake of transuranic elements are chemical form. Solubility, oxidation state of the radioactive element composition and pH of the soil and plant species. From the data available, the uptake of Pu was assigned as 10(E-4) (pCi/g fresh weight per pCi/g dry soil) plus or minus an order of magnitude, with uptake of Am and Cu about 30 times greater. The ingestion and inhalation pathways of fallout Pu to man are considered in detail. Ingestion intake of fallout Pu has been determined from concentration results and food consumption estimates. The results for the annual intake during 1972 was 1.6 pCi due 35% to grain products, 20% each to vegetables, fruits and meats and less than 4% to dairy products. Inhalation intake of fallout Pu can be determined directly from the measured air concentrations. Estimates of retention in lung, transfer to blood and organ distributions are obtained using the ICRP Task Group Lung Model. The measured inhalation intake of fallout Pu and the computed organ burdens are shown graphically. The cumulative doses through 1973 to an individual exposed throughout the entire fallout period since 1954 have been 15 mrem to lung, 8 mrem to bone and 4 mrem to liver. (PHN)

Figure 2 shows inhalation intake and burden in man of /239, 240/239,240/ food in New York, 1972. Table 2 shows Pu 239,240 dietary intake in New York, 1972. Table 3 shows fallout Pu 239,240 inhalation intake and computed body burdens. Table 4 shows fallout Pu 239,240 in man.

<358>
Bennett, B.G., Health and Safety Laboratory, New York, NY. 1974, January 1

Fallout Plutonium 239 Dose to Man. HASL-278; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, September 1, 1973 through December 1, 1973, (p. I-41 - I-63), 163 p.

The dose to man through the year 1972 due to Pu 239 from weapons testing is estimated to be 15 mrem to lung, 7 mrem to bone and 4 mrem to liver. The dose commitments through the year 2000 are somewhat larger than the doses already delivered due to the continued irradiation of tissue from the accumulated organ burdens. The dose estimates are based on the predominant inhalation pathway, considering the Pu 239 concentrations in air in New York and utilizing the ICRP Task Group lung model. The computed organ burdens are in general agreement with the reported tissue analyses. The equations used to obtain the organ burdens and doses are presented and examples of acute and chronic intake situations are also given. (Auth)

Table 1 shows Sr 90 and Pu 239 measurements in surface air and deposition in New York. Table 2 shows fallout Pu 239 data for New York including deposition, inhalation intake, and content in tissues of man. Table 4 shows Pu 239 in man, New York 1968. Table 5 shows Pu 239 in man, Colorado and New Mexico, 1970-1971.

<359>
Burr, W.W., Jr., U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC. 1974, December

Biomedical Effects of Plutonium on Humans. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 231-234), 327 p.

Comparatively little information is available regarding the effects of Pu and other actinide elements on man. There are three groups of individuals who have been exposed to and/or retained Pu for some time. The first group consists of persons who have been occupationally exposed to Pu at some time in their working life. Included in this group are some workers from the Manhattan Project who have maintained multiples of the maximum permissible body burden (MPBB) for nearly 300 yr. Also there are over 200 industrial exposures between 1953 and 1970 that resulted in burdens of Pu exceeding 25% of the MPBB. The second group consists of 18 people thought to be hopelessly ill, who were injected with Pu during and immediately after the days of the Manhattan Project to study excretion and distribution patterns in man. The third group is the world at large. The general population has accumulated minute quantities of Pu from the fallout debris that resulted from nuclear testing in the atmosphere and from the atmospheric burn-up of a thermoelectric generator. The clinical follow-up of persons with burdens has been

<359> CONT.
reassuring, but any conclusions with respect to late effects of Pu in man must remain tentative for some time. It can be stated, however, that available data dose not support the viewpoint that the current radiation protection standards and guidelines which have been followed for many years underestimate by many orders of magnitude the risk due to Pu deposition in man. (FMM)

<360>
Caldecott, R.S. (Ed.), and L.A. Snyder (Ed.), University of Minnesota, Center for Continuation Study of the General Extension Division, Minneapolis, MN. 1960, April 25

Radioisotopes in the Biosphere. Proceedings of a Symposium held at the University of Minnesota, Minneapolis, Minnesota, October 19-23, 1959. University of Minnesota Printing Department, Minneapolis, Minnesota, 597 p.

The symposium was concerned with a discussion of the facts and deficiencies in knowledge relating to the pathway of radioisotopes from the time they enter soils until they are excreted from living systems. Papers were reported under the following sections; radioisotopes in soils and plants; radioisotopes and their relation to the genetic mechanism and physiological processes; radioisotopes and environmental circumstances; radioisotopes in the skeleton; radioisotope toxicity; and radioisotope absorption and methods of elimination. Particular emphasis was placed on the uptake of radioisotopes by plants, animals, and man and the genetic consequences of their ingestion. Thirty-seven papers were presented; seven were abstracted separately for the data base. (ST)

<361>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Modification of Radiation Injury. Part of Radiation Biology, Chapter 11. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 336-365), 368 p.

Physical and biological factors and chemical protective agents are considered. Some of the current concepts of the treatment of radiation injury are reviewed. Physical modifications of radiation injury include partial body radiation, relative biological effectiveness and the influence of linear energy transfer, dose rate, and chronic irradiation. Parameters considered under biological factors are age, genetic constitution, sex, health, diet, endocrine status, oxygen concentration, temperature, and hibernation. The most effective class of chemical protectors, the aminothiols--cysteine; cysteamine; S,2-aminoethylisothiourea dihydrobromide, which rearranges to 2-mercaptoethylguanidine; and related structures, and theories of their radioprotective mechanisms are discussed. Several other substances which have demonstrated dose reduction factors (DRF) are reviewed. The chapter concludes with a brief discussion of postirradiation treatment. (ST)

<362>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Effects on Microorganisms and Independent Cell Systems. Part of Radiation Biology, Chapter 7. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 136-158), 368 p.

Target theories are reviewed and the interpretation of experimental results in terms of the target theories is discussed. Studies of radiation effects on microorganisms and mammalian cells in tissue culture in which the parameters of survival, ability to carry on metabolic processes, ability to repair and divide, and growth were studied are reviewed. Radiation sensitivity of in vivo and in vitro mammalian cells is compared. Indirect effects from the irradiated medium are discussed. (ST)

<363>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Differential Cell Sensitivity. Part of Radiation Biology, Chapter 8. Prentice-Hall, Inc., Englewood Cliffs, New Jersey (p. 159-170), 368 p.

Various cellular characteristics which have been shown to correlate with radiosensitivity are discussed. These are nuclear and chromosome volume, ploidy, extra nucleoli, location of centromeres, ratio of nuclear volume to cytoplasmic volume, number of mitochondria, mitotic rate, and degree of cell differentiation. On the basis of these characteristics and histologic observations of cellular changes, mammalian parenchymal cells were divided into four general categories of radiosensitivity. Based on the criterion of early cell death as judged by histologic study, groups of mammalian cells in order of decreasing sensitivity are: mature lymphocytes, erythroblasts, and certain spermatogonia; granulosa cells from ovarian follicles, myelocytes, intestinal crypt cells, and epidermal germinal cells; gastric gland cells and endothelial cells of small blood vessels; osteoblasts, osteoclasts, chondroblasts, granulosa cells of primitive ovarian follicles, spermatocytes, and spermatids; granulocytes, osteocytes, sperm, and superficial cells of the gastrointestinal tract; parenchymal and duct cells of glands, fibroblasts, endothelial cells of large blood vessels, and erythrocytes; fibrocytes, reticular cells, chondrocytes, and phagocytes; and muscle and nerve cells. (ST)

<364>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Effects on Major Organ Systems of Mammals. Part of Radiation Biology, Chapter 9. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 171-216), 368 p.

This chapter concentrates on the histologic and functional changes in the major mammalian organ systems following exposure to total body radiation. The presentation involves a summary of many experiments in which varying doses of radiation were used. A brief review of the normal histology and function of the tissues is included where such information is considered important to an understanding of the radiosensitivity of the organ. Effects on the following organ systems are reviewed:

<364> CONT.
blood and hematopoietic tissue, digestive system, vascular system, bone, skin and hair, respiratory system, urinary system, muscle and connective tissue, nervous system, eye, ear, male and female reproductive systems, and endocrine system. The stress and immune responses to radiation are briefly discussed. The test is accompanied by numerous pictures and histologic sections. (ST)

<365>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Applied Radiation Biology. Part of Radiation Biology, Chapter 14. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 315-345), 368 p.

Some of the practical applications of ionizing radiation are described. These include medical, industrial, and research uses. The effects of background, medical, fallout, and industrial and research radiation exposures on the human population are considered. Risk to individuals is assessed in time of detrimental somatic and genetics effects and genetic effects on later generations. (ST)

<366>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Late Effects of Radiation. Part of Radiation Biology, Chapter 12. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 266-283), 368 p.

This chapter deals with long-term radiation effects, apparent months or years after recovery from initial radiation syndromes. These effects include life-shortening, carcinogenesis, and aging. Theories of radiation carcinogenesis are discussed in terms of somatic mutation, viruses, tissue lesions, threshold dose, direct versus indirect irradiation, and the dose-response relationship. Thresholds of carcinogenesis and dose-response effects are cited from rat experiments. Radiation carcinogenesis studies in man--tumor incidence in Japanese bomb survivors, radiation therapy patients, radium dial painters and laboratory workers, and following diagnostic radiation, and leukemia in radiologists--are reviewed. Other late effects of radiation, effects on fertility and bone and radiation cataracts, are mentioned. (ST)

<367>
Comar, C.L. (Chairman), National Academy of Sciences, National Research Council, Division of Medical Sciences, Washington, DC. 1972, November

The Effects of Populations of Exposure to Low Levels of Ionizing Radiation. Report of the Advisory Committee on the Biological Effects of Ionizing Radiations; 217 p.

A summary and analysis of current knowledge relating to risks from exposure to ionizing radiation is presented. The report deals with the scientific basis for the establishment of radiation protection standards and encompasses a review and reevaluation of existing scientific knowledge concerning radiation exposure of human populations. The following general principles are recommended: consideration of cost-benefit, upperlimits for non-medical exposure for personnel and the general public, restrictions on medical radiation exposure, guidance for nuclear power industry and consideration of uncontrolled releases, occupational and emergency exposure limits, more environmental radiation studies, and accurate estimates and predictions of radiation equivalent dosages from all planned and existing sources. Current information is reported under the following chapter titles: needs of the times, sources of ionizing radiation and population exposures, environmental transport and effects of radionuclides, genetic effects of ionizing radiation, effects of ionizing radiation on growth and development, and somatic effects of ionizing radiation. (ST)

The appendices contain tables of basis of risk estimates and incidence or risk of leukemia, thyroid, bone, skin, breast, and lung cancer, and other neoplasms.

<368>
Cooper, J.A., Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1973, April

Elemental Characterization of Simulated Uranium Mine Atmospheres. BNWL-1751 (Part 2); Part of Nielson, J.M., et al, Annual Report for 1972 (p. 1-2), 116 p.

The correlation of the high incidence of lung cancers and other respiratory ailments in uranium miners with lung exposure requires accurate characterization of the radionuclide, elemental and organic content of the uranium mine atmosphere. Simulated uranium mine aerosols used in animal exposure chambers are being characterized and compared to the aerosols found in operating uranium mines. (Auth)

<369>
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, 439-441

Direct measurements with an ultrasonic analyzer were made to estimate the thickness of soft tissue in the chest wall overlying the lungs. More than one point was measured since thickness in individuals varies considerably. Also, the right chest wall is typically thicker than the left. Six measurements were made in each of the 393 individuals between the ribs in a 120 mm diameter circle on each side of the chest. All of the measurements were made with the subjects standing. The effective thickness for both sides of the chest was calculated. The average effective tissue thickness for this group of subjects was 22.6 mm, with a standard deviation of 3.9 mm and a range of 14-33 mm. The effective tissue thickness also was calculated from measurements of various body parameters such as weight, height and chest circumference. (RAF)

<370>
Dolgirev, E.I., G.N. Kaidanovsky, and V.P. Shamov, Institute of Radiation Hygiene, Leningrad, USSR. 1973

In Vivo Counting of Transuranium Isotopes in the

<370> CONT.
Human Body. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 497-502), 655 p.

The method of the determination of Pu and Am deposited in human lungs, liver and skeleton is described. Calibration of a scintillation counter (NaI(Tl) crystal 0.1 cm long, 15 cm diameter) and a proportional counter (AR-CH4, window area of 300 cm2 and gas layer thickness of 7.5 cm) is made with a phantom providing variabe thickness of tissue absorber. Activity distribution in three subjects is presented. Organ contents are given as a percentage of the total body content. The skeleton contains more than a half of the total incorporated activity. This suggests that the contamination occurred many years ago. Considerable variation is observed in isotope distributions between lung, liver and skeleton in different subjects, that can be attributed to different chemical forms and modes of entering of transuranium isotopes into the human body. (Auth) (FMM)

<371>
Dolphin, G.W., and S. Jackson, Atomic Energy Research Establishment, Health Physics and Medical Division, Harwell, Berkshire, England. 1964, October

Interpretation of Bioassay Data. AHSB(RP)-R-41; 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, (p. 329-354)

In order to estimate the radiation dose to the critical organ due to internal contamination with a radionuclide, it is necessary to measure the amount of radionuclide in the body. When the radionuclide emits gamma or x radiation, or beta radiation giving rise to suitable bremsstrahlung, direct measurements of the body content can be made in a whole body activity measuring facility, but when there is no suitable emission of radiation it is necessary to resort to estimation of the body content from measurements of the amount of radionuclide in excreta, blood, breath or swabs taken from the nose or mouth. There has been some study of the excretion of radionuclides in urine as an index of internal contamination, and urine analysis is the most extensively practised form of bioassay. In the review three broad categories have been used in classifying the different modes of metabolism of various radionuclides. The first group includes those radionuclides which are rather uniformly distributed throughout the body. The second group includes those which are concentrated particularly in one or more organs of the body. The third group, really a specially important subgroup of the second, comprises the bone seekers. The pattern of urinary excretion and particularly its relationship to the radiation dose delivered to the critical tissues, is distinctly different for these different groups. It is emphasized that, following the recognition of an accidental intake, it is desirable to analyze a carefully planned series of urine samples, to provide a measure of the urinary excretion rate for a suitable period. The uncertainty associated with each individual result because of fluctuation in excretion rate can thus be minimized. A somewhat different approach is suggested in the case of urine sampling for routine surveillance of a group of personnel. The data available about metabolism of the radionuclide are used to evaluate an investigation level, namely, the urinary excretion rate corresponding to a chosen level of body content. A summary is presented of the human data available on metabolism and urinary excretion of tritium, cesium, uranium, strontium, radium and plutonium. (Auth)

Figure 1 is a simplified compartment model illustrating metabolic pathways for inhaled or ingested radionuclides. Figure 5 shows the excretion of soluble uranium following a single intake. Figure 8 shows urinary excretion of Pu following an intake of 0.04 uCi.

<372>
Donoghue, J.K., E.D. Dyson, J.S. Hislop, A.M. Leach, and N.L. Spoor, United Kingdom Atomic Energy Authority, Harwell, Didcot, Berkshire, England. 1972

Human Exposure to Natural Uranium, A Case History and Analytical Results from Some Postmortem Tissues. British Journal of Industrial Medicine, 29(81), 81-89

After the collapse and sudden death of an employee who had worked for 10 years in a natural uranium workshop, in which the airborne uranium was largely U308 with an Activity Median Aerodynamic Diameter in the range 3.5-6.0 um and average concentration 300 ug/m3, his internal organs were analyzed for uranium. The tissues examined included lungs (1041 g), pulmonary lymph nodes (12 g), sternum (114 g), and kidneys (217 g). Uranium was estimated by neutron activation analysis, using irradiated tissue ash, and counting the delayed neutrons from uranium 235. The concentrations of uranium (ug U/g wet tissue) in the lungs, lymph nodes, sternum, and kidneys were 1.2, 1.8, 0.09, and 0.14, respectively. The weights deposited in the lungs and lymph nodes are less than 1% of the amounts calculated from the environmental data using the parameters currently applied in radiological protection. The relation between these results, the environmental exposure data, and biological monitoring data is discussed in the context of current views on the metabolism of inhaled insoluble uranium. (Auth)

Table 1 shows human metabolism of insoluble uranium (giving chest burden and biological half-life). Table 5 gives distribution of uranium in postmorten tissues.

<373>
Ducousso, R., J. Menot, C. Pasquier, and J. Lafuma, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France. 1972, July

Surgical Treatment of Wounds Contaminated by Radioactive Substances, About Six Cases Related in the Literature. CEA-BIB-203; 35 p. (French)

The booklet is designed to be an aid to surgeons likely to be faced with the fine removal of radioactive substances from wounds. Basic data are presented in the first part: notion of transferability, units used for internal contamination, properties of Pu 239, characteristics of x-ray detectors. The second part is devoted to both an account of six cases published in recent years and a critical review in order to bring out what should be done and above

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<373> CONT.
all what should not be done in such cases. The third part gives a summary of the surgical handling of a wound contaminated by plutonium. (Auth)

<374>
Heid, K.F., Fuqua, P.A., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA; Hanford Environmental Health Foundation, Richland, WA. 1974, May

Review of Uranium Inhalation Case. Health Physics, 26, 399-403

A case involving chronic exposure to natural uranium-contaminated atmosphere over a 14 yr period is discussed. In vivo examination data, including some obtained following an extended absence from work, are used, along with other supporting data, to evaluate the resulting lung dose. In vivo chest examination data are compared to results of four samples of lung tissue and three lymph nodes which were analyzed for uranium content using both neutron activation and fluorometry techniques. As a result of the study conducted, the routine surveillance program for uranium workers was changed. (Auth)

<375>
Hempelmann, L.H., W.H. Langham, G.L. Voelz, and C.R. Richmond, University of Rochester, Strong Memorial Hospital, Rochester, NY; Los Alamos Scientific Laboratory, Health Division, Los Alamos, NM. 1973

Biomedical Follow-Up of the Manhattan Project Plutonium Workers. LA-UR-73-83A; CONF-730907; Part of Proceedings of the IRPA 3rd European Congress held in Washington, D.C., September 9-14, 1973, (7 p.)

Long-term studies have been performed on 25 men who were exposed to Pu during World War II at what is now the Los Alamos Scientific Laboratory. Almost all of the subjects had body burdens of Pu ranging from 0.1-1.3 ug or 6-80 nCi of relatively pure Pu 239 as estimated from the urine assay method for Pu used at Los Alamos prior to 1950. The paper reconstructs the war-time exposure conditions, discusses the estimates of body and lung burdens based primarily on urine assay for plutonium, and recapitulates the medical studies that have continued during the intervening years. (Auth)

Table 1 shows Pu body burden estimates in man based on urine assay data.

<376>
Howells, H., G.B. Schofield, J.C. Lynn, and P.A. Ward, British Nuclear Fuels, Limited, Seascale, Cumberland, England. 1973

Assessment and Management of a Plutonium Contaminated Wound Case. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 601-603), 655 p.

A plutonium contaminated wound case is described. Initially 14.2 uCi were present at the wound site. After two excisions about 1.8 uCi remained. Measurements of the activity were also made along the line of the lymphatic drainage and in the liver region. DTPA was administered intravenously. Urinary excretion data indicated a systematic uptake of 1.2 uCi. (Auth)

<377>
Hursh, J.B., and N.L. Spoor, University of Rochester, Rochester, NY. 1973

Data on Man. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 4. Springer-Verlag, New York, New York, (p. 197-239), 995 p.

Human data on uranium exposure is reviewed in three sections: 1) planned experiments organized according to route of administration; 2) data from industrial exposure; and 3) data from background studies. Some of the problems involved in the collection and use of data from these sources and the extrapolation of animal data to man are discussed. The experiments and data reviewed range in time from 1851, when uranyl nitrate was used as a treatment for diabetes mellitus, to 1972. Where possible, the effects of the valence state, physico-chemical form, solubility, dose rate, and biological half-life are included. The three sets of intravenous injection experiments show good agreement where comparisons are possible--excretion rate, minimal dose to produce kidney injury, and tissue distribution of uranium. The reported results of the oral experiments--gastrointestinal disturbances, urine analysis, and kidney injury--are critically evaluated. The build-up of tolerance to uranium toxicity with slowly increasing doses is discussed. Interpretation of the inhalation experiment is discussed in terms of deposition of uranium dust in the upper respiratory tract, excretion, chemical form, tissue deposition, and loss from the nostrils. Data has been obtained from occupational exposures to uranium by biological monitoring following known exposures and from postmortem data. Rate of metabolism of uranium compounds is correlated with chemical form. From the postmortem data it is concluded that although there is no tendency for uranium to accumulate in the body, most of the uranium absorbed into the body from the lungs and gastrointestinal tract is deposited on skeletal bone; the amount of uranium burden in the lungs of workers exposed to insoluble uranium is considerably less than that calculated using the parameters for inhalation from the evaluated air concentration data; and the concentrations of uranium in the tracheobronchial lymph nodes are not greatly different from those in the lungs. Normal and chronic level exposure to uranium compounds appears to produce no permanent damage to the human body. Values, taken from numerous sources, are given for natural uranium in soil, plants, water, raw and prepared foods, and in man. Data from natural uranium in man and his diet is used to estimate absorption from the gastrointestinal tract and the rate constant for loss of uranium from the total body. (ST)

This review includes a bibliography of 121 references on uranium data on man.

<378>
Langham, W.H., Los Alamos Scientific Laboratory, Los Alamos, NM. 1959

Physiology and Toxicology of Plutonium 239. Part of Proceedings of the 7th Hot Laboratories and Equipment Symposium held in Cleveland, Ohio, April 7-9, 1959, (p. 256-275)

<378> CONT.
The physiological and toxicological properties of Pu 239 are summarized to provide better understanding of its potential as an industrial hazard and to explain the necessity for rigorous industrial hygiene and engineering control over all plutonium processing. In particular the radiological properties; absorption, deposition and excretion; toxicological and radiation effects on body systems and organs; maximum permissible and estimated body burdens; accelerated excretion; and human experiences with Pu 239 exposure are reviewed. (ST)

<379>
Lanzola, P., and A. Marinoni, Universita di Pavia, Istituto di Igiene, Pavia, Italy. 1973

Comparison of the Radioactive Contamination of the Total Diet of Adolescents in the Community. 3. Analysis of Food Consumption in the Institutional Diet Program. EUR-3945-e (Part 3); 31 p.

As part of an investigation into the degree of radioactive contamination of the diet of young people in the six European Community Countries, the consumption of the following food groups was evaluated: milk, cheese, cereals and cereal products, potatoes, vegetables, fruit, meat, and fish. The intake of calories, proteins, lipids, and calcium were calculated. Application of statistical techniques resulted in evidence of significant differences between areas in individual countries. The foods displaying the greatest frequency of significant difference between the various places were cereals, cheese, and vegetables. Statistically significant differences are present at an international level for some principal foodstuffs between various places in Europe, probably implying considerable differences in eating habits and traditions. Results from a previous investigation carried out by the Association Euratom-CEA are constantly lower than those of the present study. (ST)

<380>
Lister, B.A.J., A. Morgan, and R.J. Sherwood, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Health Physics and Medical Division, Harwell, Didcot, Berkshire, England. 1962, May; 1973

Excretion of Plutonium Following Accidental Skin Contamination. AERE-R-4064; 27 p.; Health Physics, 9, 803-815

An extensive study was made of the fecal and urinary plutonium excretion from two subjects who sustained high levels of contamination on the uncut skin of the hand from accidental contact with acid plutonium solutions. In one case, where the contaminant was mixed plutonium isotopes in aqua regia and nitric acid, the measurements reported covered 150 days. In the other case, excretion after contamination with a solution of plutonium in dilute hydrochloric acid containing EDTA and a detergent was followed for 110 days. The excretion patterns show marked differences from the human experimental data published by Langham, particularly in the high and variable amount of plutonium excreted in feces relative to urine. The excretion data are supplemented in one case by a series of measurements on the levels of skin contamination, by exploratory body radioactivity measurements and by a few inconclusive blood plutonium analyses. Attempts were made to estimate the body burdens in various ways. The wide variation of these estimates indicates the uncertainities in predicting body burden from excretion data. The present study gives no indication as to the major site of deposition of the plutonium. (Auth)

<381>
Lushbaugh, C.C., and J. Langham, Los Alamos Scientific Laboratory, Los Alamos, NM. 1962, October

A Dermal Lesion from Implanted Plutonium. Archives of Dermatology, 86(4), 461-464

Histologic and autoradiographic examination of a piece of palmar human skin said to have been contaminated by a penetrating piece of plutonium revealed intense alpha-track concentration in a minute focus of subacute and chronic radiodermatitis. Although the penetration of the alpha-particles was minimal, the severe local effects seemed to indicate that a massive dose of alpha-radiation had been delivered to the area in the 4 years the contamination had been present. (Auth)

<382>
Mays, C.W., University of Utah, Radiobiology Division, Salt Lake City, UT. 1973, March 31; 1973, December

Cancer Induction in Man from Internal Radioactivity. COO-119-248; Part of Dougherty, T.F., Research in Radiobiology, Annual REPORT OF Work in Progress in the Internal Irradiation Program, (p. 378-400), 400 p.; Health Physics, 25, 585-592

Literature on the induction of malignancies in uranium miners by Rn 222, dial painters by Ra 226, thorotrast cases by Th 232, German patients by Ra 224, polycythemia patients by P 32, and Marshall islanders by I 131 is reviewed. Almost all of the induced malignancies arose within the irradiated tissue. (ST)

<383>
Miller, K.C. (Comp.), Oak Ridge National Laboratory, Toxicology Information Response Center, Oak Ridge, TN. 1973, April

Diagnosis, Treatment, and Occurrences of Radionuclide Contamination of Wounds: A Bibliography. ORNL-TIRC-73-18; 16 p.

The bibliography contains 164 selected references, which are divided into primary and secondary references; each section is arranged by year and alphabetically by first author within each year. The sources searched a twenty-year time span, from 1952 through March 1973. The bibliography contains citations about both accidental and experimental incidences of wound contamination. The radionuclides primarily concerned are alpha-emitters, including Pu, with a few references to beta and gamma emitting elements. (Auth)

<384>
Nelson, I.C., and V.W. Thomas, Jr., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1973, April

Evaluation of Radionuclides in Man. BNWL-1751 (Part 2); Part of Nielsen, J.M., et al, Annual Report for 1972, (p. 95-96), 116 p.

<384>

MEDICAL ASPECTS

<384> CONT.
Progress is reported on evaluating postmortem tissue samples of individuals residing or formerly residing in the vicinity of the Hanford complex. Twenty-two postmortem tissue and blood samples from the U.S. Transuranium Registry and 44 environmental samples were processed in 1972. (ST)

<385>
Norwood, W.D., P.A. Fuqua, R.H. Wilson, and J.W. Healy, Hanford Atomic Products Operation, Health and Safety Operation, Richland, WA. 1958

Treatment of Plutonium Inhalation: Case Studies. A/CONF-15/P-765; Part of Proceedings of the 2nd Internation Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 1-13, 1958, Vol. 23, (p. 434-438)

After 13 years of operation at the Hanford Atomic Products Operation an accident occurred which released an unreported amount of plutonium throughout a working area and resulted in the exposure of personnel. The procedures are reported for handling this accident in which the maximum permissible amount of plutonium deposited in the body (0.6 ug, 0.04 uCi) was greatly exceeded in one operator, with much less exposure reported in other personnel. Analysis of a nose swab revealed almost 1,000,000 dpm. All urine analysed during the 12 hours after the accident contained a total of 310 dpm indicating that a significant amount of plutonium had entered the blood stream almost immediately. Ca EDTA was administered intravenously for 71 days and oral Ca EDTA was administered for 21 days. Treatment continued for 7 months. Oral doses of Ca EDTA were determined to be of no practical value because of the small increase in elimination of plutonium. Zirconium citrate was given intravenously on three occasions. The curve for excretion data assumed by sample results indicated a half life of 30-40 days in the lungs and an initial deposit of approximately 0.36 uCi. The total plutonium excretion measured during the 220 days of observation indicated that 0.037 uCi was eliminated in urine, with 0.033 uCi eliminated during Ca EDTA therapy and 0.004 uCi during no treatment. Total elimination in feces was 0.35 uCi. Extended treatment increased urinary elimination by a factor of 10 but resulted in only 10% of the estimated body deposit being eliminated by this route. The study indicates the need for continued research to obtain an effective method of treatment. The most exhaustive control methods must be used to prevent plutonium deposition. (BBM)

<386>
Norwood, W.D., P.A. Fuqua, and B.C. Scudder, Hanford Atomic Products Operation, Health and Safety Section, Richland, WA. 1956, March

Treatment of Acute Plutonium Poisoning. Industrial Medicine and Surgery, 25(1), 135-139

A method is outlined for the treatment of individuals who may receive by inhalation, ingestion, or through a contaminated wound an estimated body deposit of plutonium greater than the 0.6 ug limit presently accepted as safe. Present knowledge is based on animal studies and limited clinical experience. Three individuals having amounts too small to cause concern have been treated. Zirconium citrate was used for two cases and Ca EDTA was used for one. With passing of time, routine urine studies of plutonium workers indicate increasing numbers of workers with measurable body deposits less than the maximum permissible limit. A need is indicated for treatment of chronic cases not presently available. From animal studies, it was postulated that the most effective dose of zirconium citrate in man would be at least 100 mg/kg of body weight, or 7 grams for a 70 kg man. To administer 7 g of zirconium citrate requires giving 29 g of sodium citrate. This results in possible lethal effects, and a less toxic salt than sodium citrate is needed. Ca EDTA has proved to be relatively non-toxic and removes plutonium from the skeleton as well as soft tissues. Based on extensive experimental work and limited clinical experience, a method of treatment of acute plutonium poisoning using both zirconium citrate and Ca EDTA is recommended. Early treatment following an accident is effective in increasing excretion and decreasing the body deposition of plutonium in bone and soft tissue. (BBM)

<387>
Not given, International Commission on Radiological Protection, Committee 2. 1959

Permissible Dose for Internal Radiation. ICRP Publication 2. Pergamon Press, New York, New York; 34 p.

Recommended values of maximum permissible body burdens of radionuclides and maximum permissible concentration (MPC) of these nuclides in air and water are given. Only the more important radionuclides are considered and the recommended values are applicable primarily to occupational exposure. Revisions of previous International Commission on Radiological Protection (ICRP) reports are included in this volume. Major changes from the 1958 Report of the ICRP are: instead of a weekly limit, a quarterly limit is recommended thus giving greater flexibility for many operations; a limit on integrated dose is imposed in the case of exposure of the blood-forming organs and gonads, but not the eyes; explicit recommendations are given for some non-occupational groups and limits are suggested for the whole population. All maximum permissible concentrations are given for a 40 hr week as well as for continuous exposure, i.e., a 168 hr week. The recommendations cover the following categories of exposure: occupational exposure; exposure of special groups including adults who work in the vicinity of or enter controlled areas and members of the public living in the vicinity of controlled areas; exposure of the population at large; and medical exposure. Recommendations with regard to individual exposure are given only for the first two groups. Doses resulting from natural background radiation or medical and dental exposure are in addition to maximum permissible doses recommended in the report. MPC values are listed only for relatively insoluble and for the more common soluble compounds, and these compounds are specified only by the extent of solubility rather than by specific chemical structure. The only methods of intake considered are ingestion and inhalation except in a few cases. All calculations are based on a standard man. For bone-seeking radionuclides estimates of maximum permissible exposures are based on a comparison with Ra 226; for all other radionuclides estimates are based on limiting the weekly relative biological effective dose received by the various organs of the body. Factors used in calculating MPC

<387> CONT.
equations were effective energies, standard man data, and other biological and related physical terms. The exponential or compartment model was used to determine retention and elimination; the power function model was used in addition to calculate MPC and body burden values. (ST)

Table 1 lists the maximum permissible body burdens and maximum permissible concentrations of 240 radionuclides in air and water for occupational exposure. Tables 3 and 4 give maximum permissible concentrations of unidentified radionuclides in water and air. Table 5 gives effective energies of radionuclides. Tables 6-11 list some parameters of standard man.

<388>
Osanov, D.P., V.V. Filatov, and M.Yu. Tissen, Institute of Biophysics, Moscow, USSR. 1973

Determination of Plutonium 239 in a Living Human Organism from the Rate of Its Elimination. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 491-496), 655 p.

On the basis of a model of the transport of inhaled plutonium in the human organism the relation has been established between the content of plutonium in the entire body, and the rate of its excretion with the urine at the same time interval. This correlation was obtained as a function of time for different regimens of plutonium aerosols penetration with a diverse degree of dispersion and solubility. The results presented graphically may be utilized for assessing the content of plutonium in the organism following single and constant rate chronic intake. (Auth)

<389>
Palmer, H.F., and N.E. Erickson, Hanford Atomic Products Operation, Richland, WA. 1962, January 15

Factors Influencing Measurement of Plutonium in Wounds. HW-73337; Part of Junkins, P.L. and Brown, J.E. (Eds.), Research and Development Activities in the Radiological Sciences-Physical Sciences Portion, January through December 1961, (p. 39-42), 308 p.

The efficiency and accuracy of plutonium measurement in wounds by thin crystal x-ray scintillation spectrometry depends on several factors including depth and area of contamination in the wound, position of the wound with respect to the crystal, and self-absorption of the 17-kev x rays by the contaminating material. A lack of allowance for wound depth will cause less than about 20% error for depths up to 3 mm. No correction is necessary for lateral size or a displacement of less than 7 mm from the center of the counter. Measurements of Pu in large particles may be inaccurate because of self-absorption in the source. (BBM)

<390>
Przyborowski, S., National Center for Radiation Protection, Berlin, German Democratic Republic. 1973

Primary Deposition of Aerosol Particles in the Human Respiratory Tract in Relation to Particle Size, Breathing Parameters and Region of Deposition. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 239-243), 655 p.

In vivo investigations of primary deposition in the human respiratory tract are described using a combined experimental-mathematical procedure. The obtained deposition values are discussed in relation to the region of the respiratory tract, breathing parameters and particle size. The applicability to PuO2 aerosol is shown. (Auth)

<391>
Ramsden, D., and D.A. Waite, United Kingdom Atomic Energy Authority, Winfrith, Dorset, England. 1972

Inhalation of Insoluble Iron Oxide Particles in the Submicron Range. CONF-711104; IAEA-SM-150/52; STI/PUB/290; Part of Proceedings of a Symposium on Assessment of Radioactive Organ and Body Burdens held in Stockholm, Sweden, November 22-26, 1971, (p. 65-81), 698 p.

Recent studies at these laboratories have been concerned with the production of aerosols of insoluble ferric oxide in the size range 0.08 to 0.5 microns using an ultrasonic nebulizer. The "tagging" of these particles with radioactive labels, the inhalation of such aerosols under controlled conditions, the detection and distribution of the material in vivo together with studies of its excretion from the body are discussed in this paper. Two groups of inhalations were studied: (1) chromium-51-labelled aerosols and (2) Pu 237 labelled aerosols. (1) Lung retentions and excretion curves were obtained for aerosols labelled with Cr 51 (0.1 microns Count Median Diameter). Two froms of chromium label, termed leachable and non-leachable, were used. The combination of in-vitro leaching studies and urine analysis enabled both sets of inhalation data to be normalized to give the retention of the iron oxide particles in the lung. Long-term retention of 80% of the initially depostied aerosol with deep-lung location and half periods of clearance of the order of 270 days were found. (2). In the context of this paper Pu 237 was considered as a simulator for Pu 239 because of the close match of their low-energy x-ray emissions. Two types of breathing pattern were used giving lung retentions of 90% and 5% with deposition in the pulmonary region and upper respiratory tract respectively. The lung-retention curves and excretion patterns are presented and the extrapolation to the cases of inhalation of Pu 239 considered. The results are compared with predicitions made from realistic chest phantoms calibrated for Pu 239. (Auth)

<392>
Richmond, C.R., Oak Ridge National Laboratory, Oak Ridge, TN. 1974, December

Biomedical Effects of Plutonium on Humans. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 235-269), 327 p.

The development of maximum permissible body burden (MPBB) is discussed and the value of

<392> CONT.
0.04 uCi for Pu 239, recommended by the International Commission on Radiological Protection (ICRP) in 1951 is quoted. A review is presented of the various groups of persons that have been exposed to Pu. Twenty-five male subjects who worked with Pu during World War II under very crude working conditions, have been followed medically during the intervening period. This group has shown only the usual diseases encountered in their age zone. In an attempt to determine relationships between urinary excretion, total excretion and body content of Pu, 18 persons who were thought to be hopelessly ill, were administered Pu (0.1 to about 6 uCi). The data from these persons were used to establish excretion equations. Some information can be obtained on the amount of Pu in the gonads of these subjects. The fraction of administered Pu found in the gonads at autopsy was 9 x 10(E-5) for one female and about 3 x 10(E-4) for three male subjects. The purpose of the U.S. Transuranium Registry, namely, to collect information on persons potentially exposed to transuranium elements, is discussed. Permission is obtained on a voluntary basis for postmorten analyses of tissues. Comparisons can then be made between estimates of the body burden based upon tissue analyes and estimates made previously on the basis of health physics and operational data. A considerable amount of information has been obtained from accidental occupational exposures to Pu. Between 1957 and 1970, about 200 personnel had depositions greater than 25% of the MPBB for Pu with inhalation being the major portal of entry. Pu from fallout is present in small quantities in various organs of man. The current lung burden as estimated for persons in the United States is about 0.3 pCi. Pu 239,240 and a rough estimate of the total amount in the body is 3.5 nCi. It is concluded that the lack of demonstrable effects of Pu in man represents presumptive evidence that the standards are not grossly inadequate. (PMM)

Table 3 shows Pu body burden estimates for selected Manhattan Project Pu workers. Table 9 shows Pu in man ffrom atmospheric nuclear weapons tests.

<393>
Rowland, R.E., and A.F. Stehney, Argonne National Laboratory, Center for Human Radiobiology, Argonne, IL. 1973

Radiological and Environmental Research Division Annual Report, July 1972 through June 1973. ANL-8060 (Part 2); 336 p.

During the report period medical examinations and radioactivity measurements of 302 radium patients were made at the Center for Human Radiobiology. The papers deal primarily with patients who have carried measured burdens of radium for many years. The parameters studied include characteristics and distribution of malignant tumors, immunity, tumor viruses, chromosome breakage, cytogenetic studies, excretion rates, blood levels, plasma clearance, and bone concentrations. In addition, x ray examination doses, techniques of bone study, radionuclide concentration determinations, instrumentation for monitoring and measurement, bone tumor induction in mice, and a radiological environmental survey are included. Radionuclides studied were Ra 226, Pb 210, Po 210, Th 228, Rn 220, Pa 231, Bk 249, and Cf 249. Twenty seven papers are included; two were selected for separate abstracts for the data base. (ST)

At the end of this volume is a complete list of 1346 radium cases with detailed exposure data, including body burdens, updated to December 31, 1972. During the past year 114 cases measured only by the New Jersey Radium Research Project were added.

<394>
Rundo, J., and J. Sedlet, Argonne National Laboratory, Center for Human Radiobiology, Argonne, IL. 1973

Retention and Elimination of Berkelium 249-Californium 249 Following Acute Accidental Inhalation. ANL-8060 (Part 2); Part of Radiological and Environmental Research Division Annual Report, July 1972-June 1973, (p. 206-217), 336 p.

A case of accidental inhalation of a small quantity of an ignited mixture of Bk 249 and its decay product, Cf 249 was studied by body radioactivity measurements (for Cf 249) and excretion analysis (for both nuclides). The results obtained thus far cover the first year after intake. External measurements of the gamma rays from the Cf 249 indicated an approximate chest content of 3 nCi of this nuclide at the time of the first measurement (day 7). The 300-fold more abundant parent, Bk 249, could not be detected. Subsequent measurements of the activity of the Cf 249 could be reasonably well described by the sum of two exponential components, 17% having a half-time of 25 days and the remainder a half-time of 1210 days. Except for an initial rapid clearance via the feces during the first 10 days, the urinary and fecal excretion rates of both nuclides increased with time until a maximum was reached 60 to 70 days after intake and thereafter declined. If the early fecal excretion was neglected, the results could be reasonably well described as the difference between two exponential components, one with half-times of 15 to 30 days representing the initial increase and one with half-times between 90 and 120 days representing the subsequent decrease in excretion rate. The increase suggests some change in the inhaled material after intake, possibly an increase in its rate of dissolution. (Auth)

<395>
Saha, S.C., Bhabha Atomic Research Center, Health Physics Division, Bombay, India. 1972, November

The Dust Problem in Uranium Mining Operations at Jaduguda. Indian Journal of Occupational Health, 15(11), 1-7

Results of dust sampling in the Jaduguda, India uranium mine from May 1965 to May 1969 are reported. Because of the wetness of the mine and the practice of wet drilling, dust concentrations were low. Drilling and channel sampling were accompanied by the highest dust concentrations. These averaged 269 and 229 particles/cm2. The weighted exposures of drillers and channel samplers were 0.89 and 0.88 of the threshold limit value (TLV) for silica bearing dust. Dust concentrations during drilling, channel sampling, and loading increased at deeper levels of the mine. (ST)

<396>
Schofield, G.B., H. Howells, F. Ward, J.C. Lynn,

<396> CONT.
and G.W. Dolphin, British Nuclear Fuels Limited, Windscale and Calder Works, Sellafield, Seascale, Cumberland, England; Nuclear Installations Inspectorate, Silkhouse Court, Liverpool, England; National Radiological Protection Board, Harwell, Didcot, Berkshire, England. 1974, June

Assessment and Management of a Plutonium Contaminated Wound Case. Health Physics, 26, 541-554

A Pu contaminated wound case is described together with its management. Initially, 14.2 miligrams Ci of Pu were present in the wound, this figure being reduced to about 1.8 miligrams Ci after two excisions. During the period of assessment DTPA was administered and the effect of this is discussed. Urinary excretion data were obtained and quantitative monitoring of the lymphatic channels of the arm and the liver were attempted. Various methods of assessment of body content are discussed which indicate the amount of retained Pu to lie between 0.1 milligrams Ci. Chromosome culture from blood lymphocytes was undertaken which indicated probable preferential irradiation of these cells. (Auth)

Figure 5 shows the urinary excretion of Am 241. A letter from G. R. Schofield mentions that continuing surveillance of the case is being undertaken. He would like to change from the concept of "body burden" to a more realistic bone content. For example, it was found that the bone content in post mortem cases studied was a factor of 5 to 10 down on the estimated body burden obtained from urinary excretion patterns. This would suggest that the bone content in the wound case described is likely to be less than the 1.8 nCi mentioned.

<397>
Sevc, J., and Placek (initials not given), Institute of Hygiene and Epidemiology, Department of Radiation Hygiene, Prague, Czechoslovakia; Institute of Industrial Hygiene in Uranium Industry, Pribram, Czechoslovakia

Lung Cancer Risk in Relation to Long-Term Exposure to Radon Daughters. CONF-720503; Part of Bujdoso, T. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 129-136), 655 p.

The first results of an epidemiological study carried out in a large group of uranium miners are shown. The highest lung cancer mortality was observed in the interval of 15-17 years since the onset of exposure to radon daughters. When the exposure exceeded 100 WLM, the observed mortality was 2-6 times higher than that was expected. A linear relationship was found between the mortality rate of additional lung cancer cases and the estimated cumulative exposure. (Auth)

<398>
Shirotani, T., Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken, Japan. 1973, October

Empirical Formula for Estimating Effective Tissue Thickness in the Assessment of Plutonium in the Lung. Journal of Nuclear Science and Technology, 10(10), 647-649

An empirical formula for estimating effective tissue thickness in the assessment of Pu in the lung was derived taking the effect of self-absorption in the lung tissue itself into account. Parameters used were chest thickness, average thickness of ribs and mean tissue thickness. Measurements were obtained from 393 subjects, using an ultrasonic analyzer. (RAF)

<399>
Shirotani, T., and M. Fujita, Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken, Japan. 1972, March

Estimation of Effective Tissue Thickness in the Assessment of Plutonium. Journal of Nuclear Science and Technology, 9(3), 33-39

For the determination of Pu 239 deposited in the lungs by external counting, the absorption of low energy photons emitted from Pu 239 in the chest must be taken into consideration because of its high attenuation. It is shown that the effective tissue thickness of the chest wall can be estimated by comparing the Am/Pu counting ratio obtained from an exposed subject with that obtained beforehand as a function of the absorber thickness of a simple chest model. The Am/Pu counting ratio is defined as the ratio of net counting rates between the Am-channel (57-63 keV) and the Pu channel (15-19 keV). An empirical expression was also derived from experiments on a phantom to estimate the effective tissue thickness. Experimental results are compared with those of another study. (Auth)

<400>
Shirotani, T., and M. Fujita, Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken, Japan. 1973, May

A Method of Determination of Correction Factors for Different Body Fluids in the Assessment of Plutonium 239 in Lung. Journal of Nuclear Science and Technology, 10(5), 301-308

In the determination of Pu 239 deposited in the lungs of exposed subjects by external "in vivo" counting, some corrections must be made for the calibration factor obtained from a phantom, to take account of differences in body size between the phantom and the exposed subjects. Three such correction factors were considered in this work, and determined experimentally: (1) the geometrical efficiency of the exposed subject was estimated using lung-shaped plane sources of actual size; (2) the shielding effect of the sternum and ribs viewed by the NaI(Tl)-detector of large area was measured from chest x-ray plates of the fifteen subjects; and (3) the effective chest wall thickness was evaluated by means of an empirical formula. Estimations of Pu 239 in the lungs are expected to contain errors up to about 24.8%, due to the uncertainties in these correction factors. (Auth)

<401>
Solnicka, M., and R. Bischof, Institute of Occupational Hygiene in Uranium Industry, Pribram, Czechoslovakia. 1971, May

The Possibility of Estimating Low Exposures to Short-Lived Decay Products of Radon 222 in Uranium Mine Workers by Determination of Polonium 210 in the Hair. Prakticky Lekar, 23(4), 110-112 (Czechoslovakian, English Summary)

The mean specific activity of Po 210 detected

<401>

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<401> CONT.
in the hair of a group of 17 persons not occupationally exposed to short lived decay products of Rn 222 was determined to be 0.048 plus or minus 0.034 pCi/g. It was ascertained on the basis of this value that the analysis of Po 210 in the hair affords under normal conditions the detection and determination of the occupational exposure of uranium mine workers to short-lived decay products of Rn 222 in an environment with a considerably lower potential energy of alpha radiation than the maximum permissible concentration which is 4 x 10(E+4) Me V/l. (Auth)

<402>
Sternglass, E.J., University of Pittsburgh, Division of Radiation Health, Department of Radiology, Pittsburgh, PA. 1969, December

Evidence for Low-Level Radiation Effects on the Human Embryo and Fetus. CONF-690501; AEC Symposium Series No. 17; Part of Sikov, M.R. and Mahlum, D.D. (Eds.), Proceedings of the 9th Annual Hanford Biology Symposium on Radiation Biology of the Fetal and Juvenile Mammal held in Richland, Washington, May 5-8, 1969, (p. 693-717), 1026 p.

Evidence is presented that indicates a high sensitivity of the developing human embryo and fetus to both acute x ray radiation at diagnostic levels and low dose rate radiation from fallout. The effect expresses itself by increased rates of childhood leukemia accompanied by a shift in age distribution at death, as well as by increased rates of stillbirths, neonatal deaths, and infant deaths in large population groups that have been exposed to known amounts of low-level fallout. The earliest evidence for low-level and low-dose-rate effects was obtained from a detailed analysis of the leukemia increase among children 0 to 10 years old in the Albany-Troy, New York, area following the rainout of radioactive debris from a 43 kt nuclear detonation in Nevada in April 1953. The subsequent doubling of the childhood leukemia rate over a period of 8 years was characterized by a 4 to 5 year delay in onset similar to that observed for children who received x ray radiation in utero or early infancy and a shift in age distribution at onset toward older age similar to that noted by Stewart and Hewitt for intrauterine x ray irradiation. More recent evidence for the effects of low dose and low-dose-rate radiation on the developing fetus, embryo, and young infant comes from a study of fetal, neonatal, and postnatal mortality rates for each state in the United States and for a number of foreign countries. Analysis of the changes in mortality rates following the detonation of specific nuclear weapons shows a geographical distribution that coincides with the known long range fallout patterns. The changes in mortality rates for different regions of the United States and the world are found to be closely correlated with the measured amounts of Sr 90 in the milk and the observed amounts in the bone and teeth of the fetus and newborn. (Auth)

<403>
Stokinger, H.E., U.S. Public Health Service, Division of Occupational Health, Toxicology Section, Cincinnati, OH. 1966

Recommended Hygienic Limits of Exposure to Beryllium. Part of Stokinger, H.E. (Ed.), Beryllium: Its Industrial Hygiene Aspects, Chapter 8. Academic Press, New York, New York, (p. 235-244), 394 p.

Limits for the concentration of beryllium in air for the plant workroom and community were adopted by the Atomic Energy Commission in 1949. These limits are based on diagnosis of acute berylliosis (pneumonitis) in plant workers exposed to levels of 1 mg/m3 and a large number of pneumonitis cases in communities surrounding processing plants. Coincident with the strict application of beryllium limits, all forms of berylliosis have disappeared. Arguments for and against changing the limits are given. The need for studies of the relative toxicities of the several beryllium compounds and for drinking water standards is stressed. (ST)

<404>
Stokinger, H.E. (Ed.), U.S. Public Health Service, Division of Occupational Health, Toxicology Section, Cincinnati, OH. 1966

Beryllium: Its Industrial Hygiene Aspects. Academic Press, New York, New York; 394 p.

The monograph provides a detailed account of the knowledge accumulated from 1946-1966 on the industrial hygiene aspects and toxicology of beryllium and its commercially useful compounds. The engineering control aspects of beryllium disease are stressed; clinical aspects are mentioned only where necessary for the understanding of the industrial hygiene control procedures and for the motivation of the beryllium toxicologic research studies. Prominence is given to the chemistry and physics of the industrial compounds, particularly to the analytic methods. The definition of the disease and the findings of research investigators are thoroughly discussed. Individual chapters were contributed by authorities in their respective fields. The monograph was written to provide a basis for environmental health practice in the beryllium industry and provides much for those interested in research and development. Four chapters were selected and abstracted separately for the data base. (ST)

<405>
Swanberg, F., Jr., and R.C. Henle, Hanford Atomic Products Operation, Richland, WA. 1964

Excretion of Plutonium 239 in a Patient with a Plutonium Contaminated Injury. Part of Proceedings of the 7th Annual Western Industrial Health Symposium held September 27-28, 1963. Published in Journal of Occupational Medicine, 6(4), 174-178

A report is given of a plutonium-contaminated minor injury sustained by a maintenance employee in a Hanford Pu-manufacturing facility. The accident, medical treatment, urinary and fecal excretion of the radionuclide, and evaluation of the body burden are described. Twenty-eight grams of DTPA were administered to the patient in four series of treatments. The total urinary excretion of Pu during the first 24 hr after treatment was equilvant to 5.4 nCi. The daily rate of Pu excretion in the feces was consistently less than in urine. Periodic examinations were made to determine the quantity of radionuclide remaining in the site of injury. Administration of chelating agents, with resultant elevated excretion rates of radionuclide, make assessment of the body burden difficult. Treatment may affect excretion rates for as long as 200 days after administration of DTPA, requiring

<405> CONT.
long-term follow-up of such cases. The marked variability in the fecal-excretion rate precludes use of these data for evaluating the body burden in this case, but they are of value as indicators of the quantity of plutonium excreted during medical treatment. Relying on the urinary-excretion data, it was concluded in this case that, 400 days after the exposure, the internal deposition of soluble plutonium did not exceed 10 nCi (25% of the MPBB). (Auth) (FMM)

<406>
Tarasov, S.I., G.V. Smorodintseva, A.F. Oreshina, M.I. Shalak, and V.Z. Vaskova, Leningrad Institute of Radiation Hygiene, Leningrad, USSR. 1968, April-June

Entry of Plutonium 239 Into the Human Body from the Air. Hygiene and Sanitation, 33(4-6), 36-41

Investigations were carried out on samples taken from large volumes of air from continuous aspiration on FPP-15 filters, the total volume of air drawn through the filter being 50,000 to 118,000 m3. The lungs of persons older than 50, who had died of cardiovascular diseases were studied. The kinetics of the plutonium 239 content in the air, the lungs and the lymphatic nodules was studied for 1964 and 1965. Assessment of the possible hazard of the aerogenic introduction of plutonium 239 into the body of persons, having occupational contact with the isotope, was carried out. Data on the atmospheric concentration of Pu 239 showed that in 1964-1965 the concentration did not exceed n x 10(E-21) Ci/l, which is four orders of magnitude lower than the maximum permissible concentration of this isotope. Confirmation was obtained for the data reported in the literature on the accumulation of Pu 239 in pulmonary tissue. The dose loads on the lungs due to the isotope did not exceed 0.3 mrem/year. The concentration of Pu 239 was considerably higher in lymph nodes than in pulmonary tissue (by an average of two orders of magnitude). (Auth) (FMM)

Table 1 shows the atmospheric concentration of Pu 239 for 1964-1966. Table 2 shows the Pu 238 concentration in human lungs in 1963-1966. Table 4 shows the concentration of Pu 239 in human tracheobronchial lymph nodes in 1965 and 1966. Article also titled the "Extent of Aerogenic Introduction of Plutonium 239 Into the Human Body."

<407>
Testa, C., and A.D. Site, Comitato Nazionale per l'Energia Nucleare, Radiotoxicology Laboratory, Medical Service, Rome, Italy. 1973

The Study of a Case which Involved a Wound Contaminated with Insoluble Plutonium and Americium 241. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 593-599), 655 p.

During a polishing operation of a UO2 ceramic sample containing 3.1% PuO2, a technician wounded his right index finger. X ray counting roughly indicated a plutonium activity of about 120 nCi. A small excision of the wound was carried out within 30 minutes. As a precautionary measure DTPA was given intravenously within 90 minutes from the contamination. Samples of urine, blood, skin and cotton wool were collected and the activity of plutonium was followed for 10 months. A 0.2% w/w concentration of Am 241 was found. The results indicated that the prompt surgical treatment reduced the initial contamination (about 70 nCi) to a low level (about 0.2 nCi) and minimized the systemic burden (about 0.5 nCi). Because of the insolubility of the plutonium the DTPA treatment did not appear to cause a significant effect. (Auth) (ST)

<408>
Vorwald, A.J., Wayne State University, School of Medicine, Department of Occupational and Environmental Health, Detroit, MI. 1966

Medical Aspects of Beryllium Disease. Part of Stokinger, H.E. (Ed.), Beryllium: Its Industrial Hygiene Aspects, Chapter 6. Academic Press, New York, New York (p. 167-200), 394 p.

Beryllium disease has occurred in relation to a variety of occupational and to some nonoccupational situations. Human cases of the disease have been observed in association with exposure to many beryllium compounds, notably the oxide, fluorides, sulfate, and synthetic silicates, and to the metal, but not in association with the mining and milling of beryl ore. The disease is caused primarily by the inhalation and pulmonary deposition of toxic beryllium in the form of dusts, fumes, and mists. The clinical features and pathology of acute and chronic forms of the disease are reviewed. Diagnostic difficulties and some features peculiar to the disease are given. General conclusions from data from various studies of beryllium in tissues and body fluids are stated. Therapy is briefly reviewed. The Beryllium Case Registry contains documented cases of workers and "neighborhood" disease. (ST)

<409>
Walton, W.H. (Ed.), Institute of Occupational Medicine, Edinburgh, England. 1970

Inhaled Particles, III. CONF-700931; Proceedings of the 3rd International Symposium on Inhaled Particles held in London, England, September 14-23, 1970, Vols. 1-2. Unwin Brothers Limited, The Gresham Press, Old Working, Surrey, England, 1090 p.

Ninety-one papers were presented at the Symposium; relevant ones have been abstracted separately for the data base. Other papers deal with inhalation and deposition in man and animals, biological reactions to dust, cigarette smoke, SO2, quartz and asbestos, immunological factors, radiology and physiology of pneumoconiosis, dust in human lungs, characteristics of airborne dusts, epidemiological studies such as chronic bronchitis and fibrosis in British coal miners, dust sampling and the introduction of new dust standards for British and American coal mines. (FMM)

<410>
Williams, K., United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berkshire, England. 1956, August

Some Cases of Internal Contamination and Their Early Detection for Possible Treatment by Chelating 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

<410>

MEDICAL ASPECTS

<410> CONT.
Poisoning by Radioactive Substances held October 20-21, 1955, (p. 45-47), 181 p.

Urine excretion tests have proved to be a valuable aid for detecting cases of accidental plutonium poisoning which would not otherwise be identified early. Prompt treatment provides the best opportunity for maximizing excretion of the radioelement. Immediate urine samples are collected in any case of small, possibly contaminated, puncture wounds. Urine estimates also work well as an adjunct to air monitoring. Examples of wounds suspected of being contaminated are given. (BBM)

<411>
Wolff, A.H., University of Illinois, School of Public Health, Chicago, IL. 1973

Scientific Basis for Radiation Protection Guidance for Underground Uranium Miners in the United States. CONF-720503; Part of Buidoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 136-143), 655 p.

The use of the Working Level Month (WLM) as a radiation exposure unit for uranium mining standards in the U.S. is discussed. The relationships of the WLM unit to lung tissue dose and cancer induction and to the ICRP/NCRP recommendations for occupational radiation protection are also discussed. Recently the guidance for the radiation protection of underground uranium miners in the U.S. was lowered from 12 to 4 WLM per year. This action was based or radiobiologic and epidemiologic evidence that indicates that the lung is a relatively sensitive organ with respect to the radiation induced cancer. The principal epidemiologic information leading to the revised standard came from a study of about 3,400 uranium miners in the U.S. In this study inhalation exposure to radon daughters down to at least 120-359 cumulative WLM was shown to be the major causal factor for a high incidence of respiratory cancer among uranium miners. (Auth)

<412>
Baker, S.I., National Accelerator Laboratory, Batavia, IL. 1973, August; 1973, March 23

Environmental Monitoring Report for Calendar Year 1972. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 553-596), 1217p.

Analyses for residual radioactivity are performed specifically for accelerator-produced nuclides as well as for radium and thorium. Environmental radiation data are collected from radiation detections throughout the accelerator and experimental areas. Except for a minute amount of tritium in the closed loop in the Neutrino Area, no accelerator produced activity other than 53 day half-life beryllium 7 has been found in the water. The concentration of Na 22 in soil was determined to be 9 x 10(E-6) uCi/g just outside the Neutrino Area Target Tube. Penetrating radiation is monitored at the Environmental Radiation Monitoring Station located in the National Accelerator Laboratory Village. No evidence of accelerator produced radiation has been seen by any detector in the station during the reporting period. The neutron monitors have indicated an average neutron dose of approximately 0.0005 mrem/hr, which is consistent with the expected cosmic-ray neutron background. There were no unusual incidents or releases during the reporting period. In addition, there were no nonradioactive materials produced in quantities which could pollute the environment, and there were no abnormal natural occurrences which could have resulted from or have had some impact upon the facility or its operation. (FMM)

<413>
Birchall, I., United Kingdom Atomic Energy Authority, Authority Health and Safety Branch, Safeguards Division, Risley, England. 1960

Radiation Dose Rates for Plutonium Isotopes. AHSB(S)-R-10; 27 p.

Calculations have been made of the expected dose rates arising from the Pu isotopes and their daughter products, resulting from irradiation at 1000 MWD/ton and 3000 MWD/ton. The results have been extended to includealpha n reactions, oxide fuels, and a range of possible fission product contents. (Auth)

<414>
Bishop, C.T., M.M. Bolton, M.L. Curtis, J.O. Frye, R.K. Gillette, and E.B. Nunn, Mound Laboratory, Miamisburg, OH. 1971, June 30

Determination of Plutonium in Soil. MLM-1792; Part of Chemistry and Physics Progress Report, October-December 1970, (p. 17-19), 36 p.

A method to determine the Pu content in soil was developed combining a fusion and dissolution process. The fusion procedure involves fusing the sample with anhydrous KF followed by a pyrosulfate fusion to completely decompose the soil. The solidified melt is dissolved and the Pu is separated from the solution by coprecipitation with BaSO4 by Aliquat 336 nitrate-in-xylene, and interfering elements are removed by back-extractions before the Pu is finally back-extracted, evaporated to dryness and prepared for electrodeposition. Electrodeposition is achieved from an (NH4)2SO4 medium or from a mixed oxalate-chloride electrolyte. After electrodeposition onto a stainless steel slide, the Pu content is determined by alpha pulse height analysis. The efficiency of the solvent extraction steps in the Pu soil analysis by fusion was determined using a Pu 238 standard and liquid scintillation counting. The results showed that no appreciably quantity of Pu is lost in the solvent extraction portion of the procedure. However, electrodeposition efficiencies less than 90% have been observed when either of the two techniques were used. (RAP)

<415>
Bramson, P.E., J.P. Corley, and W.L. Nees, Battelle Memorial Institute, Pacific Northwest Laboratories, Occupational and Environmental Safety Department, Richland, WA. 1973, September

Environmental Status of the Hanford Reservation for CY-1972. BNWL-B-278; 70 p. (OUO Cancelled)

The report summarizes data collected during 1972 from locations within the Hanford plant for the enviornmental surveillance program. Groundwater and offsite sampling data are not included. Some offsite data are used for comparison with similar measurements made onsite. Concentrations of radionuclides and/or radioactivity in Columbia River water, drinking water, swamps, ditches and ponds, birds and mammals, air, and soil and vegetation and results of surface contamination and external exposure rate radiation surveys are given. Columbia River water quality measurements are included. Results of the analyses were generally within the expected range. (ST)

<416>
Bramson, P.E., and J.P. Corley, Battelle, Memorial Institute, Pacific Northwest Laboratories, Occupational and Environmental Safety Department, Richland, WA. 1972, August

Environmental Surveillance at Hanford for CY-1971 (Addendum). BNWL-1683 (ADD); 95 p.

This supplemental report is a compilation of results obtained from both analyses of environmental samples and from radiological measurements made in the Hanford environs during 1971. The significance of these data is discussed in the parent report (BNWL-1683). The report contains tables of radionuclides in Columbia River Water, radionuclides in drinking water, radionuclides in fish and wild fowl, radionuclides in shellfish, radionuclides in the atmosphere, radionuclides in farm produce and commercial foodstuffs, measurement of external radiation exposure, water quality measurements of Columbia River water, chemicals in drinking water, suspended particulates and nitrogen in the atmosphere, and radionuclides in soil and vegetation. (ST)

<417>
Bramson, P.E., and J.P. Corley, Battelle Memorial Institute, Pacific Northwest Laboratories, Occupational and Environmental Safety Department, Richland, WA. 1973, August; 1973, May

Environmental Surveillance at Hanford for CY-1972. BNWL-1727 (ADD); WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 975-1086), 1217 p.

<417>

MONITORING, MEASUREMENT AND ANALYSIS

<417> CONT.
This supplemental report is a compilation of results obtained from both analyses of environmental samples and from radiological measurements made in the Hanford environs during 1972. The significance of these data is discussed in the parent report (BNWL-1727), which has already been included in the data base. The tables in the supplement are grouped into eleven appendixes and cover the following subjects: radionuclides in Columbia River water, in drinking water, in fish, wild fowl and shellfish, in the atmosphere, in farm produce and commercial foodstuffs and in soil and vegetation; measurements of external radiation exposure; water quality measurements of Columbia River water; chemicals in drinking water, and suspended particulates and nitrogen in the atmosphere. (FMM)

See also Report BNWL-1727. Numerous tables of concentrations of several radionuclides (including U and Pu) in air, water, plants, animals, soils and food are presented.

<418>
Budnitz, R.J., Lawrence Berkeley Laboratory, Berkeley, CA. 1973, November

Plutonium: A Review of Measurement Techniques for Environmental Monitoring. LBL-2039; CONF-731112; Part of Proceedings of the IEEE Nuclear Science Symposium held in San Francisco, California, November 14-16, 1972, (9 p.)

Overviews are given of the typical levels at which plutonium is found in environmental media, of the radiation protection guides, and of some of the types of measurement techniques which have been developed for plutonium measurements in air, water, soil and other media. Emphasis is on measurements for surveillance and protection in environmental and occupational situations. The discussion concentrates on the various broad categories of instruments and techniques, their senstivities, areas of applicability, and limitations. Bioassay methods are not discussed in detail. (ST)

<419>
Budnitz, R.J., Lawrence Berkeley Laboratory, Berkeley, CA. 1974, February

Radon 222 and Its Daughters, A Review of Instrumentation for Occupational and Environmental Monitoring. Health Physics, 26, 145-163

An overview is provided of the techniques that have been developed for measuring Rn 222 and its daughters in various media. The main emphasis is on measurements for surveillance and protection in occupational and environmental situations. Measurements in specialized research applications are not treated in detail. Overviews are first provided of the physical characteristics of Rn 222 and its daughters; of the sources of and typical levels of concentration in the natural environment and in occupational exposures; and of the radiation guides. The various measurement techniques are then discussed. (Auth)

<420>
Busick, D.D., and E. Holt, Stanford University, Stanford Linear Accelerator Center, Stanford, CA. 1973, August; 1973, March

Annual Environmental Monitoring Report, January-December 1972. SLAC-159; WASH-1259; Part of Environmental Monitoring at Major U.S Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 1177-1188), 1217 p.

The Stanford Linear Accelerator Center regional surveillance program is intended to assess the contribution, if any, from SLAC operations, to the existing radiation environment. Samples of soil, vegetation, groundwater, surface water, sanitary and storm sewers are periodically collected and activity levels determined. Airborne radioactivity is measured and recorded continuously at the release point. Continuous physical radiation measurements of neutron and gamma dose is also provided near the site boundary. The results of the environment analysis for gross beta activity show an average of 2.4 x 10(E-8) uCi/ml for well water, 9 x 10(E-9) uCi/ml for surface water, 4.3 x 10(E-5) uCi/g for stream silt as soil and 4.3 x 10(E-5) for vegetation. There has been no significant increase in radioactivity in water, soil or vegetation since SLAC operations began in 1966. The measurements of annual dose from gamma and neutron radiation near SLAC's boundaries indicate a slight increase in total dose over the background value, resulting in a maximum dose above background of 3.5% of the individual standard for the general population. (Auth) (FMM)

Table 2 shows radioactivity content of environmental samples (water, silt, vegetation) collected at Stanford Linear Accelerator Center in 1972. Table 3 shows annual radiation dose measured near Stanford Linear Accelerator Center's boundaries.

<421>
Cantelow, H.P., Lawrence Berkeley Laboratory, Safety Services Department, Berkeley, CA. 1973, August; 1973, March 1

Annual Environmental Monitoring Report, 1972. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 1115-1129), 1217 p.

Neutron and gamma fields are measured at each of four perimeter stations as well as at several locations within the site at the Lawrence Berkeley Laboratory (LBL). It is shown that the total radiation levels are well below the standards set for the general public. An environmental air sampling program is carried on to make sure no releases occur, and to provide a direct measurement of possible exposure to the nearby population. The results show that there has been no significant exposure from radioactive materials released by LBL. The results of water sampling show that the total concentration of radioactivity, (L + B), in sewage is less than 1% of the AEC standard for discharges to sewers and the radioactivity in onsite streams is safely below the standard for drinking water. (FMM)

Table 4 shows concentration of tritium and C 14 in air.

<422>
Cooper, J.A., N.A. Wogman, H.E. Palmer, and R.W. Perkins, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Radiological Sciences Department, Radiological Sciences Section, Richland, WA. 1968, October

<422> CONT.
The Application of Solid State Detectors to Environmental and Biological Problems. BNWL-715 (Part 2); Part of Nielsen, J.M., et al, Annual Report for 1967, (p. 119-122), 230 p.

Investigations involving the behavior of complex mixtures of radionuclides in environmental and biological systems require highly sensitive and selective measurement techniques. Artificial radionuclide mixtures present in the environment are usually extremely complex and are often present at concentrations comparable to or lower than those of the natural radionuclides present. The applicability of the new high-resolution solid state detectors has been evaluated in the analysis of several complex radionuclide mixtures which are encountered in both natural and neutron activated environmental and biological samples. These investigations have shown that, in many cases, the increased selectivity of the solid state counting system, when combined with proper sample preparation, allows much more precise analysis for many of the constituents than is possible with rather elaborate NaI(Tl) detector systems. (Auth)

Figure 1 shows a gamma ray spectrum of airborne radionuclides collected on an air filter at Richland, Washington. Figure 2 shows a comparison of the gamma ray spectrum of a neutron activated human lung tissue sample as measured with a NI(T1) scintillator and a Ge(Li) diode. See also Health Physics, 15, 419-433 (1968).

<423>
Corley, J.P., Battelle Memorial Institute, Pacific Northwest Laboratories, Occupational and Environmental Safety Department, Richland, WA. 1973, August

Environmental Surveillance at Hanford for CY-1970 Data. BNWL-1669 (ADD); 118 p.

This supplemental report is a compilation of results obtained from both analyses of environmental samples and from radiological measurements made in the Hanford environs during 1970. The report consists of tables of concentrations and estimated rates of transport of radionuclides and beta activity in Columbia River water, concentrations of radionuclides and beta activity in drinking water, radionuclides in fish, wild fowl, shellfish, farm produce, commercial foodstuffs, soil, vegetation and the atmosphere, and measurements of external radiation exposure. Included in the table are analytical limits--the concentrations at which the laboratory can measure the radionuclides with a precision of plus or minus 100% at the 90% confidence level. (ST)

<424>
Cushing, C.E., D.G. Watson, D.E. Robertson, and W.B. Silker, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Ecosystems Department, Richland, WA. 1974, January

Decline of Radioactivity in the Columbia River--McNary Reservoir Ecosystem Following Shutdown of Hanford Reactors. BNWL-1850 (Part 2); Part of Vaughan, B.E., et al, Annual Report for 1973, (p. 84-89), 200 p.

Since January 1971, a special study of the rates and mechanisms of the radionuclide interactions in the Columbia River has been in progress with the purpose of characterizing the long-range behavior of the radionuclide inventory which was discharged into this ecosystem during the reactor operating period. Radionuclides currently present in the river system are those deposited in the sediments during previous reactor operations and those currently released from the dual purpose power-plutonium production N-Reactor. The concentrations of Mn 54, Co 60, and Zn 65 in the suspended material of the river decreased approximately tenfold during the first year following the shutdown of the original Hanford production reactors. N-Reactor radionuclides were deposited to a large degree in the sediments behind McNary Dam and were not significantly transported down river. Plutonium 239 concentrations in presently deposited sediments are at background, fallout levels. Concentrations of gamma radionuclides have generally decreased in the biota sampled in McNary Reservoir, but at a slow rate. The concentration of Zn 65 in plankton, periphyton, chironomid larvae, and suckers from 1971-1973 is shown in graphical form. The effects of sediment scouring, radioactive decay, burial of radioactive sediments, biological turnover, radionuclide solubility, and biota concentration factors are included in the discussion. (ST)

<425>
Doyle, J.F., C. Jupiter, and G.P. Stobie, EG&G, Inc., Aerial Surveillance Department, Las Vegas, NV; EG&G, Inc., Radiation and Environmental Sciences Department, Las Vegas, NV. 1972, August 1

Radiological Survey of the Nevada Test Site (Survey Period: 1970-1971). EGG-1183-1552; 80 p.

The Nevada Aerial Tracking System (NATS), operated for the United States Atomic Energy Commission by EG&G, Inc., was used to perform aerial radiological surveys of the Nevada Test Site (NTS) and surrounding area during 1970 and 1971. All areas of the NTS and areas within five miles of the NTS boundary over which the NATS aircraft could operate at 300 feet altitude were surveyed. The data collected on these surveys include the gross count rate for gamma radiation between 50 keV and 3.0 MeV, and gamma ray spectra taken at 300 feet altitude. The gamma gross count data were used to determine radiation exposure rates, which were normalized to an equivalent value three feet above ground and processed into isoexposure rate contours. Gamma ray spectral plots are given and radionuclides are listed that are consistent with photopeaks found in the spectral plots. (Auth)

<426>
Dymerski, L.J., U.S. Environmental Protection Agency, Division of Radiological Health, Denver, CO. 1965, April

Uranium Mill Tailings Study, Phase 1, Progress Report. Final Report; 56 p.

A study was undertaken to evaluate the impact that tailing piles from uranium mills impose upon people who reside in certain towns near the operations. It was estimated that near Durango, Colorado 1.5 million tons of tailings contained 150 Ci of Radium 226, and 2 million tons of tailings near Grand Junction, Colorado contain 200 Ci of radium 226. Air samples were collected on gummed paper at 17 locations in these towns and the

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<426> CONT.
control cities of Delta, Colorado and Farmington, New Mexico. The mill at Grand Junction is in operation; the mill at Durango is closed. Samples were collected during the period September 3 to November 5, 1964. The radiation contamination at selected sites in the two cities all showed greater levels than did the control cities. The air contamination at Grand Junction was approximately twice that at Durango. Although the radiation levels taken as a whole do not indicate a serious problem, individual stations, particularly those within a mile of the tailings and in the direction of prevailing winds, indicate a potential radiation exposure problem. The extent of the insult to the cities should be determined, and it was proposed that a more detailed volumetric air study be instituted in April, 1965 in order to define more adequately the air impact on the communities. It was recommended that it would be desirable to learn what the total intake of radium 226 by residents of these communities may be. Other environmental media (food, milk, water) should be studied in connection with the proposed air study. (BBM)

<427>
Eisenbud, M., and J.H. Harley, New York Operations Office, New York, NY. 1953, February 13

Radioactive Dust from Nuclear Detonations. Science, 117, 141-147

The monitoring program for measuring changes in radioactivity levels caused by fallout from nuclear detonations and a summary of some of the general conclusions drawn from these studies are described. The monitoring system consists of 121 stations located at Weather Bureau stations across the nation and mobile teams equipped to undertake more intensive measurements in the region 200 to 500 miles from the test site. For brief periods immediately following a detonation, the radioactive background can be markedly increased in some areas, but the cumulative dose from such depositions are minute because of the rapid decay of the activity. The long-lived components of the radioactivity are of a low order compared with the natural radioactivity of the earth's surface and atmosphere. (BBM)

<428>
Elder, J.C., M. Gonzales, and H.J. Ettinger, Los Alamos Scientific Laboratory, Health Division, Industrial Hygiene Group, Los Alamos, NM. 1973

Plutonium Aerosol Size Characteristics. LA-UR-73-1326; CONF-730603; Part of Proceedings of the 18th Annual Health Physics Society Symposium held in Miami Beach, Florida, June 17-21, 1973, (17 p.)

Field sampling in three AEC plutonium processing plants has provided size characteristics and activity concentrations of plutonium aerosols generated by a variety of research, production, and recovery operations. These data provide basic information for the design and testing of air cleaning systems for plutonium plants. Isokinetic sampling with eight-stage impactors immediately upstream of process ventilation exhaust HEPA filters collected particles representing "worst normal" challenge aerosols. Where particle diameters met established statistical criteria for a lognormal distribution, activity median aerodynamic diameter (amad) and geometric standard deviation (sigma sub g) were determined by a least squares computer fit of the cumulative radiometric data versus impactor stage effective cutoff diameters. Amad's varied from 0.10 um to 11.0 um and Sigma Sub g's from 1.5 to 9.0. All impactor data, including size distributions which were apparently nonlognormal, were treated on a stage-by-stage basis; i.e., mean fraction of total activity deposited on a given stage. A ^{239}Pu recovery plant produced the smallest aerosol encountered, with the size range under 1 um containing over 70% of total activity. Fabricating plants produced a larger aerosol with over 50% of total activity associated with particles in the 1 um to 5 um range. Research and development facilities produced a broader spectrum of particle sizes, predominantly in the 1 um to 2 um range. Details of these results and a description of sampling, data handling, and statistical techniques are presented. (Auth)

<429>
Emler, W.S., and S.H. Hullett, Goodyear Atomic Corporation, Piketon, OH. 1973, August; 1973, February 28

Portsmouth Gaseous Diffusion Plant, Environmental Monitoring Report, 1972. GAT-740; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 957-974), 1217 p.

At the Portsmouth Gaseous Diffusion Plant, the ambient atmosphere and all effluent streams are monitored and analyzed regularly for conformance to the applicable, specified standards. Also, because fluoridesare used in the diffusion plant, the concentrations of fluorides in the ambient atmosphere are measured routinely. Concentrations of fluorides in vegetation are measured because fluoride ingestion can cause adverse effects effects in livestock. None of the annual average concentrations of radioactivity measured at the many sampling points around the plant exceed 1.4 percent of the applicable standards. Background radiation levels are the same as they were in 1954 before the plant began to operate. Average concentrations of fluorides in air, fluorides in water, fluorides in vegetation, sulfur dioxide in air, and chromium in water are not excessive; average pH of water is within the specified range. Analyses for particulate matter in air showed concentrations in excess of those permitted by applicable standards, but the samples were collected only downstream from the steam plant, and, therefore, are not truly ambient averages. (Auth)

Table 1 shows alpha and beta-gamma radioactivity in air samples. Table 2 shows alpha and beta-gamma radioactivity in water samples.

<430>
Ershova, Z.V., V.K. Markov, N.E. Tsvetaeva, and L.A. Ivanova, et al, State Atomic Energy Committee, USSR. 1972

Methods of Determining Radionuclide Content at or Below MPC Level in Waste Water, Environmental Objects and Biological Samples. CONF-710901; STI/PUB/300; A/CONF-49/P-451; Part of Proceedings of the 4th International Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 6-16, 1971, Vol. 11, (p. 641-642), 766 p.

As a result of the appearance in the

<430> CONT.
environment of man-made radionuclides, particularly those such as Sr 90, Cs 137 and Pu 239, daily monitoring of their spread has become necessary. Existing methods for the quantitative determination of these radionuclides are surveyed and new methods are described for determining Sr 90 (in the presence of Y 90) and Ce 144 and Cs 137 in salt-free and salt-containing aqueous solutions. These methods are based on the new, very effective principle of concentrating certain radioisotopes, whereby liquid-liquid extraction is combined with coprecipitation. The extractant used is an organophosphorus compound, the monoisooctyl ester of methyl phosphonic acid with this method, particular radioisotopes can be almost completely (98-100%) recovered from large volumes (1-20 litres) of aqueous solutions the time taken being less than 30 min. Moreover, it is possible to carry out a separate determination of these radioisotopes from the same sample. The combination of liquid-liquid extraction and coprecipitation has two advantages: first, a very high distribution coefficient is attained for the three above-mentioned radioisotopes; second, a solid organic phase is formed which is radily separable from the aqueous solution. Due to these two properties, a very high degree of concentration can be attained with these radioisotopes (factors of more than than 10(E+3) with sufficiently complete and selective extraction. Because of the simplicity and speed of the proposed methods they can be used for systematic monitoring of effluents from separation facilities, surface and underground waters, atmospheric precipitations, etc. even under field conditions. The possibility of using the method where macrocontaminants are present is discussed and the analytical conditions for determing Sr 90, Ce 144 and Cs 137 contents in seawater, foodstuffs and various biological samples (urine, bone tissue, lung tissue, teeth) are stated. Strontium 90 can be determine satisfactorily in biological specimens even when below the MPC. A method is described for determing Pu 239 based on liquid-liquid extraction with monoisooctyl methyl phosphonic acid and a mixture of isoamyl phosphoric acids with a phase volume ratio up to 100. This method is used for determing Pu 239 content in lung tissue, bone tissue, surface waters and other environmental objects. (Auth)

<431>
Fairchild, R.G., Brookhaven National Laboratory, Medical Research Center, Upton, Long Island, NY. 1969, January

Dosimetry of Californium 252. CONF-691032; Part of Parker, J.J. (Ed.), Proceedings of a Symposium on Californium 252 held in New York City, New York, October 22, 1968, (p. 277-284), 376 p.

The problems encountered and methods used in measuring the mixed dose of gamma rays and fast neutrons to tissues from Cf 252 are reviewed. In particular, dosimeter calibration, tissue tolerance to Cf 252 irradiation, relative biological effectiveness, oxygen enhancement ratio determination, and the effect of protracted irradiation on the oxygen enhancement ratio are discussed. Planar arrays of Cf 252 containing needles were used to administer uniform doses to tissues. Acute irradiations using fission neutrons from U 235 are being used to obtain a ratio of neutron to gamma ray dose that is similar to Cf 252. (ST)

<432>
Feely, H.W., D. Katzman, and S. Kaminsky, Isotopes, Inc., Westwood Laboratories, Westwood, NJ. 1968, January 1; 1967, October 31

Flight Data and Results of Radiochemical Analyses of Filter Samples Collected During April-June 1967. HASL-184; Part of Hardy, E.P., Jr. and Rivera, J., Fallout Program Quarterly Summary Report, September 1, 1967 through December 1, 1967, (p. III-2 - III-21), 406 p.

Flight data and results of radiochemical analyses of stratospheric and tropospheric air filter samples collected during Project Stardust are presented. From early 1965 to mid-1967, the General Dynamics' RB-57F aircraft was the primary sampling vehicle used. Samples were analyzed for fission products such as Sr 90 and Sr 89, also Pu 239, Pu 238 and Cd 109 and tables showing the activities of the various radionuclides (in pCi/100 STP) are included. (FMM)

<433>
Folsom, T.R., V.F. Hodge, and K.M. Wong, Scripps Institution of Oceanography, Soledad Environmental Radioactivity Laboratory, La Jolla, CA. 1972, May 31

1972 Results of the Continued Intercomparisons of Methods for Analyses of Cesium, Cobalt, Silver and Other Radionuclides Sponsored by IAEA. Part 2: Analysis of Dried Seaweed Samples Collected by British Fisheries Radiobiological Laboratory. TID-26206; 3 p.

Measurements of Cesium 134, cesium 137, Cobalt 60, and silver 110m in subsamples of three IAEA dried seaweed samples are reported. Precise intercomparisons of the longer lived nuclide silver 108m would require a ten times larger sample. Ruttienium 106 was evident, but the present standards of this nuclide are believed unreliable. A preliminary measurement of plutonium has been made in one of the seaweed samples, but because much more activity was found than expected, the plutonium measurement must be repeated and reported later. (BBM)

<434>
Folsom, T.R., V.F. Hodge, and K.M. Wong, Scripps Institution of Oceanography, Soledad Environmental Radioactivity Laboratory, La Jolla, CA. 1972, June 23

Plutonium Concentrations of IAEA Seaweed Samples. Addendum to 1972 Results of the Continued Intercomparisons of Methods for Analyses of Cesium, Cobalt, Silver and Other Radionuclides Sponsored by IAEA. Part 2: Analysis of Dried Seaweed Samples Collected by British Fisheries Radiobiological Laboratory. TID-26208; 3 p.

The method used for determination of plutonium in IAEA seaweed samples is reported, and values found were given. Activities in picocuries per gram of dried seaweed were 3.4 + or - 0.1, 3.2 + or - 0.1, and 3.3 + or - 0.1 for plutonium 238 and 22.9 + or - 0.4, 21.5 + or - 0.4, and 22.5 + or - 0.5 for plutonium 239,240. (BBM)

This is an Addendum to TID-26206.

<435>
Gudiksen, P.H., C.L. Lindeken, J.W. Meadows, and

<435>

MONITORING, MEASUREMENT AND ANALYSIS

<435> CONT.
K.O. Hamby, Lawrence Livermore Laboratory, Livermore, CA. 1973, March 7; 1973, August

Environmental Levels of Radioactivity in the Vicinity of the Lawrence Livermore Laboratory, 1972 Annual Report. UCRL-51333; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 1131-1176), 1217 p.

The Lawrence Livermore Laboratory continously monitors the levels of radioactivity within the Livermore Valley and Site 300. Results for gross radioactivity and for specific radioisotopes of interest in a variety of environmental samples are presented. Airborne particulate samples were analyzed for Pu 239, Pu 238, U 235, and U 238 activities. The monthly averaged Pu 239 activities were in the range of 5 X 10(E-17) uCi/ml while the Pu 238 activities were about an order of magnitude lower. These activities are typical of those due to global fallout. Air samples taken at Site 300 were analyzed for uranium. These analyses showed a lower than normal ratio of U 235 to U 238. Soil samples collected within the Livermore Valley and Site 300 were subjected to uranium, plutonium, strontium and gamma spectral analyses. Samples collected within several hundred meters of the firing bunkers at Site 300 were depleted in U 235; however, samples collected on the site perimeter and offsite showed normal U 235/U 238 ratios. The mean Pu 239 deposition value on soil is about 1 X 10(E-3) uCi/m2 which appears to be typical of global fallout in this area. Traces of plutonium were detected in one of the dry holding ponds at the Livermore Sewage Treatment Plant. The maximum Pu 239 activity in the plant effluent was less than 3/100 of one percent (0.03%) of the AEC drinking water standard. Gamma spectral analyses of vegetation samples revealed no gamma-emitting radionuclides other than those present naturally or in global fallout. The vegetation samples collected in areas generally downwind from the Livermore Laboratory revealed elevated tritium activities but these activities are within recommended standards. Assessment of the radiation doses to an individual from the observed environmental activities indicates the contribution from artificially produced radionuclides is small in comparison with the approximately 100 mrem/yr dose received from natural sources. (Auth) (PMM)

Table 5 shows activity levels of Pu 238, Pu 239 and Sr 90 in soils. Table 6 shows activity levels of various gamma emitting radionuclides in soil. Table 10 shows Livermore sewage treatment plant sampling results during 1972 with concentrations for tritium, Sr 90 and Pu 239 activities. Table 18 shows Pu and U concentrations in Site 300 air during 1972. Tables 20 and 21 show U and Pu activities in site 300 soils.

<436>
Hakonson, T.E., J.W. Nyhan, L.J. Johnson, and K.V. Bostick, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973, May

Ecological Investigation of Radioactive Materials in Waste Discharge Areas at Los Alamos for the Period July 1, 1972 through March 31, 1973. LA-5282-MS; 47 p.

This report describes the ecological research program at the Los Alamos Scientific Laboratory and, in addition, summarizes the progress which has been made on current project activities between July 1, 1972, and March 31, 1973. Information is presented on an environmental inventory of the Los Alamos area, a radionuclide inventory in three liquid waste disposal areas, studies to determine the applicability of the honeybee as an indicator of environmental radiocontamination and a resurvey of the Trinity area to determine the bioavailabilty of the plutonium from the world's first nuclear detonation. (Auth)

<437>
Hardy, E.P., P.W. Krey, and H.L. Volchok, Health and Safety Laboratory, New York, NY. 1973, February 16

Global Inventory and Distribution of Fallout Plutonium. Nature, 241(5390), 444-445

Plutonium isotopes, Pu 239, 240 and Pu 238 in particular, have been injected into the stratosphere as a result of atmospheric nuclear weapon tests, and have reached the ground as particulate fallout. An accidental atmospheric injection of Pu 238 in 1964 resulted in almost a 3-fold increase of the global fallout of this isotope. The accumulated fallout and geographical distribution from this unexpected release, as well as from weapon testing, is described. On April 21, 1964, a Transit navigational satellite was launched from Vandenburg Air Force Base in California. The payload included a Systems for Nuclear Auxiliary Power generator, SNAP-9A, containing 17 kCi or about 1 kg of Pu 238. Because the rocket failed to boost the satellite into orbital flight, the payload reentered the atmosphere in the Southern Hemisphere. Stratospheric checks indicated that the generator completely burned up during re-entry and turned into small particles at an altitude of about 50 km. Concentrations of the SNAP Pu 238 in the stratosphere were measurable at the end of 1970 when it was estimated that less than a kCi remained above 12 km. Soil sampling techniques were employed as indicators of cumulative fallout. By mid-1970 95% of the SNAP Pu 238 was deposited on the earth's surface. Distribution and records of ground deposit were investigated. The distribution pattern for weapons' plutonium shows heaviest deposition in the Northern Hemisphere temperate latitudes and a minimum in the equatorial region. There is a slight rise in the Southern Hemisphere temperate zone which, at its peak, is about one-fifth of the Northern Hemisphere maximum. The SNAP-9A Pu 238 has an entirely different distribution pattern. Most of the SNAP debris has deposited in the Southern Hemisphere where the maximum fallout is 2.5 times that in the Northern Hemisphere. (Auth) (RAP)

<438>
Hardy, E.P., Jr., Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1974, January 1

Health and Safety Laboratory, Fallout Program Quarterly Summary Report, (September 1, 1973 through December 1, 1973). HASL-278; 163 p.

Current data from the HASL Fallout Program and the Radiological and Environmental Research Division at Argonne National Laboratory are presented. The initial section consists of interpretive reports and notes on the dose to man from Pu 239 fallout; the respirable fraction of Sr 90, Pu 239, and stable lead in surface air; Cs 137 and Sr 90

<438> CONT.
in bone; the quality of 1972 surface air analyses, and quality control of 1973 samples of fallout, diet, tap water, and human bone. Subsequent sections include tabulations of radionuclide levels in fallout, surface air, stratospheric air, milk, diet, and tap water. A bibliography of recent publications related to radionuclide studies, is also presented. (Auth)

<439>
Hardy, E.P., Jr., Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1971, October 1

Fallout Program Quarterly Summary Report, (June 1, 1971 through September 1, 1971). HASL-245; 254 p.

The report presents current data from the HASL Fallout Program, the National Radiation Laboratory in New Zealand, the Radiological Physics Division at Argonne National Laboratory, and the EURATOM Joint Nuclear Research Centre at Ispra, Italy. Three papers have been abstracted separately for the data base. The initial section consists of data summaries and notes covering the following topics: strontium 90 fallout and precipitation by ten degree latitude bands, the stratospheric inventory of Pu 238, and stratospheric inventories of fission products. Subsequent sections include tabulations of radionuclide levels in surface air, stratospheric air, fallout, milk, and tap water; a description of Project Airstream, which employs the RB-57F aircraft as a sampling platform. The high altitude balloon sampling program and the WHO Bone Program. A bibliography of recent publications related to radionuclide studies, is also presented. (Auth) (FMM)

<440>
Hardy, E.P., Jr., Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1973, October 1

Fallout Program Quarterly Summary Report, (June 1, 1973 through September 1, 1973). HASL-276; 176 p.

This report presents current data from the HASL Fallout Program; The National Center for Atmospheric Research in Boulder, Colorado; The National Radiation Laboratory in New Zealand; and the EURATOM Joint Nuclear Research Centre at Ispra, Italy. The initial section consists of interpretive reports and notes on the global deposition of Sr 90 through 1972, sulfate concentrations in the lower stratosphere, global fallout in a forest compared with an open field, and detection of Ir 192 from recent nuclear tests in the southern hemisphere. Subsequent sections include tabulations of radionuclide levels in fallout, surface air, stratospheric air, milk, diet, and tap water. A bibliography of recent publications related to radionuclide studies, is also presented. One article, concerning fallout in a forest as measured by Pu 239 content, was abstracted separately for the data base. (Auth) (ST)

<441>
Hardy, E.P., Jr., and J. Rivera, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1968, January 1

Fallout Program Quarterly Summary Report, (September 1, 1967 through December 1, 1967). HASL-184; 406 p.

Current data is presneted from the HASL Fallout Program, Isotopes Inc., National Radiation Laboratory in New Zealand, the Division of Biological and Medical Research at Argonne National Laboratory, Euratom Joint Nuclear Research Centre, the Division of Biology and Medicine, USAEC, and the Air Resources Laboratory, ESSA. Five articles have been abstracted separately for the data base. In the report radionuclide lelels in stratospheric air, surface air, fallout, milk, other diet components, and tap water, are given in tabular form. The initial section consists of interpretive reports and notes covering the following topics: Pu 238 fallout from SNAP-9A, significance of Cs 137 levels in man, seasonal stratospheric distribution of Cd 109, Pu 238, and Sr 90, stratospheric radioactivity in November 1967, and the HASL quality control program. Also described are the Surface Air Sampling Program and the High Altitude Balloon Sampling Program. A progress report on Project Stardust is given and a bibliography of recent publications related to radionuclide studies is presented. (FMM)

<442>
Hardy, E.P., Jr., and J. Rivera, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1968, April 1

Fallout Deposition. HASL-193; Part of Fallout Program Quarterly Summary Report, December 1, 1967 through March 1, 1968, (p. II-2 - II-25), 303 p.

Precipitation and dry fallout are collected over monthly periods at stations in the United States and overseas. The samples are analyzed for strontium 90 and strontium 89 when it is expected to be present. Fission Product and Activation Product Radionuclides are measured in monthly deposition at a number of stations in the United States. Multi-nuclide analyses of monthly deposition at these sites were discontinued as of July 1967. A table of plutonium data is included and will be repeated in future quarterly reports, as deposition samples will continue to be collected and analyzed for Pu 238 and Pu 239,240 at New York City and Melbourne, Australia. In the table the isotope ratios are also given. Measurement of radiostrontium in precipitation and dry fallout collections at four U.S. Coast Guard Stations in the North Atlantic Ocean are carried out for comparison with land stations in the same latitude band. (FMM)

<443>
Herceg, J.E. (Comp.), Los Alamos Scientific Laboratory, Los Alamos, NM. 1973, August; 1973, March

Environmental Monitoring in the Vicinity of the Los Alamos Scientific Laboratory, Calendar Year 1972. LA-5184; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (P. 39-96), 1217 p.

The environmental monitoring program in effect at the Los Alamos Scientific Laboratory of the University of California for calendar year 1972 is described. Results are given of routine monitoring of radiation levels and levels of radioactive and nonradioactive contaminants in the Laboratory environs, including the atmosphere, the Los Alamos water supply, local surface and

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<443> CONT.
groundwater, sediments, and soils. Concentrations and levels are compared with applicable guide values and with results obtained at other geographical locations and locally during other reporting periods. Descriptions are given of special programs aimed at describing the physical and biological processes involved in the transport of Laboratory-generated radionuclides in liquid waste disposal areas. There is also a description of an environmental survey of certain AEC-controlled land parcels, as well as geologic, seismic, and meteorological studies of the Los Alamos area. Technical notes discuss the use of the honeybee as a biological indicator of radiocontamination, a new gamma-ray pulse height analyzer system intended for field use, an automated meteorological data acquisition system, and the determination of salt in pine trees near Los Alamos roadways. (Auth)

Table 7 shows Pu and Am concentrations in air. Table 8 shows tritiated moisture and total uranium concentrations in air. Table 12 shows analyses of regional surface water samples including range and average of Pu 239, Pu 238, and U. Table 29 shows Pu concentrations in tissues of rodents.

<444>
Hull, A.P. (Comp.), E. Hartmann, D. Henze, E. Miller, J. Nobile, J. Phillips, D. Simpson, and J. Steimers, Brookhaven National Laboratory, Upton, Long Island, NY. 1973, August; 1973, May

1972 Environmental Monitoring Report. BNL-17874; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Sites, Calendar Year 1972, (p. 413-466), 1217 p.

Natural background and radiation levels in the vicinity of Brookhaven National Laboratory attributable to its operations during 1972 are summarized. Among the data reported are external radiation levels; air particulate, tritium and radioiodine concentrations; precipitation and liquid effluent-related concentrations in stream, groundwater and surveillance wells, as well aslevels in milk, grass and soil samples. Other than tritium, there was no indication of BNL effluents in environmental air and precipitation samples. In air, the largest BNL effluent-related tritium concentration was 4 x 10(E-12) uCi/ml which is 0.002% of the applicable standard. In precipitation it was 2.77 x 10(E-4) uCi/ml, which is 0.01% of the standard for drinking water. Quarterly milk samples were obtained from two nearby dairy farms. No significant differences between Cs 137 levels in these and those generally prevailing in the northeast United States were apparent. Two sets of grass and soil samples were also collected from these and three other farms, as well as from perimeter and onsite locations. There was no significant difference between offsite samples generally downwind and those generally upwind of Brookhaven. (Auth) (PHM)

Table A shows total activities and average concentrations of identifiable nuclides in groundwater, site boundary and former perimeter. Tables 10 and 11 show concentrations of re-emitting nuclides (including Th and U) in Peconic River, Carman's River sediments and Carman's River vegetation. Table 12 shows concentrations of emitting nuclides in turtles and catfish obtained from the Peconic River. Other tables show concentrations of nuclides in milk, grass, soil and waste disposal areas.

<445>
Iredale, P., and G. Hirder, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Electronics Division, Harwell, Didcot, Berkshire, England. 1962

The Detection of Airborne Plutonium Hazards. AERE-R-3783; 17 p.

The detection of the very low levels of activity which constitute an airborne plutonium hazard is limited in practice to methods based onalpha activity measurement, and assessment of maximum permissible concentrations for long term exposure is made more difficult because of the large variable background of alpha-activity produced by the decay of the products of radon and thoron. Two instruments have been investigated both of which make corrections for the activity of these naturally occurring products and improve the threshold sensitivity of air sampling monitors. In the first the activity of radon and thoron derivatives on a filter paper is estimated from the count rate for a beta-alpha coincidence and this is used to compensate the total alpha-count rate for the contribution of the natural activities. The second method distinguishes the 5.1 MeV alpha-activity above 6.0 MeV energy. The spectrometer method of detecting plutonium is slightly less sensitive than the coincidence apparatus but has been chosen for further development because of its insensitivity to beta and gamma-ray backgrounds and its greater simplicity. It should be possible to operate the monitor with a threshold of integrated dose of approximately 40 MPC hours in an atmosphere of unfiltered air. (Auth)

<446>
Ishiguro, H., S. Terunuma, S. Sekita, and S. Motoyama, Tokai Works, Power Reactor and Nuclear Fuel Development Corporation, Tokai, Ibaraki, Japan. 1973, December

New Thermoluminescent Dosimeter for Personnel Dosimetry System at PNC Tokai Works. PNCT-831-73-02; Part of Tokai Works Semiannual Progress Report, January-June, 1973, (4 p.), 122 p.

A new personnel dosimeter badge with a thermoluminescent dosimeter (TLD) was developed. The badge can measure the radiation exposure doses due to gamma, beta, and neutron radiation. It has not only satisfactory response to routine monitoring but also to accidental dosimetry. The specifications of the dosimeter badge, including the TLD elements employed and the range of radiation dose measured, are given. (PHM)

<447>
Kalkwarf, D.R., and H.A. Kornberg, Hanford Atomic Products Operation, Biology Section, Richland, WA. 1954, January 4

Determination of Alpha Particle Emitters in the Lung. HW-30437; Part of Biology Research Annual Report, 1953, (p. 122-125), 163 p.

The alpha-particle induced decomposition of nitrous oxide was investigated as a means of detecting isotopes emitting this type of radiation when deposited in the lung. The source of alpha particles used was a deposit of Pu 239 PuO2 upon a platinum disc. The activity of the source corresponded to 18 ug

<447> CONT.
of Pu 239 and the rate of energy emission as alpha particles to the surrounding gas was calculated to be 6.5 x 10(E+12) ev/min. Nitrous oxide alone and in mixture with other gases was admitted to the reaction vessel for definite time periods. The NO2 formed during the irradiation was used as a measure of the extent of N2O decomposition. None of the gas mixtures used produced a significantly greater yield than could be obtained with pure N2O although small amounts of CO2 appeared to lower it. Using pure N2O, it would take approximately one day for a detectable amount of NO2 to accumulate with the source used. Thus this reaction does not appear suitable as a means of determining microgram amounts of Pu 239 in the lung. (FNM)

<448>
Kearny, C.H., Oak Ridge National Laboratory, Health Physics Division, Civil Defense Research Section, Oak Ridge, TN. 1973, November

Trans-Pacific Fallout and Protective Countermeasures. ORNL-4900; 22 p.

Data from the measured lower tropospheric fallout deposited in the United States from past Chinese nuclear tests was extrapolated to estimate tropospheric fallout rates from a theoretical war in which 65 megatons of weapons are detonated on or over China. The resultant trans-Pacific fallout would dangerously contaminate milk in most of the 50 states with I 131. Protective countermeasures are discussed. Hazards and expected long-term casualties from eating other fallout-contaminated foods and from exposure to total whole-body gamma doses of 1 to 10 rems from such trans-Pacific fallout in the year following the war are summarized. Recommended protective countermeasures and the psychological-political advantages likely to be attained if the government were prepared to give an early, factual account of the approaching trans-Pacific fallout dangers and of the protective countermeasures being taken to minimize casualties and economic losses are outlined. (Auth) (ST)

<449>
Keefer, D.H., and M. Dauer, U.S. Department of Health, Education, and Welfare, Bureau of Radiological Health, Training Manpower Development Program, Washington, DC; University of Miami, Graduate School, Department of Radiology, Miami, FL. 1970, September

Natural Environmental Radioactivity in South Florida Sands and Soils, February-June 1968. Radiation Data and Reports, 11, 441-448

An investigation of the naturally occurring gamma-emitting radionuclides present in selected sands and soils of south Florida was conducted. Although the primary interest was in the natural environmental radioactivity from uranium 238, radium 226, thorium 232, and potassium 40, the concentrations of five fission products were also determined to minimize the error in computing the concentrations of the four naturally occurring radionuclides. The determination of these nine radionuclides in 45 environmental samples was performed by the linear least-squares method of analysis utilizing a computer. It was found that the uranium 238 concentration in sands and soils of southern Florida is approximately 0.75 ppm. This level of natural radioactivity is expected because of the higher uranium content of specific limestone formations native to south Florida. (Auth) (FNM)

Table 1 shows radionuclide content of southern Florida sands and soils. Table 2 shows natural environmental radioactivity in sands and soils of southern Florida.

<450>
Khan, A.H., and G. Jha, Bhabha Atomic Research Center, Health Physics Division, Bombay, India. 1971

Evaluation of Atmospheric Radon Around the Uranium Complex at Jaduguda. CONF-701138; Part of Proceedings of the National Symposium on Radiation Physics held in Trombay, India, November 24-27, 1970, (p. 487-491)

A brief account of surveys to evaluate the atmospheric radon concentration at Jaduguda during the period from 1965 to 1970 are described. The probable sources of atmospheric radon is presented. The average atmospheric concentration of radon in Jaduguda during 1966-1970 was 4.60 times 10(E-10) uCi/ml. Although day-to-day variations were observed, the average value, however, was of the same order over these years. The total radon output from the mines was found to have increased from 0.76 Ci/d in 1967 to 1.5 Ci/d in 1970, while the concentration inside the mines came down by nearly a factor of 2. Although the radon output from the mines has substantially increased over the years, there appears to be no significant rise in the atmospheric radon concentration. This, perhaps, may be attributed to the large dilution available at site. Comparison has also been made with the available data on atmospheric radon in Trombay and Alwaye. (Auth) (FNM)

<451>
Kiefer, H., L.A. Konig, E. Piesch, E. Pose, and K.J. Vogt, Karlsruhe Nuclear Research Centre, Karlsruhe, German Federal Republic; Julich Nuclear Research Establishment, Julich, German Federal Republic. 1972

Personal Dose Burden Caused by Nuclear Research Centers, Experience Gained at the Nuclear Research Centers of Karlsruhe and Julich. CONF-710901; STI/PUB/300; A/CONF-49/P-395; Part of Proceedings of the 4th International Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 6-16, 1971, (p. 141-159)

At the Julich and Karlsruhe Nuclear Research Centres investigations on the assessment of the personal doses to the persons working in restricted and controlled areas and to the population in the environs of the plants have been carried out for many years. They have taken into account both radiation exposures from external sources and those arising from incorporated radioactive substances. For measurements of local and personal dosimetry, film, pen, RPL and TL dosimeters are employed. Incorporation measurements are performed with whole-body counters and sensitive excretion measurements. The environmental exposure resulting from potentially radioactive gaseous effluents is determined by means of sensitive emission measurements and comprehensive meteorological assay programs. Moreover, data are available on the radioactivity of the liquid effluents discharged. The evaluation has shown that the external exposure of the individual groups of persons due to nuclear facilities amounts to only a few percent each

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<451> CONT.
of the dose levels permitted by legislation and by the International Commission on Radiological Protection (ICRP). The radiation burden due to incorporation is negligibly small relative to the dose from external radiation exposures. These findings are not changed significantly by individual cases both of internal and external exposure in which the permissible levels had been reached or exceeded. Since tritium and Pu 239/Pu 240 in the body cannot be detected by a body counter, regular urine checks are performed on personnel handling these materials. The results show that no Pu incorporation was detected in any of these measurements, but there were frequent tritium incorporations. On the average, the tritium incorporations expressed as a percentage of the maximum permissible body burden are higher than those found for other nuclides. (Auth) (FMM)

<452>
Kleinman, M.T., Health and Safety Laboratory, New York, NY. 1971, October 1

The Stratospheric Inventory of Plutonium 238. HASL-245; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, June 1, 1971 through September 1, 1971, (p. I-84 - I-102), 254 p.

The stratospheric concentrations and burdens of Pu 238 from the re-entry and burnup of a satellite containing the SNAP-9A nuclear power source in April 1964 are presented. The period covered is August 1967-November 1970. At the beginning of 1971 about 5% of the original 17 kCi of SNAP-9A Pu 238 remained in the stratosphere. (Auth)

<453>
Koranda, J.J., and J.R. Martin, Lawrence Radiation Laboratory, Livermore, CA. 1969, July 15

Persistence of Radionuclides at Sites of Nuclear Detonations. UCRL-71867; CONF-690303; Part of Proceedings of a Symposium on the Biological Implications of the Nuclear Age held in Livermore, California, March 5-7, 1969, (49 p.)

Research was aimed at defining the distribution of radioactivity at detonation sites where earth has been moved to create a crater or trench. Subsequent ecological studies involved biological systems that come in contact with the radioactive substratum. Studies of detonation sites are reviewed and some of the salient results of studies at SEDAN crater are presented. Tritium was the most abundant radionuclide in the ejecta five years postshot (2.39 x 10(E+4) uCi/ft2) and in the biological systems, both plant and animal, that are present in the SEDAN ecosystem. It was the most abundant radionuclide present in every sample analysed. Results of the studies showed that tritium concentrations decreased with distance from the crater; soil-water tritium profiles peaked between three and four feet regardless of ejecta depth--indicating distributional patterns produced by rainfall leaching; different maximums occurred at different depths in summer and winter; surface air above the ejecta contained elevated concentrations of tritium; and residence time of tritium in SEDAN ejecta was short. Tissue-water tritium in plants growing on the ejecta and tritium content in body water, biological half-life, and specific activity in tissue of small mammals (kangaroo rats) were also studied. The distribution of radionuclides in Cabriolet ejecta and detection of a radionuclide not evident in SEDAN ejecta were briefly mentioned. An explanation for the distribution of radionuclides found in nuclear crater ejecta is given. (ST)

<454>
Krey, P.W., Health and Safety Laboratory, New York, NY. 1974, January

Plutonium 239 Contamination in the Denver Area. Health Physics, 26, 117-120

This letter to the editor is a criticism of a study on Pu 239 contamination in the Denver area published in Health Physics, 23, 537 (1972) by Poet, S.E. and Mortell, E.A. While acknowledging the value of the report, possible omissions, errors and misconceptions in the areas of soil sampling and analysis, Pu distribution with depth, and feasibility studies of the Pu mass isotopic analyses are pointed out and discussed. (RAF)

<455>
Krey, P.W., Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1968, January 1

High Altitude Balloon Sampling Program. HASL-184; Part of Hardy, E.P., Jr. and Rivera, J., Fallout Program Quarterly Summary Report, September 1, 1967 through December 1, 1967, (p. II-26 - II-86), 406 p.

Results of analyses of upper stratospheric nuclear debris collected by balloon-borne filtering devices from October 1966 through June 1967 are presented. Determinations were done for Fe 55, Sr 89, Cd 109, Ce 144, Pu 238 and Pu 239. Periodically Mn 54, Cd 113m, Sb 125, Cs 137 and Pm 147 were measured. The concentrations of general radionuclides are reported in tabular form. (FMM)

<456>
Krey, P.W., H. Beck, E.P. Hardy, and P.D. Raft, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1973, October 1

Fallout in a Forest. HASL-276; Part of Hardy, E.P., Fallout Program Quarterly Summary Report, June 1, 1973 through September 1, 1973, (p. I-27 - I-39), 176 p.

Global fallout is uniformly distributed in both forest and grassy field areas at the Brookhaven National Laboratory. The total fallout in the forest, as measured by relatively immobile Pu 239, is only 16% higher than in the grassy field. This difference is within the statistical uncertainty of the measurements. If the difference were real, it could be due to an increase in deposition by impaction in the forest relative to the grassy field by a factor of about 2. (Auth)

<457>
Krey, P.W., and M.T. Kleinman, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1971, October 1

High Altitude Balloon Sampling Program. HASL-245; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, June 1, 1971 through September 1, 1971, (p. II-37 - II-93), 254 p.

<457> CONT.
Upper atmospheric nuclear debris was collected by balloon-borne filtering devices and analyzed radiochemically for Sr 89, Sr 90, Pu 238 and Pu 239. The results from samples collected in calendar years 1970 and 1971 are given. For Pu 239 the results range from 0.512 picocuries per 10(E+3) standard cubic meter of air (pCi/KSCM)TO 28.3 pCi/KSCM, where the standard deviation of the counting error is less than 20% of the count. (FMM)

<458>
Krey, P.W., and M. Kleinman, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1971, October 1

Project Airstream. HASL-245; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, June 1, 1971 through September 1, 1971, (p. II-8 - II-36), 254 p.

Radioactivity in the lower stratosphere was studied employing the RB-57F aircraft as a sampling platform. The radiochemical data from the November 1970 mission is reported and includes results for Sr 89, Sr 90, Pb 210, Po 210, Pu 238, Pu 239 and Pu 240. The values for Pu 239 range from 0.007 picocuries per 100 standard cubic meters of air (pli/100SCM) to 11.900 pCi/100SCM where the standard deviation of the counting error is less than 20% of the count. (FMM)

<459>
Krey, P.W., M. Schonberg, and L. Toonkel, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1973, April 1

Updating Stratospheric Inventories to March 1972. HASL-273; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, December 1, 1972 through March 1, 1973, (p. I-37 - I-63), 227 p.

The stratospheric inventories of Sr 90, Zr 95, Cs 137 and SNAP-9A Pu 238 are reported up to March 1972. Sr 90 inventories react to recent large atmospheric tests while SNAP-9A Pu 238 decreases with a half residence time of about 14 months. Cs 137/Sr 90 inventory ratios are close to the theoretical production value of 1.44. The French test of August 14, 1971 injected about 130 kCi of Sr 90 into the Southern Hemisphere stratosphere. (Auth)

<460>
Kristan, J., and I. Kobal, University of Ljubljana, Institute Jozef Stefan, Ljubljana, Yugoslavia. 1973, January

A Modified Scintillation Cell for the Determination of Radon in Uranium Mine Atmosphere. Health Physics, 24, 103-140

Two modified alpha scintillation cells having inlet and outlet tubes were used to measure the concentration of Rn 222 in mine atmospheres in Yugoslavia. Sampling was performed by pumping the air of the sampling site through the cell by means of a rubber hand pump. Thus the need for a vacuum and vacuum pumps was eliminated. Without radon absorption traps, radon concentrations down to 10 pCi/l could be measured. The total error of measurement was about 5%. The method proved simple and of adequate accuracy for field measurements. (ST)

<461>
Larson, K.H., and J.W. Neel, University of California, Medical Center, Laboratory of Nuclear Medicine and Radiation Biology, Environmental Radiation Division, Los Angeles, CA; University of California, Medical Center, Laboratory of Nuclear Medicine and Radiation Biology, Biophysical Relationships Section, Los Angeles, CA. 1959, May 5-8

Summary Statement of Findings Related to the Testing Program at the Nevada Test Site. Part of Hearings Before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy on Fallout from Nuclear Weapons Test held May 5-8, 1959, Vol. 3, (p. 2006-2019)

Proximity to ground surface as well as increased mass of support and cab structures increased fallout in areas adjacent to the Nevada Test Site. Aerial bursts were not detectable by ground survey methods within 200 miles of Ground Zero (GZ). Two 1,500-foot balloon shots which did not intersect the soil surface deposited less than 0.2% of the theoretical fallout activity within the 1 mr/hr radiation intensity contour (at H+12 hours) between the distance of 1 mile from GZ and that corresponding to a fallout time of H+12 hours. A balloon shot which intersected the soil surface deposited 2.12% of the theoretical fallout. Tower shots, which in some cases intersected the soil surface and in other cases did not, deposited 6.7 to 24.5% of the theoretical fallout activity within the same distance limits. Fallout particle sizes decrease with distance from GZ and with lateral distance from the midline of fallout. The relative amount of radioactivity associated with small particle sizes (less than 44 micron) and hence the amount of fallout occurring at greater distances from GZ was increased by decreasing the mass of support and cab materials. It foundIt was found that vegetation in the environs of Nevada Test Site during the Teapot series retained only the 0-44 micron fallout particle fraction. Within the limits of 1 mile from GZ to a distance corresponding to H+12 hour fallout time, 500 and 700-foot tower shots had approximately 30% of the fallout activity associated with particles less than 44 microns in diameter. A 700-foot balloon shot had 70% of the fallout activity associated with the same size fraction. On the average, 38 to 50% of the less than 44 micron diameter fallout activity of tower shot fallout samples was associated with the less than 5 micron diameter particles and 51 to 83% in the case of balloon shot samples. Various percentage contributions of less than 5 micron diameter fallout particles were observed at virtually all sampling locations for both tower and balloon shots. The solubilities of balloon shot fallout material exceeded those of tower shots in both water and 0.1N HCl. The solubility of tower shot fallout increased with decreasing particle size. However, in balloon shot fallout, the smaller particles were somewhat less soluble than large particles. (Auth)(HP)

<462>
Lindeken, C.L., P.H. Gudiksen, J.W. Meadows, K.O. Hamby, and L.R. Anspaugh, Lawrence Livermore Laboratory, Livermore, CA. 1973, April 16

Environmental Levels of Radioactivity in Livermore Valley Soils. CONF-730603; UCRL-74424; Part of Proceedings of the 18th Annual Health Physics Society Symposium held in Miami Beach, Florida, June 17-21, 1973, (14 p.)

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<462> CONT.
Soil samples collected from areas surrounding the Lawrence Livermore Laboratory in the Livermore Valley were analyzed for Pu 239, Pu 233, Am 241, Sr 90, Cs 137, and naturally occurring gamma emitters as part of a continuing environmental surveillance program. The median Pu 239 activity corresponds to a surface deposition value of 1.1 mCi/km(2). Activities from Pu 233 and Am 241 were lower than Pu 239 activity by a factor of about 10. Median Sr 90 and Cs 137 deposition values were 13 and 31 mCi/km(2), respectively. All deposition values appear to be typical of those expected from global fallout in this area. At present, Cs 137 is the principal gamma emitter observed in fallout. The radiation exposure rate at 1 m, calculated from the median Cs 137 soil activity, was about 0.1 uR/hr. Natural terrestrial exposure rates calculated from the K 40, Bi 214, and Pb 212 soil sample activities vary from 3 to 7 uR/hr. These values are in good agreement with measurements made using CaF2:Dy TLD dosimeters and those obtained with a field-operated Ge(Li) detector. (Auth)

Table 1 shows the comparison of Pu 239 content of soils downwind from LLL with samples from the Livermore Valley. Table 2 shows activity of U 238, Th 232, K 40, Cs 137, Zr 95 and Nb 95 at different stations.

<463>
Lossner, V., National Center for Radiation Protection, Berlin, German Democratic Republic. 1973

Assessment of Low Energy Photon Emitters in Man, Technical Aspects of Detection. CONF-720503; Part of Buidoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 459-463), 655 p.

For in vivo measurements of radionuclides emitting low energy photons, e.g., Pu 239, Pb 210, U, and Sr 90, a special whole-body counter system was built consisting of two large-area proportional counters and a CsI(Tl)/NaI(Tl)-sandwich detector. The pulses from both detection systems are shaped and analyzed in respect to pulse-height and rise-time. A generalized pulse shape analyzer was developed for this purpose. A block diagram of the proportional counter system, especially designed for Pu 239 is shown. (Auth)

Figure 2 is a block diagram of a Pu lung counter.

<464>
Low-Beer, A. deG., T.W. Sargent, S.R. Wright, B.C. Buckley, and D.J. Yeager, Lawrence Berkeley Laboratory, Berkeley, CA. 1973, May

Report of the Bioassay Laboratory, 1969 to 1972. LBL-1799; 9 p.

The report covers activities of the Bioassay Program, including whole-body counting of laboratory employees, from July 1, 1969, to June 30, 1972. Results of routine monitoring and investigation of cases of suspected exposure to radionuclides are presented. The scope and accomplishments of the research and development program are described. A number of exposure cases have been referred for investigation by outside agencies. Results of these investigations are presented. (Auth)

<465>
McDowell, W.J., Oak Ridge National Laboratory, Oak Ridge, TN. 1971

Liquid Scintillation Counting Techniques for the Higher Actinides. Part of Organic Scintillators and Liquid Scintillation Counting. Academic Press, New York, New York, (p. 937-950)

Liquid scintillation counting procedures developed in studies of the aqueous complexes of the trivalent transplutonium actinides and having 100 percent counting efficiency, high accuracy and very simple, convenient sample preparation are described. Liquid scintillation spectra are presented for U 233, Am 241, Am 243, Cm 244, Bk 249, Cf 252, and Es 253 taken both on a commercial liquid scintillation detector (Packard Tri-Carb) and a single-phototube instrument built for optimum energy resolution. Both instruments give a linear relationship between alpha energy peak and channel number. The commercial instrument gave an average alpha energy resolution of 26 percent while the ORNL-built detector gave 8.2 percent. Under some favorable conditions it was possible to count one actinide in the presence of others or in the presence of other radiotracer impurities. Conditions where this was possible, and examples, are given. A simple extractive scintillator consisting of scintillators plus a suitable extractant in toluene was shown to be an effective means of placing radionuclides in the scintillation medium. It was demonstrated that subsequent removal of the barren aqueous phase from contact with the scintillator was not necessary, that the same counting efficiency was obtained with and without bulk water present, and that liquid scintillation spectra obtained with bulk water present gave as good, or better, resolution than those taken from dry scintillator solutions. (Auth)

Figures 1-8 show liquid scintillation spectra of selected actinides under varying conditions.

<466>
McKee, R.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Physics and Instrumentation Department, Richland, WA. 1973, February

Population Radiation Exposure. BNWL-1850 (Part 4); Part of Nielsen, J.M., et al, Annual Report for 1973, (p. 101-103), 117 p.

The objective of this project is to develop reliable estimates of the radiation dose to the population that would result from successful development and routine use of Pu 239 fueled artificial hearts. At the beginning of 1973, preliminary calculations indicated the most significant component of dose was that resubmitted to spouses. Because the age and sex of persons exposed are critical factors in developing estimates of possible genetic or somatic effects, the objectives of the study were broadened to develop greater definition of the age and sex of persons potentially exposed. An extensive survey to collect required interpersonal distance data was carried out in the Salt Lake City area. To obtain required detailed descriptions of the household characteristics of potential artificial heart recipients, copies of the data tapes from the March 1972 Current Population Survey program were obtained from the Census Bureau, and a special computer program was written to

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<466> CONT.
process these tapes. At year end, the principal effort was being devoted to the computer program to carry out the detailed dose calculations and summations. (Auth)

<467>
Moore, J.D., Atomics International, Canoga Park, CA. 1973, August

Environmental Monitoring Annual Report, 1972. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 1087-1113), 1217 p.

Environmental monitoring at Atomics International is performed by the Operational Safety and Waste Management Unit of the Health, Safety and Radiation Services Department. Soil, vegetation, water, and air are routinely sampled up to a distance of 10 miles from Atomics International sites. Site perimeters are monitored for radiation levels by means of thermoluminescent dosimeters. The environmental radioactivity reported herein is attributed to natural causes and to nuclear weapons testing, rather than to Atomics International operations. (Auth)

Table 1, 2 and 5 show soil, vegetation and airborne radioactivity data, respectively, for 1972.

<468>
Nathans, M.W., and W.D. Holland, Trapelo/West, Richland, CA. 1971, October 25

Analysis of Plutonium 239 Particles Collected Near the Rocky Flats Facility, Final Report. TLW-6105; 28 p.

The results of the analysis of some air filter samples conducted to determine the relation between the size and the plutonium content of particles of airborne material collected at the periphery of the Rocky Flats plant are reported. Plutonium oxide equivalent diameters and the size distribution of plutonium-containing and background particles are given in tabular form. It was concluded that the plutonium content of particles in the air samples was a small fraction of their total content; plutonium was dispersed throughout the particles; plutonium-containing particles had a size distribution larger than that of all particles on the filters; and the size distribution of all particles on the air filters was the same as that for soil samples, except that very large particles were not present in the air samples. (ST)

<469>
Nickson, J.J., University of Chicago, Chicago, IL. 1945

Medical Industrial Hazards. CN-2786; Part of Health Problems Relating to Product for Month of March 1945, (p. 13-17), 35 p.

Building and equipment surveys for alpha radiation and personnel alpha exposure surveys are reported. Although several plutonium spills took place, no personnel were found with activity significantly above background. Stool analysis development work is continuing. (ST)

<470>
Nielsen, J.M., et al, Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1972, May

Annual Report for 1971 to the USAEC Division of Biology and Medicine, Vol. 2: Physical Sciences, Part 2: Radiological Sciences. BNWL-1651 (Part 2); 117 p.

The report covers work done in the fields of environmental and radiological chemistry, radiation instrumentation, radiation dosimetry, and radiation and health physics. In particular, monitoring techniques; radiation instrumentation; radionuclide fallout rates and mechanisms; radionuclide content in the ocean, environment, and man; and uranium inhalation hazards are described. A large number of natural and fallout radionuclides are covered. Six articles were selected and abstracted separately for the data base. (ST)

<471>
Norwood, W.D., Hanford Environmental Health Foundation, Richland, WA. 1972

U.S. Transuranium Registry: Progress and Expectations. Part of Stover, B.J. and Jee, W.S.S., (Eds.), Radiobiology of Plutonium. J.W. Press, Salt Lake City, Utah, (p. 531-537), 552 p.

The purpose, progress and expectations of the U.S. Transuranium Registry (National Plutonium Registry), established in 1968, are discussed. Problems of estimating internal dose and human and animal experiments using the transuranium elements are reviewed. The Registry collects, codes, analyzes, and data processes material on the health and health physics aspects of present and past exposed employees during life and compares these data with pathological, bioassay, and mortality findings after death. (ST)

<472>
Not given, Health and Safety Laboratory, New York, NY. 1974, January 1

Appendix to Health and Safety Laboratory Fallout Program Quarterly Summary Report (September 1, 1973 through December 1, 1973). HASL-278 (APP); 459 p.

Data are presented for Sr 90 and Sr 89 in monthly deposition at world land sites. There are 35 monthly monitoring sites in the United States and 90 in other countries. Several tables are presented for the concentrations of radionuclides (Mn 54, Fe 55, Sr 90, Cs 137, Cd 109, Ce 144, Pu 238 and Pu 239) in surface air in various countries. Stable lead analyses are also included. Data are given for the Sr 90 content in New York City tap water and milk and finally there is a table of conversion factors and a listing of radionuclides of interest in the HASL fallout program. (FWM)

<473>
Not given, National Environmental Research Center, Las Vegas, NV. 1973, May; 1973, August

Environmental Monitoring Report for the Nevada Test Site and Other Test Areas Used for Underground Nuclear Detonations, January-December 1972. NERC-LV-539-23; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 713-866), 1217 p.

During 1972, the monitoring of gamma

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<473> CONT.
radiation levels and concentrations of radioactivity in the environs of the Nevada Test Site (NTS) was continued through the use of offsite networks of radiation dosimeters and gamma-rate recorders, air samplers, and selected locations at which monthly samples of water and milk were collected for radiological analyses. For each of the underground nuclear detonations and the seven experimental tests of the Nuclear Furnace-1, mobile radiation monitors equipped with radiation monitoring equipment and supplies were on standby in offsite locations. The only radioactivity produced by nuclear tests at the NTS and detected offsite was Xe 133, the levels of which, were less than 0.04% of the Concentration Guide of the AEC Manual, Chapter 0524, for a population sample. All other increases in radioacitivity concentrations observed in media collected around the NTS were attributed to seasonal variations in old atmospheric fallout and fallout from nuclear detonations by the People's Republic of China on January 7, 1972, and March 18, 1972. Radioactive noble gases were released during the Nuclear Furnace-1 test series and detected by aircraft sampling. An estimate of the potential radiation exposure to offsite populations was determined to be less than 1% of the Radiation Protection Standards of the AEC Manual, Chapter 0524. The results of soil samples collected around the NTS and analyzed for plutonium content showed that Pu 239 is present outside the boundaries of the NTS at levels greater than that which would be expected from world-wide fallout (approximately 1 mCi/m2). During the year, a Long-Term Hydrologic Monitoring Program was begun for off-NTS sites used previously for underground nuclear tests. These sites are located near Fallon, Nevada (Project Shoal), Central Nevada Test Area (Faultless Test), Grand Junction, Colorado (Project Rulison), Farmington, New Mexico (Project Gasbuggy), Carlsbad, New Mexico (Project Gnome), Hattiesburg, Mississippi (Projects Dribble/Miracle Play.) All radioactivity concentrations in the samples collected during the year were at natural background levels with the exception of samples collected at USGS Wells Nos. 4 and 8 at the Project Gnome site and the HT-2M Well at the Project Dribble/Miracle Play site. High levels of H 3 and Sr 90 were observed in samples collected from both wells while Cs 137 was detected only in the sample from Well No. 8. The highest concentration of radioactivity was for Sr 90, which was 4.3 times its Concentration Guide of 3 x 10(E-7) uCi/ml for exposure to individuals. High levels of H 3 was detected in the HT-2M Well at the Dribble site, the highest being 6.7 x 10(E-5) uCi/ml, which is 2.2% of the Concentration Guide for H 3. The potential radiation dose equivalents received by offsite populations near the NTS and other locations referred to above were all estimated to be less than 1% of the Radiation Protection Standards of the AEC Manual, Chapter 0524. (Auth) (FMM)

Table 6 gives a summary of background radiation doses for the dosimetry network. Tables 8 and 9 give summaries of analytical results for the milk and water surveillance network.

<474>
Not given, Pinellas Plant, St. Petersburg, FA. 1973, March 2; 1973, August

Environmental Monitoring Report, 1972. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 177-195), 1217 p.

The primary radionuclide used at the Pinellas plant is tritium. During 1972 the average tritium oxide concentration in liquid effluents was less than 2% of the radioactivity concentration guide for permissible continuous non-occupational exposures. In-stack monitoring of tritium releases to the atmosphere from the two plant exhaust stacks revealed that the average gas concentrations were 0.06% and 0.6% of the applicable guide. Similar monitoring indicated tritium oxide concentrations which were 110% and 95% of the guide. However, the associated ground level concentrations were less than 0.0055 and 0.0004% of the guide. Discharges of radicactive krypton gas, measured in stack, resulted in an average concentration of 8% of the guide for continuous non occupational exposure. Offsite surface water samples collected in all directions from the plant to a distance of six miles and analyzed for tritium content all showed less than the minimum detectable level. (FMM)

<475>
Not given, U.S. Atomic Energy Commission, Division of Operational Safety, Washington, DC. 1973, August

Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972. WASH-1259; 1217 p.

The environmental monitoring reports of the major U.S. Atomic Energy Commission contractor sites are presented, with the facilities grouped according to the various operations offices, namely the Albuquerque, Chicago, Idaho, Nevada, Oak Ridge, Richland, San Francisco and Savannah River Operations Offices, and the Naval Reactors Facilities. Separate abstracts are prepared for the data base for each facility with the exception of the Bendix Corporation, Kansas City, Missouri which does not machine or process any radioactive materials and is thus considered clean industry. In the reports, results are given for concentrations of radioactivity in air, water, soils, rivers, food stuffs, plants and animals, and the environmental data is analyzed to determine whether the operation of the facility had any significant effect on the quality of the human environment. (FMM)

<476>
Not given, Pantex Plant, Amarillo, TX. 1973, August

Environmental Monitoring and Pollutant Inventory Program Report for Pantex Plant Covering Calendar Year 1972. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 129-176), 1217 p.

During calendar year 1972, a total of 45 test shots involving radioactive materials were fired from Firing Site No. 5 as compared to 383 test shots fired from the same location not involving radioactive material. Following each test fire, a small quantity of radioactive material is suspended in the dust cloud that accompanies the explosion. As the dust cloud dissipates, the potential exists for deposition of radioactive materials on environmental soil and vegetation. Routine analysis of offsite soil and vegetation has been performed to survey levels of uranium

<476> CONT.
and plutonium in the environment surrounding the Pantex facility to determine the net impact of Pantex operations upon the surrounding environment. Meteorological conditions in the area are such that there is frequent blowing of area top soil. A summary of the area wind conditions is shown. In no case was excessive activity discovered for any of the analyses performed. For soil deposition, the U 238 concentration was approximately 0.006 ug/g or approximately 8 x 10(E-10) uCi/g. A section is devoted to the nonradioactive environmental monitoring and pollutant inventory program report. (PMM)

Table 4 shows fluorometric determination of total uranium in vegetation. Table 5 shows determination of Pu 239 in soil samples. Table 6 shows radiometric analysis of environmental water samples.

<477>
Not given, Comitato Nazionale per l'Energia Nucleare, Rome, Italy. 1971, October

Data on Environmental Radioactivity Collected in Italy, (January - December 1972). PROT-SAN-11-71; 233 p.

Data are presented for the content of Sr 90, Sr 89, Cs 137, Zr 95 and Pu 239 in fallout in various locations in Italy. The methods of sampling, sample treatment, alpha, beta and gamma counting are outlined. (PMM)

<478>
Not given, Australian Academy of Science, Canberra, Australia. 1973, April

The Biological Effects of Nuclear Explosion Fallout. NP-19823; 21 p.

The study was undertaken to assess the actual or potential harm to Australia, its population, resources, and environment, from the explosion of nuclear devices by France in the Pacific. In the first section assessments were made of the radiation doses to humans in Australia from I 131, short lived fission products, Sr 90, Cs 137, and C 14 and dose rates were calculated. In the second section cancer and genetic effects from the calculated dose rates were discussed. It was concluded that fallout from the French nuclear tests is unlikely to result in any statistically detectable increase in the number of cases of cancer or genetic defects in the Australian population. Guarding against unwarranted exposure to radiation is emphasized. (ST)

The appendix contains an estimate of the fallout in Australia from nuclear weapons explosions at the French site in Polynesia, 1966-1972.

<479>
Not given, U.S. Environmental Protection Agency, Office of Radiation Programs, Surveillance and Inspection Division, Washington, DC. 1972, September

Proceedings of the Southern Conference on Environmental Radiation Protection from Nuclear Power Plants, April 21-22, 1971. ORP/SID-72-4; 236 p.

The purpose of the Southern Conference on Environmental Protection from Nuclear Power Plants was to present techniques used to identify and monitor radionuclides contained in liquid and gaseous effluents produced by operating nuclear power plants and to specify pathways through which radioactive materials released by the nuclear power industry may reach the populations. The report consists of papers presented at the conference and the deliberations following their delivery. The following papers were presented: man and his environmental responsibilities; problems in meeting AEC reporting and compliance requirements; evaluation of environmental factors affecting population exposure; region 4 radiation office activities related to the national radiological data management project; waste management; PWR nuclear power plant systems for reducing radioactive releases; regulatory experience and projections for future design criteria; what the future holds for nuclear power; the terrestrial radiological monitoring programs at Duke Power Company's Oconee and Mcguire nuclear stations; aquatic radiological monitoring, Browns Ferry nuclear plant; an ecological approach to marine radiological monitoring at the Florida Power Corporation Crystal River nuclear plant; interrelationships of federal, state, academic, and industrial interests in environmental studies; and nuclear power and a protected environment. Two papers were selected for separate abstracts for the data base. (ST)

<480>
Not given, U.S. Atomic Energy Commission, Washington, DC. 1959, October 9

Second Quarter Report. Part of Hearings Before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy on Fallout from Nuclear Weapons Tests held May 5-8, 1959, Vol. 3, (p. 2191-2198)

The report summarizes information on surface air radioactivity, strontium 90 levels in milk and other foods, fission product radioactivity in soils, cesium 137 levels in man and milk, strontium 90 in milk and bones of Nevada cattle, and monthly fallout collections for the second quarter of 1959. Monthly fallout activity and radionuclide levels for several stations in the United States are given in tabular form. Concentrations of total fallout beta radioactivity in surface air decreased somewhat in both hemispheres in May compared with April. Plutonium added a measurable but small portion to the dose from fission product fallout. (ST)

<481>
Not given, Congress of the United States, Joint Committee on Atomic Energy, Washington, DC. 1959

Fallout from Nuclear Weapons Tests. Hearings Before the Special Subcommittee on Radiation, First Session, Vol. 3, held May 5-8, 1959, 649 p.

Volume 3 is an appendix to the hearings containing additional material pertinent to the discussions. These materials cover supplimental statements on general aspects of the fallout problem; the hot spot problem and strontium 90 in foods; Atomic Energy Commission quarterly reports; comments on the General Advisory Committee Report; maximum permissible levels; biological effects; carbon 14; the report of the United Nations Scientific Committee on the effects of atomic radiation (1958); nuclear detonation and meteorological aspects; classification and declassification; fallout research and organization; and a bibliography. Several parts of the appendices were abstracted

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<481> CONT.
separately for the data base. (ST)

<482>
Not given, Savannah River Plant, Health Physics Section, Aiken, SC. 1973, August

Environmental Monitoring in the Vicinity of the Savannah River Plant, Annual Report for 1972. DPSPU-73-30-1; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 1189-1217), 1217 p.

A continuous monitoring program has been maintained since 1951 (before plant startup) to determine the concentrations of radioactive materials in a 1200-square mile area outside the Savannah River Plant. Included are parts of Aiken, Barnwell, and Allendale counties in South Carolina; and Richmond, Burke, and Screven counties in Georgia. Although very small amounts of gaseous and liquid radioactive materials are discharged to the environment, environmental levels continue to be far below levels considered significant from a public health viewpoint. The quantity of radioactivity released by SRP to its environs during 1972 is, for the most part, too small to be distinguished from natural background radiation and fallout from worldwide nuclear weapons tests. Particulate beta activity detectable in air is due entirely to global fallout. This concentration in air at the plant perimeter and 25 miles away represents 0.1% of the Concentration Guide. Tritium oxide in air at the plant perimeter is greater than in air at more distant locations; however, the average concentration at the plant perimeter is only 0.1% of the Concentration Guide. Tritium, Cs 137, and Sr 90 are the only radionuclides of plant origin detectable in river water. None of these had an average concentration that exceeded 0.2% of the Concentration Guide in river water sampled 8 miles downstream from the plant. Radioactive materials in river fish also continue to be very low. Various water-quality analyses of river water samples by SRP indicate that Savannah River water is not adversely affected by SRP operations. This is substantiated by surveys of the health of the Savannah River biota by the Academy of Natural Sciences of Philadelphia and pesticide analyses of river water and sediment by the United States Geological Survey Water Quality Laboratory, Washington, D.C. (Auth)

Table 3 shows fallout and rainwater analyses. Tables 5, 6 and 7 show radioactivity in vegetation, milk and agricultural products. Table 9 shows Cs 137 concentration in deer and hogs. Table 10 shows average concentration of radionuclides in Savannah River water.

<483>
Not given, Dow Chemical Company, Golden, CO. 1973, April

Rocky Flats Plant, January-December 1970. Radiation Data and Reports, 14(4), 267-271

Results of routine environmental monitoring of air, water, fallout, vegetation, and soil for long-lived alpha radioactivity in the vicinity of the Rocky Flats Plant are given in tabular form. The plant is engaged in routine production operations involving plutonium and uranium. Following a fire in a plutonium production building in 1969, plutonium analysis of environmental samples was expanded. (ST)

<484>
Not given, Union Carbide Corporation, Nuclear Division, Office of Safety and Environmental Protection, Oak Ridge, TN. 1973, August; 1973, March 26

Environmental Monitoring Report, United States Atomic Energy Commission, Oak Ridge Facilities, Calendar Year 1972. UCC-ND-244; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 889-929), 1217 p.

The Environmental Monitoring Program for the Oak Ridge area includes sampling and analysis of air, water from surface streams, several food products, flora, and soil for both radioactive and nonradioactive materials. A summary of the results of the program for calendar year 1972 is presented. Surveillance of radioactivity in the Oak Ridge environs indicates the atmospheric concentrations of radioactivity were not significantly different from other areas in East Tennessee. Concentrations of radioactivity in the Clinch River and in fish collected from the river were less than one percent of the permissible concentration and intake guides for individuals in the neighboring environemnt. Only very low-level radioactivity is being released to the environment from plant operations and the resulting concentrations in all of the media sampled were well below permissible standards. Surveillance of nonradioactive materials in the Oak Ridge environs shows that established limits were not exceeded for those materials possibly present in the air as a result of plant operations. The data obtained from the water sampling program indicate compliance with "standards" with the exception of chromium in the discharge of White Oak Dam and chromium, pH, and dissolved oxygen at the outlet of New Hope Pond on East Fork Poplar Creek. (Auth) (FMM)

Table 8 shows radionuclides in the Clinch River. Table 9 shows uranium concentration in surface streams. Table 18 shows radionuclide content of Clinch River fish. Table 19 shows Pu and U content of soil samples from near perimeter air sampling stations. Table 20 shows U in soil, pine needles and grasses at a five-mile radius from the Oak Ridge Gaseous Diffusion Plant.

<485>
Not given, National Lead Company of Ohio, Health and Safety Division, Cincinnati, OH. 1973, August; 1973. February 16

Feed Materials Production Center, Environmental Monitoring Annual Report for 1972. NLCO-1098; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites. Calendar Year 1972, (p. 867-887), 1217 p.

Environmental monitoring data collected at the Feed Materials Production Center (FMPC) during 1972 are summarized. These data shows that the average offsite concentrations of radioactive contaminants from FMPC operations were less than 0.5% of the guide levels published in AEC Manual Chapter 0524. At least once each year, soil samples are collected near the six Boundary Sampling Stations and analyzed for uranium to observe the possible contribution from stack effluents. The average concentrations of uranium, thorium and radium added to the Great Miami river was < 0.001% of the AEC Radiation Protection standards. The average

<485> CONT.
upstream concentrations of radium 226 and radium 228 were 2.8% and 1.4% of the standard for uncontrolled areas. State criteria for gross beta and dissolved alpha radioactivity were not exceeded in the river. The average radionuclide concentrations in air, at the boundary sampling stations, were no greater than 0.4% of their respective standards for offsite areas. It is concluded from these data that any offsite radiation exposure resulting from FMPC airborne contaminants would be a small fraction of the standards. (FMM)

Table 1 shows radioactive contaminants in air. Table 3 shows radioactive contaminants in water. Table 5 shows uranium in soil.

<486>
Not given, Knolls Atomic Power Laboratory, Schenectady, NY. 1973, August; 1973, July

Knolls Atomic Power Laboratory Annual Environmental Monitoring Report, Calendar Year 1972. KAPL-M-7324 (Rev. 1); WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 655-698), 1217 p.

The results of environmental monitorng at the three sites, namely Knolls site, Kesserling site and Windsor site are reported. The radioactivity released in water, which totaled less than 0.0064 Ci and less than 0.5 percent of the off-site concentraton guide at the point of release to the Mohawk River, had no discernible effect on the radioactivity concentration in river water and sediment downriver from Knolls Site. Similarly, the airborne radioactivity concentrations in stack effluents, except for noble gases, all average less than 1.5 percent of the applicable concentration guides at the point of discharge. Water released from the Kesselring Site to the Glowegee Creek during 1972 contained less than 0.0013 Ci, which results in an average concentration of less than 0.0083 percent of the reference concentration guide for release of cobalt 60. Water released from the Windsor Site to the Farmington River during 1972 contained less than 0.001 Ci which results in an average concentration of less than 0.02 percent of the reference concentration guide for release of cobalt 60. As a result of the effluent and environmental monitoring programs, it is concluded that operations at the three sites do not significantly affect the natural radioactivity levels of the local environment, and do not cause significant radiation exposure to the public. (FMM)

<487>
Not given, Bettis Atomic Power Laboratory, Pittsburgh, PA. 1973, August; 1973, June

Effluent and Environmental Monitoring Report for Calendar Year 1972. WAPD-RS(EA)-86; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 629-654), 1217 p.

The Effluent and Environmental Monitoring Progam in effect at the Bettis Atomic Power Laboratory during Calendar Year 1972 is described. The results obtained demonstrate that the existing controls for solid, liquid and airborne effluents ensure that all such releases have been made in accordance with the applicable federal regulations. The quantity of radioactivity released in water during this report period amounted to 0.0011 Ci. The average concentration of radioactivity in liquid effluents was only 0.44 percent of the Radioactivity Concentration Guide; all liquids were released at concentrations far below the Radioactivity Concentration Guide. Airborne particulates released to the atmosphere contained less than 0.024 Ci and were generally below the sensitivity of the measuring equipment. The airborne particulate radioactivity concentration was less than 5.7 percent of the applicable Radioactivity Concentration Guide for unknown mixture of radionuclides in air. Solid radioactive waste materials are shipped in Department of Transportation approved sealed containers to an Atomic Energy Commission approved burial ground. Water quality measurements are made on water samples, which are collected from the small streams on the Laboratory site. In addition, analysis of the radioactivity in silt from these streams is also performed. Conservative calculations of the estimated radiation dose to the public based on the radioactivity released from the laboratory indicate that the estimated exposure to an individual or population group was less than one percent of the applicable standards. Evaluation of these environmental data shows that the operation of the Laboratory during the period from January through December, 1972 did not have any significant effect on the quality of the human environment. (Auth) (FMM)

<488>
Not given, Duquesne Light Company, Shippingport Atomic Power Station, Shippingport, PA. 1973, August; 1972, January-December

Annual Effluent Data and Environmental Monitoring Report. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 699-712), 1217 p.

Environmental monitoring conducted during 1972 in the vicinity of the Shippingport Atomic Power Station is described. The Shippingport environmental monitoring program consists of sampling the water and bottom sediment of the Ohio River and posting film badges in the area of the power station. Releases of small quantities of radioactivity ot the air and to the Ohio River, are reported. Additional analyses of the effluent from the portion of the facility which is operated under USAEC contract is performed to ensure that the water quality standards specified by Atomic Energy Commission Manual Chapter 0510 and the Commonwealth of Pennsylvania have been met. The results of environmental monitoring described by the report show that Shippingport operations have not adversely affected the surrounding environment. (Auth)

Table 2 gives results of analyses of Ohio River water during 1972. Concentrations are given for alpha, beta-gamma and K 40 radioactivity.

<489>
Not given, Idaho Operations Office, Environmental Sciences Branch, Idaho Falls, ID. 1973, August; 1973, April

1972 National Reactor Testing Station, Environmental Monitoring Program Report. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 597-627), 1217 p.

The results of the air monitoring program for

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<489> CONT.
1972 indicated that onsite and offsite air concentrations resulting from National Reactor Testing Station releases were indistinguishable from the natural radioactivity in air. However, special techniques were used to measure worldwide radioactive fallout, which is usually much less than 1% of the natural radioactivity in air. These sensitive techniques indicated that at a few onsite sampling locations the small releases of National Reactor Testing Station radioactivity were measurable above the worldwide fallout. There was no evidence that National Reactor Testing Station operations caused any increased air concentration at offsite communities. None of the offsite well water or surface water samples contained any gross alpha, gross beta, or tritium activity above the detection limits of the analyses. The only fission or activation product detected in milk samples was Sr 90. However, the Sr 90 concentrations are similar to those reported for the region in the U.S. Environmental Protection Agency's Radiation Data and Reports, and the source is assumed to be fallout from nuclear device testing and not NRTS operations. Wheat samples collected at harvest also contained small amounts of Sr 90 from worldwide fallout. (Auth)

Tables show sampling data for air, well water, drinking water, surface water, milk and wheat.

<490>
Not given, Battelle Columbus Laboratories, Health Physics Section, Columbus, OH. 1973, August; 1973, February

Environmental Report for Calendar Year 1972 on Radiological and Non-Radiological Parameters. WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year, (p. 401-412), 1217 p.

The Battelle-Columbus contract nuclear activites are conducted at two locations. The primary nuclear area, the Nuclear Research Center, is located approximately 17 miles west of the King Avenue Laboratories. The contract operations at this location are primarily associated with metallurgical studies with plutonium and mixed fission products. Reactor fuel element studies comprise most of the research effort at the JN-1, Hot Cell Facility. The general activities at the King Avenue Laboratories are primarily associated with uranium compounds. The radiological operations at the West Jefferson Nuclear Center during 1972 were basically without incident in respect to the environs. The King Avenue, Building 3 Site has experienced a substantial decrease in contract uranium activities and no incidents were recorded that resulted in excessive air or water effluent releases to the environs. One instance of inadvertant dumping of mop water at the JN-1 Hot Cell into the sanitary system occurred. This was detected and remedied without serious consequences. Sampling at the release point of the filter bed showed that concentrations were less than the Concentration Guides for release to uncontrolled areas as per AECM 0524. (Auth)(PMM)

Table 1 shows results of the radioassay of the spring 1972 grass samples. Concentrations of gross alpha and beta activity, Pu and Sr 90-Y 90 are given.

<491>
Not given, International Atomic Energy Agency, Vienna, Austria. 1973

Environmental Isotope Data No. 4: 1973 World Survey of Isotope Concentration in Precipitation (1968-1969). STI/DOC/10-147; Technical Reports Series No. 147; 334 p.

This is the fourth volume of the publication "Environmental Isotope Data: World Survey of Isotope Concentration in Precipitation". The first volume, which was published in May 1969 as IAEA Technical Reports Series No. 96, included data from 1953 to 1963; the second volume, published in June 1970 as IAEA Technical Reports Series No. 117, included data from 1964 and 1965 and the third voume, published in September 1971 as IAEA Technical Reports Series No. 129, included data from 1966 and 1967. This fourth volume is primarily concerned with the concentration of the environmental isotopes (tritium, deuterium and oxygen 18) in monthly samples of precipitation taken by a global network of 177 stations in the period 1968-1969. Selected meteorological data, such as amount of precipitation, vapor pressure and temperature are also presented. Data before 1968 which were not appropriate or were unavailable at the time of the earlier issues have also been included in the latter part of this volume as late reports. The collection of the precipitation samples is carried out by the meteorological services of 65 countries and territories. Analyses of the network samples are made in co-operating laboratories in Canada, Denmark, India, Israel, New Zealand, Sweden and the United States of America and in the IAEA laboratory in Vienna. (PMM)

<492>
Not given, Dairyland Power Cooperation, Genoa, WI. 1973, August

Environmental Monitoring Report of the La Crosse Boiling Water Reactor from January 1, 1971 to December 31, 1972. DPC-851-53; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 529-552), 1217 p.

The monitoring program at the La Crosse Boiling Water Reactor (LACBWR) includes monitoring of liquid and gaseous releases from the plant as well as environmental samples of surface air, river water, sediment, milk, fish, vegetation and penetrating radiation. The penetrating radiation is measured by thermoluminescent dosimetry. The dose at the site boundary of the LACBWR facility was approximately 20-30 mrem/yr. The offsite exposures received from the facility were well within the exposure guidelines to the general population. The activities found in the environmental samples, (i.e., milk, water, fish, etc.,) collected in 1972 in the vicinity of the LACBWR facility were found to be within the range of the natural background. (PMM)

Tables show the concentration of radioactivity in river and rain water in the LACBWR vicinity, Mississippi river sediment samples, milk, grass and fish samples.

<493>
Not given, Minnesota Department of Health, Minneapolis, MN; United Power Association, Elk River, MN. 1973, August; 1973, February

Survey of Environmental Radioactivity.

<493> CONT.
COO-651-88; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 467-528), 1217 p.

A considerable increase in radioactivity in all media analyzed occurred in the middle of 1961 due to fallout from nuclear weapons testing. The peak for gross beta activity in Minnesota surface waters was reached early in 1963. A peak for air particulates was reached in the latter half of 1961, followed by a second peak early in 1963. From 1963 to 1965, the general trends of radioactivity in precipitation, surface waters and air have been downward. Since 1965, levels of radioactivity in these media have generally stabilized. The values for the gross beta radioactivity of air particulates from seven environmental stations operated by the United Power Association (UPA) in the Elk River vicinity for the period January, 1972 through December, 1972 ranged from a low of 0.01 to a high of 1.11 pCi per cubic meter. The average value of the weekly samples from the environmental stations was 0.15 pCi per cubic meter. The average value of the weekly samples from the onsite stations was 0.14 pCi per cubic meter, not statistically different from the results of the offsite stations. Gross beta activity of the Mississippi River water was determined at three points, one point upstream, one just downstream from the reactor, and one about fifteen miles downstream from the reactor site. During 1972 the low was 5 and the high 42 pCi/l. The average concentrations for the twelve-month period was 16 pCi/l. The concentrations of I 131, Sr 90 and Cs 137 in milk samples are given and range from < 4 pCi/l for I 131 to < 18 pCi/l for Cs 137. The gross beta concentration in surface soil at offsite locations averaged 30 pCi/g while onsite measurements averaged 36 pCi/g. Results for vegetation samples indicated an average gross beta concentration of 59 pCi/g dry weight offsite and 50 pCi/g dry weight onsite. (FNM)

<494>
Not given, Union Carbide Corporation, Nuclear Division, Office of Safety and Environmental Protection, Oak Ridge, TN. 1973, August; 1973, March 26

Environmental Monitoring Report, United States Atomic Energy Commission, Paducah Gaseous Diffusion Plant, Calendar Year 1972. UCC-ND-245; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 931-955), 1217 p.

Air water, soil, and grass in the vicinity of the Paducah Gaseous Diffusion Plant were continuously or periodically sampled during 1972. Analyses for materials known to be in plant effluents were made to provide effluent control information and to determine compliance with applicable air and water quality standards. The air analyses for radioactivity indicate concentrations at all off-site sampling stations averaged less than one percent of teh applicable Radioactivity Concentration Guide. Air and grass off-site analyses for fluorides met the Kentucky air quality requirements. Soil samples collected to provide background data were analyzed for uranium. The results ranged from 1.1 ppm to 2.0 ppm at the AEC property boundary. None of these concentrations would be expected to have a significant impact on the environemnt. There was no detectable change in chemical, physical, or radioactive characteristics of either the Ohio River or ground water attributabel to Paducah Gaseous Diffusion Plant operations. The results of water samples analyses of the Ohio River show the chromium and fluoride concentrations were in compliance with the requirements of the applicable Kentucky regulations. The concentration of hexavalent chromium at the mouth of the combined Big and Little Bayous is slightly in excess of the Ohio River Valley Sanitation Commission (ORSANCO) discharge standard of 0.05 ppm. (Auth)

Table 8 shows uranium in environmental water samples. Table 12 shows concentrations of uranium in soil.

<495>
Not given, University of California, CETO Laboratory, Mercury, NV. 1973, July

Rock Valley Ecology Study Area and Irradiation Facility Procedure. Rock Valley Miscellaneous Publication No. 2; 26 p.

The Rock Valley Ecological Study Area at the Nevada Test Site is a lock facility designed to provide a uniform dose rate (4 + or - R/day) from a partially shielded Cs 137 source over a 22 acre area. The area is used for radiation studies and the U.S. International Biological Program. Operating procedures, the irradiation facility, and safty plans for the site are detailed. (BBM)

<496>
Not given, Savannah River Plant, Health Physics Section, Aiken, SC. 1972

Environmental Monitoring in the Vicinity of the Savannah River Plant, Annual Report for 1971. DPSPU-72-30-1; 19 p.

A continuous monitoring program has been maintained since 1951 (before plant startup) to determine the concentrations of radioactive materials in a 1200-square mile area outside the Savannah River Plant. Included are parts of Aiken, Barnwell, and Allendale counties in South Carolina; and Richmond, Burke, and Screven counties in Georgia. Although very small amounts of gaseous and liquid radioactive materials are discharged to the environment, environmental levels continue to be far below levels considered significant from a public health viewpoint. The quantity of radioactivity released by SRP to its environs during 1971 is, for the most part, too small to be distinguished from natural background radiation and fallout from worldwide nuclear weapons tests. Particulate beta activity detectable in air is due entirely to global fallout. This concentration in air at the plant perimeter and 25 miles away represents 0.2% of the Concentration Guide. Tritium oxide in air at the plant perimeter is greater than in air at more distant locations. The average concentration at the plant perimeter, only 0.1% of the Concentration Guide, is the largest percentage of any air Concentration Guide for plant-released radionuclides. Tritium, cesium 137, strontium 89, and strontium 90 are the only radionuclides of plant origin detectable in river water. None of these had an average concentration that exceeded 0.2% of the Concentration Guide in river water sampled 8 miles downstream from the plant. Radioactive materials in river fish also continue to be very low. Various water-quality analyses of river water samples surveyed by SRP indicate

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that Savannah River water is not adversely affected by SRP operations. This is substantiated by surveys of the health of the Savannah River biota by the Academy of Natural Sciences of Philadelphia. The standards applicable to concentrations of radionuclides in air and water at SRP are the Concentration Guides, "Standards for Radiation Protection," AEC Manual, Chapter 0524, 1963. (Auth)

<497>
Osborne, R.V., Royal Cancer Hospital, Institute of Cancer Research, Department of Physics, London, England. 1963, July 13

Plutonium 239 and Other Nuclides in Ground Level Air and Human Lungs During Spring 1962. Nature, 199(4889), 143-146

A technique using alpha spectrometry that allows measurement of Pu 239 and/or Pu 240 directly in ground level air at concentrations as low as 5 x 10(E-17) Ci/kg is described. Samples of dust from ground level air at Sutton, Surrey were collected and complete lungs together with associated lymph nodes were obtained from human adults from southern England and analysed for Pu 239. From February-July 1962 Pu 239 concentrations and Pb 210 concentrations were also measured. The average lung burden of Pu 239 was 0.16 pCi. Zirconium 95-Nb 95 burdens agreed well with those of previous studies. Results were used to evaluate some of the parameters of standard man. (ST)

<498>
Pendleton, R.C., J.J. Koranda, W. Wagner, P. Phelps, R.D. Lloyd, L. Anspaugh, and W. Chapman, Lawrence Livermore Laboratory, Biomedical Division, Livermore, CA; University of Utah, Laboratory of Environmental Radiation, Salt Lake City, UT. 1971

Radioecological Studies in Utah Subsequent to the Baneberry Event. CONF-710501; Part of Nelson, D.J. (Ed.), Radionuclides in Ecosystems, Proceedings of the 3rd National Symposium on Radioecology held in Oak Ridge, Tennessee, May 10-12, 1971, Vol. 1, (p. 150-169), 1268 p.

The Baneberry event was an underground weapons test conducted at the Nevada Test Site on the morning of December 8, 1970. Accidental venting occurred, producing a cloud of radioactivity which moved over central and northern Nevada into Utah. At the time of the Baneberry venting, the University of Utah's Department of Radiological Health and the Biomedical Division of the Lawrence Radiation Laboratory were conducting cooperative radioecological studies throughout the state of Utah. These studies were designed to document the distribution and movement of radionuclides in agricultural and natural environments in the state of Utah. As part of a program of environmental sampling, an air sampling network had been activated on 30 October 1970, and filter samples were obtained through 11 December 1970. These samples, when compared with those obtained during passage of the Baneberry cloud, enable a precise description of the radioactivity present in the state of Utah. Radioanalyses were made on air filters, water, vegetation, and animal organs obtained subsequent to the passage of the Baneberry cloud. Analyses were made by conventional NaI scintillation crystal and Ge(Li) solid-state gamma spectroscopy. Pre- and post-Baneberry air radioactivity levels will be compared. Radioisotope data for nine radionuclides will be given for air filters exposed during passage of the Baneberry cloud, which contained a highly fractionated nuclear debris. The concentration of I 131 in thyroid glands of deer, sheep, and rabbits was also measured subsequent to the Baneberry event. The buildup and decay of I 131 in various environments in Utah will be described. A large sample of sheep thyroid glands obtained near Garrison, Utah, in mid-January 1971 was found to contain low but quantitatable levels of I 131. An analysis of the human hazard as the result of the Baneberry venting based on actual measurements and conditions during cloud passage, and on predictive models, will be made. Dose calculations for various radioisotopes have been made for a child living in northern Utah. (Auth)

<499>
Pendleton, R.C., C.W. Mays, R.D. Lloyd, and N.V. Hancock, University of Utah, Salt Lake City, UT; Utah State Department of Fish and Game, UT. 1964, May 16

Fallout Plutonium 239 and Zirconium 95 in the Lungs of Deer. Nature, 202(4933), 715-716

To evaluate the inhaled fallout activity in a man-sized mammal, lungs were analyzed from Utah wild deer (ODOCOILEUS H. HEMIONUS). The plutonium concentrations in 15 deer taken during February-April, 1962, averaged 0.05 pCi Pu 239/kg wet lung, ranging from 0.01 to 0.27 pCi/kg. Concentrations of zirconium 95 in the lungs of deer taken at various times ranged from 35 to 5,700 pCi/kg. Because of its 65 day half-life, zirconium 95 is present in fallout for several months after a fission explosion in the atmosphere. For comparison of the contribution by plutonium 239 and zirconium 95, the concentrations of several other fallout nuclides, in deer, and man are given in tabular form. (ST)

<500>
Pillai, K.C., Bhabha Atomic Research Center, Health Physics Division, Bombay, India. 1970

Aquatic Pollution Control Systematics for Discharge of Radioactive Effluents. CONF-700847; INIS-mf-160; Part of Proceedings of the COST Seminar on Pollution and Human Environment held in Bombay, India, August 26-27, 1970, (p. 164-191)

Since Bhabha Atomic Research Centre discharges low level radioactive liquid effluents into Bombay Harbor bay, detailed studies were undertaken to obtain data on dilution mechanisms in the bay, transport and diffusion of tracer discharged, and possible concentration of radionuclides in fish and crabs harvested from the bay and salt produced from bay waters. The concentration of Cs 137 and Sr 90 in these foods are given in tabular form. Radiation exposure to individuals consuming these foods was a small percent of the maximum permissible dose. On the basis of dose limits for population recommended by ICRP, average consumption rate for fish and the concentration of stable elements in sea water, salt and fish, the maximum permissible concentration of radionuclides in sea waters were evaluated. The operations were guided by these limits for waste releases into the aquatic environment. Post operational monitoring results indicated that the levels in sea water were never exceeded even in areas close to the discharge point. Radioactivity levels

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in silt and bottom sediments indicated higher concentrations of some radionuclides but radiation exposure from such sources were negligible. In the case of the freshwater environment of Chambal River-Rana Pratap Sagar, evaluation of acceptable limits for radiocontaminants were made utilizing the data obtained from preliminary studies at site. The limits were prescribed for the guidance of operations for control of waste release into the river. The limits will be reviewed when more data is available on the environment and its utilization. (Auth) (ST)

<501>
Romney, E.M., W.A. Rhoads, A. Wallace, and R.A. Wood, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA. 1971

Persistence of Radionuclides in Soil, Plants, and Small Mammals in Areas Contaminated with Radioactive Fallout. CONF-710501; Part of Nelson, D.J. (Ed.), Radionuclides in Ecosystems, Proceedings of the 3rd National Symposium on Radioecology held in Oak Ridge, Tennessee, May 10-12, 1971, Vol. 1, (p. 170-176), 1268 p.

The persistence of radionuclides in soil, plants, and small mammals was investigated periodically in areas contaminated with fallout from aboveground nuclear detonations at the Nevada Test Site. Study sites were established at various locations out to about 225 km from ground zero. Emphasis was placed upon the movement of Sr 90 and Cs 137 from abiotic to biotic components. Several neutron activation products also were studied in fallout areas located within 5 km of nuclear excavation tests. Radionuclides continued to be taken up through plant roots in small amounts, as time progressed, and some continued to be deposited on foliage as resuspended dust particles. The inhalation route of entry became less important with passing time, whereas ingestion continued to be the most important route through which radionuclides entered small mammals living in old fallout areas. Long-lived Sr 90 accumulated primarily in bone tissue, while Cs 137 accumulated in muscle and soft tissue. Most of the neutron activation products are short-lived but among those found in animal tissues were isotopes of Co, Mn, and W. Findings indicate that Sr 90 and Cs 137 will continue to move in small amounts from abiotic to biotic components in fallout-contaminated areas with passing time. (Auth)

<502>
Schiff, A., Lawrence Livermore Laboratory, Livermore, CA. 1973, August 14

Problems with Predicting Fallout Radiation Hazard in Tactical Battlefield Situations. UCRL-51440; 30 p.

Prediction capabilities are reviewed to determine whether they are suitable for describing the fallout radiation hazards that may exist in tactical nuclear battlefield situations. One aspect of fallout predictability is illustrated by a collection of aberrant results from nuclear tests conducted under fairly stabilized conditions; there are a number of warnings about the confidence that should be placed on prediction schemes derived from nuclear test shots. A comparison of current fallout models shows uncertainties including wind, terrain, rainout, and cloud parameters. Some consequences of depending upon faulty predictions are serious. The search for the best-of-all-possible prediction schemes will not lead to fruitful results because of the complexities involved; a set of limits to the upper and lower bounds to expected fallout should be adopted as a practical means of using prediction schemes for tactical warfare. It is emphasized that there is no substitute for hard data and that a computerized radiation data collection, reduction, and display system should be contemplated to satisfy the need to respond to fallout problems on the battlefield. (Auth)

<503>
Scott, L.M., Union Carbide Corporation, Y-12 Plant, Oak Ridge, TN. 1973

Environmental Monitoring and Personnel Protection in Uranium Processing. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 6. Springer-Verlag, New York, New York, (p. 271-294), 995 p.

The problems of environmental monitoring and personnel protection are reviewed and criteria and guidelines for establishing a monitoring program are given. To aid in setting guidelines, uranium is classified according to the rate that it leaves the critical organ. The type of process equipment design used depends on the specific activity of the material. A complete environmental monitoring system consists of general air sampling, diagnostic and breathing zone sampling, monitoring of stack emissions and effluents, surface contamination sampling, optional personal air samplers, and a study of particle size distribution in processing areas. The kind and extent of personnel monitoring depends upon the type of material and/or operation and past experience and is usually limited to urine sampling. In the case of processing of uranium materials enriched in U 235, in vivo lung monitoring by gamma spectrometry has come into routine use. For each type of monitoring, federal regulations and International Commission on Radiological Protection limits are given. The difficulty in establishing a relation between uranium in air and in vivo measurements with urine excretion rate is discussed. A general discussion of the more important points to be considered when establishing and conducting laboratory analyses for uranium in air and smear samples, soil and plant water discharges, and urine samples is given. (ST)

<504>
Sedlet, J., W.W. Golchert, and T.L. Duffy, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL. 1974, March

Environmental Monitoring at Argonne National Laboratory, Annual Report for 1973. ANL-8078; 85 p.

The results of the environmental monitoring program at Argonne National Laboratory for 1973 are presented and discussed. To evaluate the effect of Argonne operations on the environment, measurements were made for a variety of radionuclides in air, surface water, Argonne effluent water, soil, grass, benthos, and milk; for a variety of chemical constituents in surface and Argonne effluent water; and of the environmental penetrating radiation dose. Sample collections and measurements were made both on and off the

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Argonne site for comparison purposes. The results of the program are interpreted in terms of the sources and origin of the radioactive and chemical substances (natural, fallout, Argonne, and other) and are compared with accepted environmental quality standards. The Pu 239 concentrations in air averaged, respectively, 13 x 10(E-18) and 10 x 10(E-18) uCi/ml on and off the site, about one half of last year's values and well within the range reported by the AEC New York Health and Safety Laboratory for Pu for weapon tests. The monthly variations indicated a spring maximum similar to that observed in the stratospheric fallout of other radionuclides. Pu concentration in soil showed the same general range on and off the site. The average Pu 239 concentrations were 2.7 x 10(E-3) uCi/m2 on-site and 2,6 x 10(E-3) uCi/m2 off-site. The corresponding Pu 238 averages were 0.17 x 10(E-3) uCi/m2 and 0.22 x 10(E-3) uCi/m2. The Pu 239 content of grass was similar to that found in previous years both on and off the site, 0.1 x 10(E-6) to 0.3 x 10(E-6) uCi/m2. The Pu content of samples from the beds of a number of streams contained from 4 x 10(E-9) to 32 x 10(E-9) uCi/g of Pu 239, a range found in previous years to be normal for fallout Pu in such materials. Samples from 2 lagoons contained 62 x 10(E-9) uCi/g and 147 x 10(E-9) uCi/g respectively. (Auth) (RAF)

Table 8 shows plutonium, thorium, uranium and strontium concentration in air filter samples, 1973. Table 16 shows radioactivity in Sawmill Creek water, 1973. Table 17 shows Argonne National Laboratory radioactive effluent and dose values for Sawmill creek water, 1973. Tables 18 and 19 show radioactivity in De Plaines River water and Illinois River water, 1973. Tables 20 and 21 show Pu concentrations in onsite and offsite soil, 1973. Tables 22 and 23 show Pu 239 concentrations in grass and benthic material, 1973. Table 31 gives concentration guides and detection limits.

<505>
Sedlet, J., N.W. Golchert, and T.L. Duffy, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL. 1973, August; 1973, March

Environmental Monitoring at Argonne National Laboratory, Annual Report for 1972. ANL-8007; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 331-400), 1217 p.

The environmental monitoring program at Argonne National Laboratory for 1972 is described and the results are presented. To evaluate the effect of Argonne operations on the environment, measurements were made for a variety of radionuclides in air, surface water, soil, grass, benthos, and milk; for a variety of chemical constituents in surface and Argonne effluent water; and for the environmental penetrating radiation dose. Sample collections and measurements were made both on and off the Argonne site for comparison purposes. Air sampling for Pu was conducted on the Argonne site beginning in March. The Pu 239 and Pu 238 concentrations in monthly samples varied from 1 to 45 x 10(E-18) uCi, well within the range reported by the AEC Health and Safety Laboratory for fallout Pu in air samples collected away from nuclear installations. The average concentration was 27 x 10(E-18) uCi/ml for Pu 239 and 2.2 x 10(E-18) uCi/ml for Pu 238. Pu concentrations in soil showed the same general range and average concentrations on and off the site. The average Pu 239 concentration was (1.83 plus or minus 0.24 x 10(E-3) uCi/m2 and (1.63 plus or minus 0.29) x 10(E-3) uCi/m2 offsite. The Pu 239 content of grass was similar both on and off the site and ranged from 0.17 -0.67 x 10(E-6) uCi/m2, a factor of two thousand to five thousand lower than in soil from the same location. The results of the program are interpreted in terms of the sources and origin of the radioactive and chemical substances (natural, fallout, Argonne, and other) and are compared with accepted environmental quality standards. (Auth) (PHM)

Table 8 shows Pu, Th and U concentrations in air-filter samples on the Argonne National Laboratory site, 1972. Table 15 shows Pu concentrations in onsite soil, 1972. Table 16 shows Pu concentration in offiste soil, 1972. Table 17 shows Pu 239 concentrations in grass, 1972. Table 18 shows Pu concentrations in benthic material. Tables 12, 13 and 14 show radioactivity in Sawmill Creek water, Des Plaines River water, and Illinois River water, 1972.

<506>
Seidel, A., and V. Volf, Kernforschungszentrum Karlsruhe, Institut fur Strahlenbiologie, Karlsruhe, German Federal Republic. 1972

Rapid Determination of Some Transuranium Elements in Biological Material by Liquid Scintillation Counting. International Journal of Applied Radiation and Isotopes, 23, 1-4

A rapid and simple procedure combining acid digestion and liquid scintillation counting for determination of the activity of the transuranium elements, Pu 239, Am 241, and Cm 242, in animal tissues or fluids, is presented. Recovery and counting efficiency amounted to 98%. Counting efficiency was independent of organic residues and quenching factors. The lower limit of detection was about 20 pCi/g of fresh tissues and 0.3 nCi/g of fecal ash. (Auth) (ST)

<507>
Siek, R.D., and J.B. Baird, Colorado Department of Health, Denver, CO. 1972, November

Uranium Mill Tailings Problems in Grand Junction, Colorado. Health Physics Society Newsletter, 12-21

The problems resulting from use of uranium tailings for fill in the Grand Junction, Colorado area and studies and actions taken to alleviate the problems are reviewed. In particular the dangers of exposure to Ra 226, the most significant radioactive waste product in the tailings, and its radon daughters and the Indoor Radon and Indepth Studies are discussed. Preliminary results of the Indoor Radon Study are summarized. Results of air sample screening and integrated air sampling in working level (WL) ranges are given in tabular form. Results of house-to-house gamma screening surveys conducted through August 30, 1972 are also given in tabular form. Of 14,974 gamma screened locations about 22% or 3,362 locations were found to have tailings under or adjacent to the building. (ST)

<508>
Stannard, J.N., University of Rochester, School of Medicine and Dentistry, Rochester, NY. 1974, December

<508> CONT.
Standards for the Transuranic Elements. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 291-305), 327 p.

The basis of present standards of transuranic elements with a brief history of their derivation is given. Body burden standards for Pu are based on a large volume of biological work in rodents, dogs, and to some extent in primates and man. Findings suggest no major differences in the metabolism in the human as compared to the animal species. The empirical ratio of the toxicity of Pu relative to Ra found in animal experiments led to a reversal of proposed early standards based on energy considerations alone and to our present standards with bone as the critical organ. Body burden and stndards for organs other than bone, however, were calculated of that amount in the organ which will yield no more than the maximum allowable dose or dose rate. For most tissues it is 15 rem/year. The official primary standards for the transuranium elements remain, despite much controversy, fairly much the same as they were in 1959 except for some additions. Quick changes could be expected if serious flaws were found. The author recommends reexamination of standards in five specific areas: 1) changes in models and parameters using new biological information available since 1959 such as new values for some metabolic parameters, more versatile models, more knowledge about standard man, 2) cancer incidence relationships, 3) non-uniform distribution and hot-particle problems, 4) population exposure, and 5) lymph node problems. It is the author's view that some of the aspects of current recommendations regarding exposure to transuranics will be changed by national and international bodies. A downward alteration of present primary and derived standards is seen of magnitudes which would probably not strain current technology. (RAF)

<509>
Swinth, K.L., and P.N. Dean, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA; Los Alamos Scientific Laboratory, Los Alamos, NM. 1973, December

Intercalibration for Low-Energy Photon Measurements. CONF-720614; BNWL-SA-4227; Part of Proceedings of the 17th Annual Health Physics Society Symposium held in Las Vegas, Nevada, June 12-1 1972. Published in Health Physics, 25, 599-603

The "Intercalibration Committee for Low-Energy Photon Measurements" was formed to find a basis for discussion and comparison of plutonium whole body counting data and techniques. Basic data on photon intensities from the isotope of interest were accumulated and tabulated. Intercomparison of counting systems was performed using a source standard, and subjects who have been accidentally exposed to plutonium will be counted. The intercalibration indicated good instrumental control between laboratories (with the exception of 1) and indicated that calibration differences are primarily due to errors in calibration standards. Although the agreement between normalized sensitivities and backgrounds is generally good, the disagreement between practically identical detectors is unexplained. Difference in coincidence techniques (many of the detectors were CsI-NaI phoswichs), in effective areas of the detector and natural radioactivity of the construction materials may explain the differences. (HP)

Table 1 is a summary of the x ray intensity data collected for Pu, Am, U, Cm and Np. Table 2 shows background count rates and counting rates with 2.5 cm of added absorber. Figures 2 and 3 show the ratio of individual laboratory determined activity to mean activity of the laboratories for Pu 238 and Am 241 calibration sources. Figure 4 shows plots of normalized sensitivities (counts/min/nCi-Cm2) for Am 241 and Pu 238 sources with 2.5 cm of added absorber.

<510>
Telegadas, K., Environmental Science Services Administration, Air Resources Laboratories, Las Vegas, NV. 1968, January 1

The Seasonal Stratospheric Distribution of Cadmium 109, Plutonium 238 and Strontium 90. HASL-184; Part of Hardy, E.P., Jr. and Rivera, J., Fallout Program Quarterly Summary Report, September 1, 1967 through December 1, 1967, (p. I-53 - I-118), 406 p.

In the report all of the known stratospheric data on Cd 109, Pu 238 and Sr 90 are documented in the form of latitudinal cross sections of mean seasonal stratospheric concentrations and their inventories are listed to aid in the understanding and modeling of stratospheric motions through the use of radioactive tracers. The 0.2 dpm/1000 SCF isoline for Pu 238 progresses downward, more rapidly in the fall and winter seasons than during the spring and summer. The highest deposition values of Melbourne, Australia were observed during the Southern Hemisphere Spring of 1966 while at New York they occurred during the Northern Hemisphere spring and summer of 1967. (JMM)

<511>
Thomas, C.W., Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Program, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1973, April

Plutonium Concentrations in Surface Air at Richland, Washington. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 117-119), 152 p.; BNWL-1751 (Part 2); Part of Nielsen, J.M., et al, Annual Report for 1972, (p. 40-42), 116 p.

The atmospheric concentrations of Pu 238 and Pu 239 were measured in surface air samples collected at Richland, Washington from 1963 to 1972 as a part of a program to define the rates of long term stratospheric processes in the northern hemisphere as well as the rates of interhemispheric mixing. The seasonal variations in the concentrations of Pu 238 and Pu 239 in surface air were similar to those of other nuclear-weapons-produced radionuclides of stratospheric origin; maximum concentration occurred in the late spring and minimums occurred in the winter. The rate of decrease in the Pu 239 concentration from 1963 through 1967 correspond to a stratospheric half-residence time of 10 to 11 months. The Pu 239 concentrations remained fairly constant from 1967 to 1972, primarily because of yearly injections of Pu by thermonuclear tests conducted by the Chinese at Lop Nor, and the French in the South Pacific. From 1962

<511> CONT.
through 1965 both the Pu 238 and the Pu 239 in surface air at Richland came primarily from the 1961-1962 U.S.-Russian test series. The Pu 238/Pu 239, ratio averaged 0.015 in 1964. The ratio increased slightly in 1965; by the spring of 1966 it had increased to 0.042, indicating that Pu 238 from the 1964 SNAP-burnup over the Indian Ocean was present. Calculations indicate that Pu 238 in air from 1967 to 1971 came primarily from SNAP-9A. From 1967 to 1969 Pu remained fairly constant indicating that the Pu was being transferred across the equator into the northern hemisphere at a rate comparable to the rate at which Pu 238 was being deposited on the earth's surface. Concentrations of SNAP-9A have decreased rapidly since that time. (Auth) (RAF)

Table 1 shows the average yearly ratios of Pu 239, Pu 238 and Sr 90 in surface air at Richland, Washington.

<512>
Thomas, C.W., W.B. Silker, and C.E. Jenkins, Battelle Memorial Institute, Pacific Northwest Laboratories Atmospheric Sciences Program, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA; Battelle Memorial Institute, Pacific Northwest Laboratories, Physics and Instrumentation Department, Richland, WA. 1973, April

Behavior and Characteristics of Radioactive Debris from Chinese Nuclear Weapons Tests. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 114-116), 152 p.; BNWL-1751 (Part 2); Part of Nielson, J.M., et al, Annual Report for 1972, (p. 37-39), 116 p.

The concentrations of trace elements, cosmogenic radionuclides and nuclear-weapons-produced radionuclides were measured in air, precipitation, and seawater to study the rates of atmospheric and oceanic mixing, the rates of air-sea interchange, and the rates and mechanisms of precipitation scavenging. Radioactive debris from the Chinese nuclear test on March 18, 1972 was measured in air and in grass samples collected on two arcs from San Francisco to Seattle and from Texas to Chicago to determine the path of the debris, the rate of deposition on the earth's surface, and the I 131 dose to man. The concentrations of plutonium isotopes resulting from nuclear tests and from SNAP-9A nuclear generator burnup were measured in air samples collected from 1963 to 1972 at Richland, Washington. (Auth)

<513>
Toonkel, L.E., M. Schonberg, and H.L. Volchok, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1974, January 1

Health and Safety Laboratory Surface Air Sampling Program, the Quality of Analysis, 1972. HASL-278; Part of Hardy, E.P., Jr., Fallout Program Quarterly Summary Report, (p. I-2 - I-15), 163 p.

Radiochemical analysis in the Surface Air Sampling Program included Sr 89, Sr 90, Pu 238, stable lead and gamma emitters Be 7, Zr 95 and Cs 144. In general the quality of the radiochemical analysis and spectrometric analysis was satisfactory. A tendency toward a negative bias was present in most of the gamma spectroanalysis. (Auth) (RAF)

<514>
Volchok, H.L., Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1968, January 1

Fallout of Plutonium 238 From the SNAP-9A Burnup-III. HASL-184; Part of Hardy, E.P., Jr. and Rivera, J., Fallout Program Quarterly Summary Report, September 1, 1967 through December 1, 1967, (p. I-2 - I-10), 406 p.

Plutonium 238 was released by the disintegration of a SNAP-9A power source upon re-entry into the atmosphere in April of 1964. The Health and Safety Laboratory (HASL) initiated a sampling and analysis program in 1966 to document the deposition of material from the burn-up. Large area collections (about one square meter) of fallout are made each month at Melbourne, Australia and New York City. Results of the plutonium analyses are presented in tabular form and the Pu 238 to Pu 239, 240 ratios for each month are given. The actual monthly deposition of the SNAP-9A Pu 238 at the two sites is compared in a graph. It showed that the New York fallout of Pu 238 attributable to the SNAP-9A was unexpectedly greater than that at Melbourne for three out of four months--April through July 1967 and the seasonal effect is discussed. The hemispheric and worldwide deposits of the Pu 238 from SNAP-9A are summarized by months, through July of 1967. From these data it can be seen that in 1966 a little more than 1.3 kCi was deposited on the earth's surface while almost as much came down in the first seven months of 1967. The deposition rate increased substantially in 1967 and based upon the last five months a stratospheric half residence time of a little over three years was calculated. (FMM)

<515>
Volchok, H.L., and M.T. Kleinman, Health and Safety Laboratory, Environmental Studies Division, New York, NY. 1968, January 1

Surface Air Sampling Program. HASL-184; Part of Hardy, E.P., Jr. and Rivera, J., Fallout Program Quarterly Summary Report, September 1, 1967 through December 1, 1967, (p. II-6 - II-25), 406 p.

The spatial and temporal distribution of nuclear weapons debris in the surface air was studied. Since the last major nuclear weapon test series occurred at the end of 1962, only the longer lived artificially produced radionuclides were present in the filters analyzed prior to May 1966. Consequently, emphasis was given to the determination of Mn 54, Fe 55, Sr 90, Cd 109, Ce 144, Pu 238 and Pu 239. In samples collected after May 1966, following the Chinese and French nuclear weapons tests, additional shorter lived nuclides were analyzed such as Sr 89, Zr 95, and Ce 141. The activity concentrations in surface air during 1966 of the radionuclides investigated are presented for several locations tabular form. (FMM)

<516>
Volchok, H.L., and M.T. Kleinman, Health and Safety Laboratory, New York, NY. 1968, October 1

Radionuclides in Surface Air. HASL-200 (APP); Part of Fallout Program Quarterly Summary Report, June 1, 1967 through September 1, 1968, (p. C-1 - C-66), 363 p.

The spatial and temporal distribution of

<516> CONT.
nuclear weapons debris in the surface air from about 76 degrees North to 63 degrees South was studied. Analyses were done for the following radionuclides: Mn 54, Fe 55, Sr 90, Cd 109, Cs 137, Ce 144, Pu 238, Pu 239, Sr 89, Zr 95 and Ce 141. The activity concentrations for the radionuclides and the results of gross gamma analyses of surface air are reported in tabular form for several locations. (FMM)

<517>
Volchok, H.L., and M.T. Kleinman, Health and Safety Laboratory, New York, NY. 1971, October 1

Radionuclides and Lead in Surface Air. HASL-245 (APP); Part of Fallout Program Quarterly Summary Report, June 1, 1971 through September 1, 1971, (p. C-1 - C-102), 431 p.

The spatial and temporal distribution of nuclear weapons debris and lead in the surface air from about 81 degrees North to 90 degrees South was studied. Determinations were made of the following radionuclides Mn 54, Fe 55, Sr 90, Cd 109, Co 137, Ce 144, Pu 238, Pu 239, Sr 89, Zr 95 and Ce 141. In response to the growing concern over air pollution and the known hazard linked to stable lead, analysis for this element was added to the program. The activity concentrations for the radionuclides, gross gamma concentration in surface air and stable lead analyses are reported in tabular form for several locations. (FMM)

<518>
Volchok, H.L., and M.T. Kleinman, Health and Safety Laboratory, New York, NY. 1970

Radionuclides and Lead in Surface Air. HASL-224 (APP); Part of Fallout Program Quarterly Summary Report, December 1, 1969 through March 1, 1970, (p. D-1 - D-9), 399 p.

Since January 1963 the Health and Safety Laboratory has been conducting a program of sampling and analysis of radioactivity and lead in the surface air. Sampling stations along with their coordinates and elevations are listed. The activity concentrations for all of the radionuclides, gross gamma, and stable lead analyses completed to date are presented in tabular form. (ST)

<519>
Volchok, H.L., L. Toonkel, and M. Schonberg, Health and Safety Laboratory, New York, NY. 1973, July 1

Radionuclides and Lead in Surface Air. HASL-274 (APP); Part of Fallout Program Quarterly Summary Report, March 1, 1973 through June 1, 1973, (p. B-1 - B-114), 439 p.

The spatial and temporal distribution of nuclear weapons debris and lead in the surface air from about 76 degrees North to 90 degrees South was studied. The following radionuclides were determined: Mn 54, Fe 55, Sr 90, Cd 109, Ce 144, Pu 238 and Pu 239. In samples collected after some French or Chinese atmospheric weapons tests, additional short-lived nuclides were analyzed, such as Sr 89, Zr 95 and Ce 141. The activity concentrations for the radionuclides, gross gamma concentrations in surface air and stable lead analyses are reported in tabular form for several locations (FMM)

<520>
Voss, M.D., Iowa State University, Ames Laboratory, Ames, IA. 1973, August; 1973, February

Survey of Environmental Radioactivity, January 1, 1972-December 31, 1972. IS-3048; WASH-1259; Part of Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites, Calendar Year 1972, (p. 285-329), 1217 p.

A report is given of the environmental monitoring program of the Ames Laboratory of the USAEC including the Ames Laboratory Research Reactor (ALRR). The environmental program consists of determination of gross alpha and beta radioactivity in air, soil, vegetation, river water, ALRR outfall, bottom sediment, precipitation, well water, and pond water samples. The average radioactivity concentration in air for 1972 was 3.0 x 10(E-15) uCi/ml alpha and 1.2 x 10(E-13) uCi/ml beta. This is the normal background at the sampling location. There was no measurable increase in airborne radioactivity attributable to Ames Laboratory operations. The alpha and beta radioactivity in stream water was determined upstream and downstream from the confluence point of streams forming the drainage pattern from the ALRR. The average concentration during 1972 for all samples not in the direct flow (pustream) was 7.2 X 10(E-10) uCi/ml alpha and 6.5 x 10(E-9) uCi/ml beta. In the direct flow pattern (downstream) the average concentration was 6.3 x 10(E-10) uCi/ml alpha and 5.7 x 10(E-9) uCi/ml beta. There is no measurable radioactivity in the stream water samples attributable to Ames Laboratory operations. (Auth)

Several pages are devoted to environmental radioactivity data.

<521>
Wollenberg, H.A., Lawrence Berkeley Laboratory, Berkeley, CA. 1974, January

Radioactivity of Nevada Hot-Spring Systems. LBL-2482; 14 p.

Field gamma radiometry and laboratory gamma ray spectrometry of waters and spring deposits were accomplished for some hot-spring systems in northern Nevada. Gamma-ray dose rates measured onsite range from 2 to 500 uR/hr, and depend mainly on the amounts of the natural radioelements in the spring deposits. At several locations Rn 222, emanating from the water causes recognizable gamma ray anomalies. High radioactivities, primarily from Ra 226, are associated with hot-spring systems dominated by CaCO3, while silica dominated systems are relatively low in radioactivity. Gamma spectrometry disclosed the enrichment of Ra 226 with respect to its parent U in CaCO3 dominated systems. Ra 226 preferentially associates with Ca; therefore, where tufa and siliceous sinter are present in a deposit, the calcareous material is highest in radioactivity. Spring deposits at fast-flowing CaCO3 dominated systems are generally less radioactive than calcareous deposits at slower flowing springs. (Auth)

<522>
Casarett, A.P., Cornell University, New York State Veterinary College, Department of Physical Biology, Ithaca, NY. 1968

Radiation Physics. Part of Radiation Biology, Chapter 2. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, (p. 7-30), 368 p.

This chapter covers basic radiation physics including a review of atomic structure, definitions, alpha and beta emissions, physical half-life, radioactive series, and sources and types or radiation. In order to understand the mechanism of radiation action on biological systems, the different ionizing radiations are compared. (ST)

<523>
Cooper, J.A., P.O. Jackson, J.C. Langford, and M.R. Petersen, Battelle Memorial Institute, Pacific Northwest Laboratories, Radiological Sciences Department, Richland, WA. 1973, April

Characterization of Actual and Simulated Uranium Mine Atmospheres. BNWL-1750 (Part 1); Part of Thompson, P.C. (Ed.), Annual Report for 1972, (p. 51-52), 103 p.

Radioactivity versus particle size studies in exposure chambers containing Rn daughters with U ore dust and/or diesel engine exhaust showed activity peaks for all Rn daughters at approximately 0.1 um. The chamber receiving Rn daughters alone contained up to 30% unattached RaA with high diffusion rates. X ray fluorescence analyses showed Ti, V, Fe, Cu, Zn, Pb and U at levels ranging from 0.06% to 2.5% in airborne U ore in chambers and mines. High molecular weight polycyclic hydrocarbons correlated closely with soot loading at different size levels. (Auth)

<524>
Denham, D.H., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1969

Health Physics Considerations in Processing Transplutonium Elements. CONF-680607; Part of Proceedings of the 13th Annual Health Physics Society Symposium held in Denver, Colorado, June 16-20, 1968. Published in Health Physics, 16, 475-487

The radiation hazards of elements 95 through 99 (americium-einsteinium) are compared with Pu 239. Most of the transplutonic nuclides decay by alpha particle emission and have higher specific activities than Pu 239. This increased specific activity creates potentially greater contamination control problems, greater alpha-neutron reactions, and more x and gamma rays per unit mass than experienced with plutonium. The spontaneous fission half lives of these radionuclides are orders of magnitude shorter than for Pu 239, leading to prompt fission neutron and gamma exposures not heretofore encountered. Disregarding fluorescent radiation, the combined gamma and neutron dose rate from tens of kilograms of Pu 239 is equivalent to that from grams of Cm 244, tenths of grams of Am 241, and only micrograms of Cf 252. The transplutonium elements provide a unique combination of hazards--high radiotoxicity, external exposure potential, and criticality--which makes their control a challenge to the practicing health physicist. (Auth)

<525>
Kigoshi, K., Gakushuin University, Department of Chemistry, Mejiro, Tokyo, Japan. 1971, July 2

Alpha-Recoil Thorium 234: Dissolution Into Water and the Uranium 234/Uranium 238 Disequilibrium in Nature. Science, 173(3991), 47-48

A radioactive disequilibrium state between U 238 and U 234 has been observed in natural waters. The probability of dissolution of Th 234 atoms produced by the alpha decay of U 238 located near the surface of solid silicate particles contributing to the disequilibrium state was investigated. The amount of Th 234 in the aqueous phase of a system consisting of fine zircon powder and diluted nitric acid or sodium carbonate solution was observed to increase with time. The rate of ejection of alpha-recoil Th 234 into solution gave an alpha-recoil range of 550 angstroms. Ejected alpha-recoil Th 234 atoms may supply excess U 234 in groundwater and contribute to the supply of U 234 in the sedimentary column of pelagic sediments. (ST)

<526>
Sehmel, G.A., and P.D. Lloyd, Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Program, Richland, WA. 1973, April

Influence of Soil Resuspension on the Airborne Particle Size Distribution. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 1-5), 152 p.

The airborne particle size distribution function of resuspended soil has been determined as a function of particle diameters from 1 to 230 um and sampling heights form 0.3 to 30m. An apparent lower limit is determined for the size distribution function. Soil resuspension can cause relatively high soil injection rates into the atmosphere which increase the magnitude of the size distribution function above this lower limit. The soil resuspension rates are a direct function of the hours of high wind speed occurring during dusty time periods. However, the resuspension rates must also be a function of the persistence of these high winds since less resuspension occurred for the same total hours of high winds when these hours were accumulated over a longer time period. (Auth)

<527>
Sehmel, G.A., and M.M. Orgill, Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Program, Richland, WA. 1973, April

Resuspension by Wind at Rocky Flats. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 15-22), 152 p.

Airborne plutonium concentrations are being related to meteorological parameters at Rocky Flats in anticipation that these data will increase understanding of environmental resuspension processes. Weekly airborne plutonium concentrations measured at one station have shown the best correlation with wind direction and speed, gustiness, precipitation, and snow cover. A model was developed which relates airborne plutonium concentrations at the station to wind speed for one time period from July 1970 to January 1971. (Auth) (ST)

<528>

PHYSICAL ASPECTS

<528>
Silker, W.B., and C.W. Thomas, Battelle Memorial Institute, Pacific Northwest Laboratories, Environmental and Life Sciences Division, Radiological Sciences Department, Richland, WA. 1969, June

Fractionation of Radionuclides During Nuclear Testing. BNWL-1051 (Part 2); Part of Nielsen, J.M., et al, Annual Report for 1968, (p. 108-110), 234 p.

A study of the size of particles with which various radionuclides combine following a nuclear detonation showed that the concentrations of Cs 137, Sr 89, and Ba 140 increased as the particle size decreased, and the quantities of Ru 103, I 131, I 133, and others present decreased with particle size. This fractionation of fission products was explained with respect to the member of the isobar present at the time of particle formation. The isobars 89, 90, 91, 137, 140, and 141 are formed as either noble gases or alkali metal isotopes with a significant half-life and their association with particles is delayed either until the chain has decayed to its alkaline earth member or until the particles have cooled to a temperature below the boiling point of the alkali metals. Thus these mass chains are associated with the small particulates resulting from delayed condensation of material vaporized by the nuclear device. The isobars 103, 131, 133, and 141 originate with elements that are more refactory and are thus available for condensation with the larger particles formed by exposure of environmental material introduced into the fireball. Fission product fractionation is also demonstrated by a direct correlation between the air concentrations of fission products and the half-life of their respective gaseous or volatile precursors. (Auth) (ST)

<529>
Chesne, A., Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France. 1971, February

Some Aspects of the Production of Transuranium Elements in France. CONF-700930; EUR-4612 d-f-e; Part of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 62-68), 660 p. (French, English summary)

Development of the production program of transuranium elements during the last decade in France is briefly reviewed. The chemical processes currently used or being studied are discussed and the production facilities are mentioned. (ST)

<530>
Flakus, F.N., W. Weinlander, and H.J. Born, Institut fur Radiochemie der Technischen, Hochschule Munchen Garching, German Federal Republic. 1971

Gamma Dose Rate of Americium 241 After Long-Term Irradiation with Reactor Neutrons. CONF-700930; EUR-4612 d-f-e; Part of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 353-362), 660 p. (German, English summary)

During the production of Cm 242 by irradiation of Am 241 with reactor neutrons, a series of fission products are generated that sharply increase the gamma dose rate of the samples. In order to provide adequate protective shielding during production, the gamma dose rate of several samples was measured. Samples of Am 241 up to 1 g in weight were irradiated for a period of several weeks in the reactors at Karlsruhe and Mol. The time dependent change of dose rate for long periods after irradiation is given in tabular form. (ST)

<531>
Ghiorso, A., Lawrence Berkeley Laboratory, Berkeley, CA. 1971, July; 1973

A History of the Transplutonic Elements. LBL-213; Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 16. Springer-Verlag, New York, New York, (p. 691-715), 995 p.

A history of the discovery of the transplutonic elements, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, lawrencium, rutherfordium, and hahnium, is described. The development of experimental and theoretical techniques from early intuitive approaches to modern sophisticated approaches is traced over a twenty-seven year period. The production and identification of alpha emitting isotopes of elements 106 and 107 is predicted and techniques for their production are given. The possibility of reaching an island-of-stability in a region of nuclides near neutron number 184 and proton numbers 114 or 126 by bombardments of the heavy elements with superheavy ions is discussed. (ST)

<532>
Hohlein, G., and R. Gasteiger, Kernforschungszentrum Karlsruhe, Karlsruhe, German Federal Republic. 1971

The Actinide Project of the Gesellschaft Fuer Kernforschung mbH, Karlsruhe. CONF-700930; EUR-4612 d-f-e; Part of Proceedings of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 69-84), 660 p.

A survey is given of work done so far in the Federal Republicof Germany on production of transuranium elements. On the basis of experience gathered in the course of this work, the Gesellschaft fuer Kernforschung is launching a program for the production and application of actinides. The aim of the project is to produce the quantities of Pu 238, Cm 244 and Cf 252 needed in order to prepare the way for industrial use, and to establish the technical requirements in conjunction with the industry. (Auth)

<533>
Nelson, I.C., A.J. Haverfield, and W.W. Schultz, Battelle Memorial Institute, Pacific Northwest Laboratories, Biology Department, Richland, WA. 1968, May

Production and Dosimetry of Experimental Quantities of Plutonium 237. BNWL-714; Part of Thompson, R.C., et al (Eds.), Annual Report for 1967, (p. 5.24-5.26), 253 p.

Plutonium 237, an electron capture isotope which emits a 60 keV gamma ray and K alpha and K beta x-rays of Np 237, was produced in experimental quantities. This material is being investigated for use in Pu metabolic studies in animals with possible extension to use in human testing. (Auth)

<534>
Barker, J.J. (Ed.), Long Island University, C.W. Post College, Greenvale, NY. 1969, January

Californium 252. CONF-681032; Proceedings of a Symposium held in New York, New York, October 22, 1968, 376 p.

The californium 252 symposium was held to help develop industrial applications of californium 252, make industry aware of progress on applications, and provide information on the problems and potentials of industrial use of this radionuclide. Sixteen papers describing the potential production of californium in large quantities and its application to a wide spectrum of practical and beneficial uses were presented. The papers described the discovery of californium 252, its nuclear, physical and chemical properties, and the means and plans for its production in large quantities; as well as numerous foreseeable practical applications. Three papers were abstracted separately for the data base. (ST)

<535>
Berger, R., R. Boucher, and J.C. Derian, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France. 1972

France's Program for the Production and Use of Plutonium 238. A/CONF-49/P-637; CONF-710901; Part of Proceedings of the 4th International Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 6-16, 1971, Vol. 14, (p. 237-255)

In its Transuranium Project the Commissariat a l'Energie Atomique (CEA) has placed particular stress on studies relating to the

<535> CONT.
production and use of plutonium 238. The Pu 238 required to meet these needs was prepared by irradiating Np 237 in the Celestin production reactors and Am 241 in the Osiris research reactor. Techniques for chemical separation, preparation of pure metallic Pu 238 and production of sealed sources have been studied and developed by the Nuclear Research Centre (CEN) at Fontenay-aux-Roses. The CEA has contributed to the development of ways to use Pu 238 by joining in the work of the isotopic battery study group (European Atomic Energy Agency--ENEA), which has mainly centered on questions of safety. The sources made available to various institutions abroad engaged in the study and development of isotopic batteries meet the specifications contained in the practical guide on safety matters compiled by ENEA. Furthermore, joint action with the Delegation generale a'la recherche scientifique et technique, in association with the CIT Alcatel Co. and the Broussais Hospital, has led to the construction of a prototype relay heart stimulator, manufactured by the Medtronic Co. The first human implantations in the world were made at Broussais Hosptial during the months of April and May 1970. Other applications are envisaged for plutonium 238; in particular this isotope seems to provide an ideal solution to the problem of powering a thermodynamic machine that can act as an artifical heart inside the human body. To evaluate the uncertainties associated with developing and making broader use of the artifical heart technqiue, the CEA has undertaken an inquiry based on the Delphi procedure. The comparison and statistical grouping of opinions given by a hundred experts questioned under a sequential sampling program has made it possible to determine the extent of the probable demand for artificial hearts and to throw more light on the feasibility of using this technqiue on a broader scale in France. A similar study has been undertaken within an all-European context in collaboration with ENEA. (Auth)

<536>
Jacobs, D.G., Oak Ridge National Laboratory, Health Physics Division, Nuclear Safety Information Center, Oak Ridge, TN. 1968

Sources of Tritium and Its Behavior Upon Release to the Environment. TID-24635; ORNL-NSIC-39; 90 p.

A state-of-the-art study is presented that reviews published information on tritium production and the pertinent factors that affect the behavior of tritium in the environment. Estimates are made for production and accumulation of tritium in an expanding nuclear power economy, including the impact of an increased tritium production on local and worldwide populations. Other topics covered are the properties of tritium and tritium compounds, sources of tritium production and its release in fuel processing plants and thermonuclear reactors, procedures for tritium enrichment, monitoring practices and instruments for the detection and assay of tritium and movement in air, soil, surface water and groundwater. (FMM)

<537>
Kato, M., and H. Amano, Tokyo University, Institute of Industrial Science, Tokyo, Japan. 1972, November

Development of Radioisotope Products and Fission Products. Genshiryoku Kogyo, 18(11), 24-28 (Japanese)

Current processes and future methods to be used for the recovery and usage of radioisotopes in wastes in Japan are outlined. These include use of radioisotopes for electric generators and large radiation sources with recovery of the noble gases; current methods of fission product recovery; future techniques for recovery of transuranium elements and fission products including installation of a pilot plant with waste recovery capabilities; and formation of a collective system for development and utilization of radioisotopes. International cooperation is encouraged. (ST)

<538>
Not given, Tokai Works, Power Reactor and Nuclear Fuel Development Corporation, Tokai, Ibaraki, Japan. 1973, December

Tokai Works Semiannual Progress Report, January - June, 1973. PNCT-831-73-02; 122 p.

The main activities of the Tokai Works are the development and fabrication of plutonium-bearing fuels, the research and development of centrifugal uranium enrichment technology, the construction of the Tokai Reprocessing Plant, and the related research and development work. The Progress report contains 21 articles, two of which were abstracted separately for the data base. They deal with the development of a thermoluminesent dosimeter for personnel dosimetry and a method for the determination of Pu in biological specimens such as urine and feces. Included in the other papers are tests done during fuel fabrications and evaluation of reactor cloddings. (FMM)

<539>
Seaborg, G.T., J.L. Crandall, P.R. Fields, A. Ghiorso, O.L. Keller, Jr., and R.A. Penneman, U.S. Atomic Energy Commission, Washington, DC; Savannah River Laboratory, Aiken, SC; Argonne National Laboratory, Argonne, IL; Lawrence Berkeley Laboratory, Berkeley, CA; Oak Ridge National Laboratory, Oak Ridge, TN; Los Alamos Scientific Laboratory, Los Alamos, NM. 1972

Recent Advances in the United States of America on the Transuranium Elements. CONF-710901; STI/PUB/300; Part of Proceedings of the 4th International Symposium on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland, September 6-16, 1971, (p. 487-528)

In the period of time elapsed since the Third International Conference on the Peaceful Uses of Atomic Energy, two additional synthetic elements have been synthesized, many new isotopes of the known transuranium elements have been identified, and theories of nuclear stability have been developed which hold further prospects for creating a new family of elements in the atomic number range of 110 to 126. The paper covers highlights of transuranium research in the United States of America over the past few years, being addressed to new elements and isotopes, the physics and chemistry of the known transuranium elements and hypothetical super-heavy elements, the search for these elements in nature, and the large-scale production of transuranium elements for use in research and practical applications. (Auth)

<540>
Willrich, M., and T.B. Taylor, University of

<540> CONT.
Virginia, Charlottesville, VA; International Research and Technology Corporation, Arlington, VA. 1974

Nuclear Theft: Risks and Safeguards. Ballinger Publishing Company, Cambridge, Massachusetts; 252 p.

The authors analyze the possibility of nuclear violence using fissionable material that might be stolen from the U.S. nuclear power industry and discuss safeguards that will reduce the risk of theft to a low level. The study contains no classified information. It describes in general terms how nuclear explosives and radiological devices can be made, where in the nuclear power industry the materials for making such weapons are present, and why and how various groups within society might attempt to obtain and use them. This information and the analysis derived from it are used to explain security risks inherent in the development and widespread use of nuclear power and to provide a basis for consideration of various safeguards. This information is contained in the following chapters: nuclear weapons, nuclear fuel cycles: 1973-80, nuclear power scenarios: 1980-2000, U.S. safeguards against nuclear theft, risks of nuclear theft, nuclear safeguards: basic considerations, safeguard measures, and costs of safeguards. The last chapter contains conclusions and recommendations. (ST)

<541>
Andreeva, O.S., M.S. Yegorova, and G.M. Parkhomenko, Institute of Biophysics, Moscow, USSR. 1973

Assessment of Radiation Safety and Efficiency of Prophylatic Measures in Natural Uranium Operation. CONF-720503; Part of Bujdoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 145-147), 655 p.

Working with uranium the personnel are exposed to the effects of various radiation factors. The most potential hazard is associated with the inhalation of uranium aerosols. Therefore, the effective air protection in the working premises from penetrating aerosols and the maintenance of radiation parameters at the levels not exceeding the average annual permissible concentrations are very important. It is important to control the uranium aerosol concentrations and to estimate the uranium content in the body and critical organs. The workers are also exposed to external gamma and beta radiation. The greatest amounts of alpha-active aerosols are produced in the drying, pounding, and annealing, of the powdered compounds. The most effective method of the protection is the use of sealed equipment and glove boxes. The concentrations of the alpha-active uranium aerosols did not exceed the permissible level and ranged, within 0.02-0.1 mg/m3. Maximum beta and gamma radiation levels were observed at the thermal treatment of metallic uranium due to the redistribution of uranium daughter products in the surface layer. Thus, the beta-ray irradiation was 230-470 beta particles/cm2 sec at a distance of 0.5-0.3 m from the block of the metallic uranium. Close to the block the intensity of the radiation exceeded 500 beta-particles/cm2 sec. After cleaning the blocks and removing the slag, the level of the beta radiation decreased by 40-60%. At melting and treatment of metallic uranium the gamma-ray dose rates were 0.2-2.5 uR/sec measured close to the products. So, the individual radiation doses of the exposed workers were considerably below the permissible level and equal to 0.004-0.005 rem/day. This is due to the mechanization of loading-unloading operations, installation of automatic processing lines and the remcte control and regulation. (PMM)

<542>
Domning, W.E., Dow Chemical Company, Rocky Flats Division, Golden, CO. 1970, December

New Fire Protection Systems for Filter Plenums. CONF-700816 (Vol. 2); Part of First, M.W. and Morgan, J.M., Jr., (Eds.), Proceedings of the 11th AEC Air Cleaning Symposium held in Richland, Washington, August 31-September 3, 1970, (p. 791-806), 969 p.

A fire test facility has been constructed at Dow, Rocky Flats,consisting of a glovebox and a filter plenum which contains 12 filters. The purpose of this facility is to study the effects of a fire originating within the glovebox on the entire glovebox system which includes the filter plenum. The details of construction of the facility are shown and the results of several experiments are discussed to show the capability of the facility. Exhaust air temperatures from burning shielded gloveboxes range between 1530 to 1620 degrees F. In order to maintain filter integrity under these conditions it is necessary to ccol the air stream prior to filtration. The most successful air cooler tested has been a water spray-cooled baffle inserted upstream of the initial stage of filtration. This baffle was effective in cooling 1672 degrees F incoming air to 125 degrees F within one minute after actuation. (Auth)

<543>
Drent, W., and W. Hunzinger, Eurochemie, Mol, Belgium. 1971, February

Application of Transuranium Elements and Related Safety Aspects. CONF-700930; EUR-4612 d-f-e; Part of Proceedings of a Symposium on Radiation Protection Problems ELATING TO Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 99-113), 660 p.

The paper focuses on the application of transuranium elements as radiation and energy sources where high energy densities are required and where the choice of the source is fixed by several limiting factors such space or weight. It enumerates those transuranium elements used in prototypes, series, or in future projects. The related safety problems are manifold and difficult, especially as transuranium elements are more and more applied in industry and public services by persons not used to working with radioactive materials. For specific applications very few standard regulations are established for ensuring adequate protection for the users. Appropriate proposals related to the various health and safety aspects are outlined. (Auth)

<544>
Ettinger, H.J., J.C. Elder, and M. Gonzales, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973, July

Performance of Multiple Hepa Filters Against Plutonium Aerosols for Period January 1 through June 30, 1973. LA-5349-PR; 11 p.

Field sampling has provided general criteria defining plutonium aerosol size characteristics and activity concentrations from typical plutonium operations. Two fabrication facilities have aerosols with activity median aerodynamic diameter's (AMAD) ranging from 2 to 5 um; the two research and development facilities indicate AMAD's ranging from 1 to 4 um; and a recovery facility consistently shows a sub-micron aerosol with a typical AMAD of 0.3 um. This recovery facility also produces aerosols as small as 0.1 um AMAD, has the highest activity concentration, and constitutes the most difficult air cleaning problem. Using laboratory produced plutonium test aerosols with size characteristics similar to those defined by the field sampling program, multiple HEPA filter systems were evaluated to provide quantitiative data defining performance of successive stages of HEPA filters, and filter performance as a function of particle size. Test data show that the first and second HEPA filter each provide overall efficiencies in excess of 99.99%, while the third HEPA filter provides an average efficiency in excess of 99.8%. These performance levels exceed AEC requirements. Data defining performance of the first and second HEPA filters as a function of plutonium aerosol size show that HEPA filter efficiencies are in excess of 99.99% for sub- micron plutonium aerosols. Theoretical calculations estimating alpha

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RADIATION, SAFETY AND CONTROL

<544> CONT.
radiation dose to the filter fibers from particles collected on the fibers indicate a dose on the order of 10(E+6) rads per minute. (Auth)

<545>
Haynes, C.E., Oak Ridge National Laboratory, Oak Ridge, TN. 1971

Transuranium Element Health Physics and Safety at Oak Ridge National Laboratory. CONF-700930; EUR-4612 d-f-e; Part of Proceedings of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held at Karlsruhe, Germany, September 21-25, 1970, (p. 291-325), 660 p.

The health physics and safety design and operating aspects of production and research programs of the Transuranium Processing Plant (TRU) and the Transuranium Research Laboratory (TRL) at the Oak Ridge National Laboratory (ORNL) are reviewed. The health physics and safety design and operating aspects involve two principal areas--prevention and analysis. Prevention is concerned with the custom engineering of necessary physical and administrative safeguards into each facility and its operating program based on the hazards anticipated in the event of the "maximum credible accident". The analysis program routinely involves assessing hazards in the work area and monitoring quantitatively personnel radiation exposures and radioactive contamination levels. It also includes the special investigation and analyses of radiation accidents. A parameter referred to as the HE^{D}, which is considered to express the amount of a radionuclide that is equivalent in inhalation hazard to 1 g Pu 239, is used in determining minimum containment facilities required for radioactive operations of various types. Hot cells and shielded manipulator boxes are used at both TRU and TRL installations to provide necessary gamma and neutron shielding; isolation laboratories equipped with fume hoods and gloved boxes provide necessary contamination control of these highly toxic materials. Containment is achieved by the use of well designed ventilation systems and absolute filters that are tested in situ for their efficiency. Various potential operational problems may arise in research and production operations with the transuranium elements. Typical problems include (1) fires and combustion explosions, (2) miscellaneous releases of radioactive material, (3) filter clogging and filter failure, (4) puncture wounds, (5) hand exposures, (6) radiation monitoring problems, and (7) cyclotron contamination. Consideration is given to problems such as these in training personnel and in planning new programs. ORNL has been successful in carrying out the tranuranium element operations well within the maximum permissible exposure limits. (Auth) (PMM)

Table 2 gives "g" values for lung and bone (critical organ) for selected list of transuranium nuclides.

<546>
Holliday, B., United Kingdom Atomic Energy Authority, Harwell, Didcot, Berkshire, England. 1971, February

Radiological Protection of Workers Handling Transuranium Elements. CONF-700930; EUR-4612 d-f-e; Part of Proceedings of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 483-514), 660 p.

The primary purpose of routine environmental monitoring is to check the working environment and confirm that operating conditions are satisfactory. The paper outlines how the results of environmental monitoring in a facility handling transuranium elements can be used to achieve this purpose and to define a routine individual monitoring program. Significant changes in the averages of the monitoring levels over an extended period can and should be used as the basis for regular reviews of the scheduled routine programs. Routine monitoring results also provide the primary trigger for special investigation of the individual in terms of retention of transuranium elements in the body. Derived working levels and investigation levels have been proposed for assessing environmental conditions and triggering special investigations respectively. (Auth)

Table 2 gives the biologically significant quantities for the transuranium elements.

<547>
Hunzinger, W., Swiss Working Party on the Safety of Nuclear Batteries, Bern, Switzerland. 1972

Safety Aspects of Incorporated Radiation Sources. CONF-720519; Part of Proceedings of the 2nd International Symposium on Power from Radioisotopes held in Madrid, Spain, May 29-June 1, 1972, (p. 805-808), 986 p.

The safety principles of isotopic sources implanted in a freely moving human are outlined. They focus on the exposure of other people to penetrating radiation, on partial loss of the radioactive material, i.e., exposure to contamination, and on total loss of control over the source. The control of exposure of persons other than the bearer are achieved by (1) the selection of the isotope, (2) its purity, and (3) its quantity. In the prevention of loss of material, confinement is the only possible safety measure. Containment of the implanted material shall maintain its function not only during contact with body fluids, but also under extreme environmental conditions (burial, cremation, exposure to glaciers, shafts, seawater) and for very long periods. The most difficult safety target is the assurance that the radioactive source, after its mission is completed, still is under safety control. In order to minimize the risk of losses of implanted radiation sources administrative controls are foreseen together with stringent measures for the containment of isotopic fuel. (Auth) (RAP)

<548>
Konig, W., W. Rossbander, and R. Ott, National Centre for Radiation Protection of the GDR, Berlin, German Democratic Republic; German Academy of Sciences in Berlin, Central Institute of Nuclear Research, Rossendorf, German Democratic Republic. 1973

Handling of Accidental Contaminations. CONF-720503; Part of Budoso, E. (Ed.), Health Physics Problems of Internal Contamination, Proceedings of the IRPA 2nd European Congress on Radiation Protection held in Budapest, Hungary, May 3-5, 1972, (p. 287-289), 655 p.

Wide-spread contaminations with sealed

<548> CONT.
sources of Sr 90, Am 241, and Ir 192 radioisotopes caused by accidents in handling are discussed. The differences between the prescribed and realized measures are explained. The results of monitoring for surface-contamination and internal-contamination as well as of the medical examination of persons involved are presented. The contribution of such accidental contaminations to the exposure of occupationally exposed personnel is discussed. (Auth)

<549>
Langham, W.H., and J.W. Healy, Los Alamos Scientific Laboratory, Los Alamos, NM. 1973

Maximum Permissible Body Burdens and Concentrations of Plutonium: Biological Basis and History of Development. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 12. Springer-Verlag, New York, New York, (p. 569-592), 995 p.

The evolution of protection standards for plutonium is reviewed in approximate chronologic order. Emphasis is placed on those biological observations that had the most impact on the derivation of current values. The chapter is subdivided chonologically beginning with radiation protection criteria prior to 1943 and ending with current (1971) standards. (ST)

<550>
Lindays, J.W., D.F. Michaels, and J.A. Martinez, Dow Chemical Company, Rocky Flats Division, Golden, CO. 1973, February 12

Scavenging Contaminated Soil with Polyurethane Foam. RFP-1949; 10 p.

Polyurethane foam has been evaluated as a stabilizing agent for radioactively contaminated soils. Results show that the foam can be applied efficiently to a wide variety of terrain and soils to form a lasting protective coating. In addition, the foam has a high capacity for picking up contamination, soil, and rocks, and has a relatively low cost. Its mechnical properties make handling and disposal easy. Plants covered totally by foam are killed presumably by smothering rather than by the toxicity of the foam. A laboratory procedure has been devised to measure quantitatively the ability of foams to pick up particulate materials by which comparisons between foams can be made. (Auth) (RAP)

<551>
Liverman, J.L., R.E. Yoder, Jr., H.Z. Wrenn, B.G. Bennett, W.J. Bair, W.W. Burr, Jr., C.R. Richmond, R.C. Thompson, J.N. Stannard, and B.W. Wachholz (Comp.), U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Washington, DC. 1974, December

Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects. WASH-1359; Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings held in Washington, D.C., December 10-11, 1974, 327 p.

The material was prepared in response to a notice which stated the intent of the U.S. Environmental Protection Agency to hold public hearings to evaluate the environmental impact of Pu and the other transuranium elements and to consider whether new guidelines or standards were needed to assure adequate protection of the general ambient environment and of the public health from potential contamination of the environment by radionuclides of these elements. Twelve articles have been abstracted separately for the data base. These include papers on worldwide distribution of Pu, environmental pathways of transuranic elements, transuranic elements in the marine environment, biomedical effects of Pu on humans, biological effects of transuranium elements in experimental animals and some material pertaining to standards and control measures, as well as a critique of the Tamplin-Cochran proposal for revision of the current Pu exposure standards. (FMM)

<552>
Morgan, K.Z., Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1961

Growth and Development of Health Physics and Responsibilities in the Field of Radiation Protection. Part of Rajewsky, B. (Ed.), Proceedings of the 9th International Congress of Radiology held in Munich, Germany, July 23-July 30, 1959, Vol. 2. Georg Thieme Verlag, Stuttgart, Germany, (p. 1146-1155), 1625 p.

Health physicists, as a group engaged in research, engineering, education, and applied activities were first organized in 1942 just prior to the operation of the first man-made nuclear reactor. Their activities involve the study and practice dealing with any and all factors relating to damage from ionizing radiation and the prevention of such damage. In the early years, there were many new and difficult problems; how and in what units to measure neutron dose; what RBE to assign to neutrons and alpha radiations; how to dispose of radioactive waste, how to work with thousands of curies of the extremely dangerous plutonium 239 without getting it into the body and if taken into the body, how to accelerate its rate of elimination; what maximum permissible concentration of plutonium 239, strontium 90 and hundreds of other newly discovered radionuclides to allow in air and water; how to measure the body burden of these radionuclides; how to prevent criticality accidents; how to train health physicists. Today health physicists are assigned responsibility for the safe operation of nuclear reactors, high voltage accelerators, isotope separation plants, metallurgical and chemical operations, and industrial radiography. Emphasis is placed on the benefits from ionizing radiation and the immediate and long range risks involved. (EBM)

<553>
Morgan, K.Z., Oak Ridge National Laboratory, Oak Ridge, TN. 1962, July

Techniques of Personnel Monitoring and Radiation Surveying. Part of Snell, A.H. (Ed.), Nuclear Instruments and Their Uses, Vol. 1, Chapter 7. John Wiley and Sons, Inc., New York, New York, (p. 391-469), 494 p.

This chapter describes techniques of personnel monitoring and radiation surveying and is of particular interest to the health physicist. The discovery and uses of ionizing radiation are traced and the role of the health physicist is reviewed. Radiation protection is discussed under the headings: working with radioactive materials, maximum permissible levels of radiation exposure,

<553> CONT.
instruments required by a small laboratory and their use, the health physicist, special monitoring problems, disposal of radioactive waste, and emergency precautions. Although the discussion is written for the laboratory that handles large amounts of radioactive substances, it is of value to industries, universities, and hospitals. Relative hazards of radionuclides, NCRP and ICRP regulations, personnel monitoring instruments for different situations, and personnel decontamination methods are reviewed. An adequate health physics program at all institutions is emphasized. (ST)

<554>
Morgan, K.Z., and C.P. Straub, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1952, April 4

External and Internal Exposure to Ionizing Radiation and Maximum Permissible Concentration (MPC) of Radioactive Contamination in Air and Water Following an Atomic Explosion. AECU-2332; 17 p.

If an atomic bomb is exploded at sufficient elevation to take full advantage of blast and thermal effects, there ordinarily will not be an appreciable amount of surface radioactive contamination. In case of an underwater or underground explosion the total curies of fission products per kilogram of uranium or plutonium fissioned at any time, t, in seconds after the explosion is given approximately by the equation C sub beta = 2.7 x 10(E+13) t(E-1). In addition there would be a small fraction of the contamination due to induced activity and fissile material from the bomb. If a person entered a contaminated area at t sub o hours after the atomic explosion where the dose rate was P sub o reps per hour and remained until t sub 1 hours after the explosion, the approximate total dose, D, in reps from external exposure is given by the equation D = 2.3 sub o t sub o log sub 10 (t sub 1) (t sub o). It is estimated that the emergency values of MPC of the radioisotopes in uCi/cc is given approximately by the equation MPC = K t (E-1.2), for the time interval from 30 min to 3 yrs following the explosion. If time, t, is given in days, K = 10(E-3) for drinking water contaminated with any expected contaminant emitting alpha, beta or gamma radiation. In case of contaminated air, K=10(E-7) for beta or gamma emitting radioisotopes or 5 x 10(E-10) for alpha emitting radioisotopes. (Auth)

Figure 1 gives results of the fission of 1 kg of Pu, of which half the escaped neutrons are captured in soil and half in water and 0.5 kg of unfissioned plutonium escapes as alpha emitting contamination.

<555>
Newbery, G.R., Radiochemical Centre, Amersham, England. 1964, March

Measurement and Assessment of Skin Doses from Skin Contamination. AHSB(RP)-R-39; Part of Wray, E.T. (Ed.), Proceedings of a Symposium on Radiation and Skin held in Winfrith, England, November 14, 1963, (p. 44-68), 102 p.

In order to assess skin dose after a contamination incident involving radionuclides, measurements must be made to determine the amount of activity on the skin and the length of time, the extent of penetration of the surface of the skin, which radionuclides were involved and their characteristics, and the depth in tissue at which the dose must be assessed. The practical requirement is to relate the observed counting rate at the surface of the skin with the dose rate, usually at the basal layer. This paper derives such relations for three typical nuclides, carbon 14, a pure beta emitter of low energy; phosphorus 32, a pure beta emitter of fairly high energy; and plutonium 239, an alpha emitter. Calculations were carried out and attempts were made to interpolate for intermediate situations. It was concluded that for skin contamination, particularly with alpha emitters, the assessment of dose is bound to be only an approximation, unless the distribution of activity with depth is accurately known. Only in rare cases will this be possible, for example when some of the skin is excised and can be examined by autoradiography or by sectioning. In practice, the dual uncertainty of the distribution of activity with depth and with time makes the dosimetry of skin contamination very inaccurate. (BBM)

<556>
Not given, U.S. Environmental Protection Agency, Radiation Office, Washington, DC; U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health, Rockville, MD. 1971, December

Third Annual National Conference on Radiation Control, New Horizons. CONF-710562; DHEW(FDA)-72-8021; BRH/ORO-72-2; Proceedings of a Symposium held in Scottsdale, Arizona, May 2-6, 1971, 378 p.

The proceedings of the Third Annual National Conference on Radiation Control, May 2-6, 1971, in Scottsdale, Arizona are presented. Cosponsors were the Conference of Radiation Control Program Directors, the Bureau of Radiological Health of the Department of Health, Education, and Welfare, and the Radiation Office, Environmental Protection Agency. Two papers have been abstracted separately for the data base. Participants, representing all state and major local radiation control programs, as well as federal agencies, concentrated on healing arts x ray exposure to the public and environmental radiation protection issues including the levels of fallout (tritium, Pu 238, Pu 239 and Kr 85 in the environment and I 131, Sr 89, Sr 90 Cs 137 in milk). In addition to formal presentations and educational seminars, the proceedings contain the reports of workshops dealing with specific x ray and environmental radiation exposure problems. Resolutions by the Conference of Radiation Control Program Directors and the new directions and organizational philosophy of the Environmental Protection Agency are also included. (Auth) (PMM)

<557>
Not given, Reynolds Electrical and Engineering Company, Inc., Nevada Test Site, Mercury, NV. 1968, July

Radiological Emergency Operations, Instructor's Manual. TID-24918; 219 p.

The Instructors' Manual provides guidance and information for the preparation and conduct of a course in Radiological Emergency Operations. The course includes the study of emergency response organization, emergency radiation monitoring theory and applied

<557> CONT.
techniques, radiation safety practices, emergency equipment and procedures, nuclear weapons accident hazards, and legal and public information considerations. The manual includes: a schedule for conducting the entire course in ten days, a list of publications recommended as texts for the course, information on where to obtain the recommended texts, a bibliography of references, movie films for use in this course and where to obtain them, outlines for each class period, sample quizes and final examination, and suggested course evaluation and review sheets. (Auth)

See also Student's Manual, TID-24919.

<558>
Not given, Reynolds Electrical and Engineering Company, Inc., Nevada Test Site, Mercury, NV. 1968, July

Radiological Emergency Operations, Student's Manual. TID-24919; 425 p.

The Student's Manual provides guidance and information for the student attending the ten-day Radiological Emergency Operations course. The manual includes: the schedule of classes, a list of publications recommended as texts for the course, information on where to obtain the recommended texts, a bibliography of references, movie films used in this course, a brief outline of the subject matter covered in each lesson, study questions and answers on the main points in each lesson, and technical reference information pertinent to the subjects covered. Section 4 of the manual contains a chapter on each of the twenty-two subjects covered in the lessons. Among these topics are: radiation detection instruments, air sampling techniques, radioactive materials (including U, Pu, Th, I, Cs, Tritium and Sr), radiological accidents, biological effects of radiation, emergency team operating procedures, safe handling of radioisotopes, decontamination, and legal and press responsibilities. (Auth) (PMM)

See also Instructor's Manual, TID-24918.

<559>
Not given, International Atomic Energy Agency, Vienna, Austria. 1973

Radiation Protection Procedures. STI/PUB/257; Safety Series No. 38; 198 p.

The three principles which can be applied to prevent or control the exposure of personnel to radiation hazards are: (a) Remove the hazard, (b) guard the hazard, and (c) guard the worker. The first is an obvious one, the second implies the proper design of work places and the provision of appropriate equipment and shielding to ensure the maximum amount of protection, and the third refers to the measures required to make a periodic check on the continuing adequacy of the controls, the personal protection measures and the equipment. These topics are discussed in the manual, and also the management of radioactive wastes, transport of radioactive materials, decontamination and radiation accidents and emergency procedures. A collection of useful health physics data is presented in tabular form in the annex of the book. (PMM)

<560>
Not given, University of Washington, Nuclear Reactor Laboratories, Seattle, WA. 1972

Plutonium Contamination Incident of June 13, 1972. Part 1. DOCKET-50139-1; 30 p.

During a series of experiments in progress at the University of Washington Nuclear Reactor, 24.2 g of plutonium 239 were irradiated resulting in a contamination of the reactor room and exposure of personnel. Incidents leading to the release, dosimetric measurements, and recovery of the contaminated area are reported. Permissible air concentration standards were exceeded and the actual air concentration at one point was 1.4 x 10(E-10) uCi/ml. Instantaneous total plutonium burden on a student exposed was 12.5 nonocuries. Additional whole body counts on the student and others are planned. (BBN)

<561>
Not given, Kerr-McGee Corporation, Kerr-McGee Center, Oklahoma City, OK. 1971, November 13

Cimarron Plutonium Production Plant, License SNM-1174, Section E, Appendix D Statement. DOCKET-70 1193-2; 12 p.

Descriptions of the physical facilities, processing techniques, and waste treatment at the Cimarron Plutonium Production Plant are given. Reasons why plant operation should not be suspended during completion of the NEPA environmental review are stated. During 18 months of operation 3.45 uCi of plutonium have been released. It is concluded that operation of the plant has no adverse effects on the environment. (ST)

<562>
Peyresblanques, H., Commissariat a l'Energie Atomique, Marcoule, France. 1971, February

Radiation Protection in a Reprocessing Plant and Study of the Different Safety Factors. CONF-700930; EUR-4612 d-f-e; Part of Proceedings of a Symposium on Radiation Protection Problems Relating to Transuranium Elements held in Karlsruhe, Germany, September 21-25, 1970, (p. 403-418), 660 p.

Safety in a reprocessing plant is dependent on technical and psychological factors. The different aspects are reviewed and several typical accidents are studied as regards their origin, their consequences and the means to prevent them. The review is supplemented by statistical data on risk distribution and doses absorbed by personnel working in reprocessing plants. (Auth)

<563>
Schubert, J., and R.E. Lapp, Not given. 1957

Radiation: What It Is and How It Affects You. The Viking Press, Inc., New York, New York; 314 p.

The topic, radiation, is introduced by a discussion on the "awesome cloud" that resulted from the atomic bomb explosion over Hiroshima. The history of rays is discussed, as well as the damage caused by its misuse. Radiation hazards, effects of radiation on tissues, maximum permissible dose, effects of radiation on the fetus and embryo in animals and man and genetic effects of radiation are presented. Accidents leading to the accumulation of Pu in the body are mentioned

<563> CONT.
such as the 27 individuals at Los Alamos and workers at the Canadian atomic energy plant at Chalk River. The measurement of Pu in the body is discussed and also treatment using chelates. Some case histories of accidental exposure to Pu 239 are given. Fallout from bomb tests is discussed with reference to the Bravo bomb detonated on March 1, 1954 and the fallout from it onto the Japanese fishing boat, the Lucky Dragon Number 5. Measurements of Sr 90 in dairy products and content in bones are given. Suggestions for bringing radiation hazards under control and thus minimizing the assault upon the future of the race are presented. (FMM)

<564>
Shappert, L.B., W.A. Brobst, J.W. Langhaar, and J.A. Sisler, Oak Ridge National Laboratory, Nuclear Safety Information Center, Oak Ridge, TN. 1973, November 11

Probability and Consequences of Transportation Accidents Involving Radioactive Material Shipments in the Nuclear Fuel Cycle. CONF-731105; Part of Proceedings of the Winter Meeting of American Society of Mechanical Engineers held in Detroit, Michigan, November 11, 1973. Published in Nuclear Safety, 14(6), 597-694

For 1980 the projected electrical generating capacity of nuclear power plants in the United States is about 130 MWe; this, in turn, will generate thousands of shipments of radioactive materials annually. The probability of accidents involving these shipments within the public domain has been estimated and broken down into five severity categories. It is estimated that in 1980 the shipments considered would be involved in less than 20 accidents, most of which would result in only moderate damage to the shipping system and no significant nuclear-related hazards. An estimate was made of the effect of an extremely severe accident involving loss of contaminated coolant from a spent-fuel shipping cask and the possible exposure to the public. As a result of the estimates, it is concluded that the likelihood of any serious radiological injury is very small and the transportation of nuclear materials in the fuel cycle has a high degree of safety. (Auth)

<565>
Smith, R.C., L.G. Faust, and L.W. Brackenbush, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1973, May

Plutonium Fuel Technology. Part 2: Radiation Exposure from Plutonium in LWR Fuel Manufacture. Nuclear Technology, 18, 97-108

Personnel radiation exposure problems in fabricating and handling plutonium fuels are described. The effects of variation in plutonium isotopic composition, due to differences in reactor types and fuel exposure and the resultant combined effects on personnel radiation exposure, are also described. It is concluded that increased shielding will be required for plutonium fuel fabrication facilities when full-scale plutonium recycle is under way, due to the higher radiation levels associated with high exposure plutonium and to more restrictive personnel radiation exposure limits than those currently used. However, it should be possible to handle completed plutonium fuel assemblies containing high exposure plutonium without excessive personnel exposure and with a minimum of special handling procedures. (Auth)

<566>
Spoor, N.L., and J.B. Hursh, University of Rochester, Rochester, NY. 1973

Protection Criteria. Part of Hodge, H.C., et al (Eds.), Handbook of Experimental Pharmacology, Uranium, Plutonium, the Transplutonics, Chapter 5. Springer-Verlag, New York, New York, (p. 241-270), 995 p.

The history of development of protection criteria for uranium in air and water is outlined and the principles on which protection criteria are based are reviewed. The calculation of limits for radioactive nuclides in the working environment is based on the general premise that injury is caused by and directly proportional to the energy absorbed per gram of tissue. Energy absorbed from alpha particles is ten times as effective as that absorbed from beta particle emissions. For bone seeking radionuclides, except radium isotopes, an additional effectiveness factor of five is applied. A second premise is that dose rate limits are set sufficiently low so as to take into account lifetime accumulations. Methods of setting limits depend on the critical endpoint--chemical toxicity or radiation injury--and the organ involved. Maximum permissible concentrations for industrial workers and modifications for application to the general public according to ICRP, NCRP, and ACGIH practices are given. The value of routine urinary assay is discussed. Practical considerations applicable to industrial conditions--uranium solubility and enrichment--are also included. (ST)

<567>
Sternglass, E.J., Not given. 1972

Low-Level Radiation. Ballantine Books, New York, New York; 214 p.

The book describes a battle of over 10 years to bring evidence of harmful effects of low-level radiation before the scientific community and the world. This book is directed to the lay audience with some emotional overtones. The author attempts to call public attention specifically to radiation damage to infants and unborn. 143 references are cited. (RAF)

<568>
Thompson, R.C., Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1974, December

Implications with Respect to Protection Criteria. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 271-289), 327 p.

The problem ofPu and other transuranic elements in the environment is reviewed in its most basic aspects. The problem is explained in the manner that an exposure to some noxious substance results in an undesirable effect and in order to control the exposure at a level that does not produce an unacceptable effect, a standard is established. Three kinds of exposure are described, namely the levels that produce

<568> CONT.
effects in animals, the levels that have occurred in man, and the levels where protection of the general populace from Pu effects is required. The effects of exposure are considered for man and animals and the problems of extrapolations to estimate the health consequences in humans are discussed. The cancer risk predictions, stated in terms of cancers produced per million person-rems are described. A graph is given plotting average organ dose equivalent, to bone or lung, in rem, against effect in unspecified units. It is concluded that "as low as practicable" is a good idea fcr Pu exposure standards in view of the uncertainties present. Exposure of total populations should be controlled at some fraction of natural background levels, because it is only in this range of exposure that tere is assurance of insignificant effect--an assurance based upon the survival, over past eons, of the human race. Because the dispersal of Pu among the general populace will be quite non-uniform, limitations on person rems cannot be accepted as a totally adequate basis of control. Instead, control must be based on environmental monitoring with attention paid to food chains and inhalation pathways. The potential for genetic effects from Pu deposited in gonads is mentioned and concern is expressed for exposure of the very young members of the population since they are usually considered to exhibit an enhanced radiosensitivity. (FMM)

Figure 5 shows average organ dose equivalent to bone or bone, in rem, and against effects in unspecified units.

SOURCES

<569>
Yoder, R.E., U.S. Atomic Energy Commission, Division of Operational Safety, Washington, DC. 1974, December

Potential Source Terms and Control Measures. WASH-1359; Part of Liverman, J.L., et al, Proceedings of the U.S. Environmental Protection Agency Plutonium Standards Hearings on Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects held in Washington, D.C., December 10-11, 1974, (p. 13-86), 327 p.

This review is intended to highlight the AEC actions in managing its transuranic materials operations. Included are the current source of transuranium materials within the AEC operations, an indication of projected inventories, and an overview of control measures taken to reduce effluents. There have been releases of Pu and these have been well publicized. The quantities of materials involved in these instances have ranged from much less than one to a few kilograms of material, and steps have been taken to reduce the accident potential in AEC operations. The major Pu releases associated with AEC plant operations have occurred at Oak Ridge, Rocky Flats, Richland, and Mound. A comparison of the quantities released to the quantities in use shows that a very small amount has been released in accidents. All routine emissions are now very low and still decreasing. Because the AEC is concerned about environmental discharges and any attendant buildup in the environment, it is fully implementing the "as low as practicable" concept. For example, if routine emissions continue at the present levels by the year 2000 less than 3 additional curies of Pu will be discharged to the environment compared to the kilocurie quantities already present from atmospheric weapons testing. The intensive environmental sampling program which quantifies the amount of Pu in the environment and its specific location in identified pathways provide confirmation that the control programs are effective. Information developed in this program will be available and analyzed well before a potential problem exists and will allow ample time to take effective action. In those instances in which environmental cleanup actions have been required, specific measures tailored to the situation have been used. (RAF)

Figure 1 summarizes the total Pu release data from all AEC sites having significant releases for the year 1967-1973. Supplemental information is given on potential Pu source terms for medical uses, waste management of transuranic solid waste, space nuclear systems operations, overview on Pu and transuranics source terms and operations, overview on reactor research and development programs areas source terms and operations, costs of Pu facility improvements, radioactive material spread by fire, weapon radioactivity spread by detonation impact, and radioactive material spread by aircraft crash.

<570>
Anderson, J.D., Atlantic Richfield Hanford Company, Richland, WA. 1973, April 9

Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During 1972. ARH-2757 (Part 3); 141 p.

The radioactive liquid wastes that have been discharged to ground within the Chemical Processing Division control zone are summarized in tabular form. Data for 1972 and cumulative data since plant start up are presented. Individual tables list radioactive waste activity discharged to individual ponds, cribs, and specific retention sites. The wastes discharged during 1972 to each site are detailed on a month to month basis in tables 4 through 40. New this year is a listing of decayed activity to the various plant sites. The tabular data includes volume in liters and Pu, beta, Sr 90, Ru 106, Cs 137, Co 60, and U activity in g or Ci. (ST)

<571>
Belter, W.G., U.S. Atomic Energy Commission, Office of Environmental Affairs, Washington, DC. 1972, December

Deep Disposal Systems for Radioactive Wastes. Memoir No. 18; Part of Cook, T.D. (Ed.), Proceedings of a Symposium on Underground Waste Management and Environmental Implications held in Houston, Texas, December 6-9, 1971. The Collegiate Press, George Banta Company, Inc., Menasha, Wisconsin, (p. 341-354), 412 p.

Geochemical research and extensive field exploration and demonstration studies have been carried out on several deep disposal systems for radioactive wastes, including the application of hydrofracturing techniques in bedded shale for low-heat-producing wastes and the use of bedded salt and crystalline bedrock for highly radioactive wastes. The Atomic Energy Commission has adopted a regulatory policy which requires that all high-level liquid wastes from licensed irradiated-fuel-reprocessing plants must be solidified and shipped to a national repository on land owned and controlled by the federal government. A tentative selection of a site near Lyons, Kansas, has been made for an initial salt-mine repository for the demonstration of long-term storage for both solid high-level and long-lived alpha-contaminated wastes. Because of a general requirement for adequate monitoring to assure the safe and effective operation of a deep-well injection system, this method has not been used generally for disposal of radioactive wastes. It appears that injection into deep permeable formations may be a practical solution for the disposal of large quantities of tritium-bearing wastes from water reactors and nuclear-fuel-reprocessing plants in the future. Additional research is also required on the potential deep disposal of noble gases such as krypton 85 from reactor and reprocessing-plant off-gas streams. It is estimated that by the year 2000, between 2 and 3 million cu. ft. (56,000-84,000 m3) of alpha contaminated wastes will be generated annually as a result of the expanding nuclear power industry, including fast-breeder reactor development. Because of the Pu contamination, deep underground disposal of these wastes may also be needed. Extensive field investigation will be required to assess quantitatively the geohydrologic suitability of specific sites to receive high activity and Pu-contaminated wastes. (Auth) (FMM)

<572>
Clark, W.E., and W.C. Ulrich, Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN. 1973, November

Pressurized Aqueous Combustion of Alpha-Contaminated Waste, Final Program Status Report. ORNL-TM-4366; 42 p.

This report describes the status of the Pressurized Aqueous Combustion of Alpha-Contaminated Waste Program (formerly called the Plutonium Burning Program) at the time it was canceled on June 1, 1973. Results of laboratory investigations involving reaction studies, liquid and gaseous effluent cleanup problems, and corrosion research are summarized. The status of the process flowsheet design, the equipment design and procurement, and the construction of an engineering-scale experiment capable of treating 0.1 ton of combustible waste per day on a continuous basis is discussed, and some equipment cost data are presented. Recommendations for further laboratory work and pilot-plant development are also included. (Auth)

<573>
Denham, D.H., D.A. Baker, J.K. Soldat, and J.P. Corley, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA. 1973, September

Radiological Evaluations for Advanced Waste Management Studies. BNWL-1764; 42 p.

Adequate risk evaluations of waste disposal concepts include estimates of radiation doses that might be received by humans of releases of such materials should occur to man's immediate environment. The evaluations should indicate incentives for additional radionuclide separations in high-level waste (waste partitioning) to reduce any eventual radiation exposure in the event of such an occurrence. A comprehensive dose computational model, was used to assist in evaluating alternative means for disposal of high-level waste. Typical input terms include source terms (radionuclide release rates to man's immediate environment) and dilution factors. Outputs include individual pathway doses and total doses to maximum individuals for both an urban and a rural population. Whole body doses plus doses to other critical organs are obtained, as well as the fractional dose contributions of individual nuclides. Doses for one year or total doses for fifty years of exposure are available. Examples of dose calculations are included to demonstrate use of the methodology for a hypothetical geological disposal concept, with direct release to man's immediate environment after storage periods ranging from 100 to 1,000,000 years. The most significant nuclides in terms of dose will vary with time and mode of release, but are likely to be Sr 90 and Cs 137 at 100 years, americium and plutonium at 1,000 to 10,000 years, and uranium daughters at longer periods. (FMM)

Tables show radiation dose to individuals and populations from hypothetical surface water and airborne releases. Appendix D gives a table of radioactivity in waste accumulated through year 2000.

<574>
Hanson, G.L., Atlantic Richfield Hanford Company, Richland, WA. 1971, January 29

Radioactive Effluent Reduction from 200 Area Facilities. ARH-1972; 28 p.

A comprehensive study of radioactive wastes discharged to the environs in 200 areas was made in 1967. It was found that gaseous waste emission guides were being met for the discharge of I 131, Sr 90, mixed fission products, and Pu 239. Treatment systems for reduction of NO2 from several stacks were proposed. A prototype system is presently being tested on UO3 plant stack gases. Proposed treatment of liquid wastes emphasized removal of the long-lived radionuclides (Sr 90, Cs 137, Pu 239) from those streams being discharged to the environs. Significant reductions of radioactivity to the ground have been realized during the past three to four years. Annual discharges of radioactivity (total beta, Pu, Co 60, Sr 90, Cs 137) to the ground in liquid wastes from 1965 to 1969 are presented in tabular form. The radioactivity content of waste streams discharged to the environment is under continuous surveillance. Further major reductions in radioactive discharges are planned to meet the goal of less than ten grams of plutonium and less than four hundred total beta curies. Other plans include facilities for plutonium effluent cleanup, separations effluent control, and for low-level effluent analysis. The above goal should be realized by the end of CY-1975 by installation and beneficial use of these facilities, the shutdown of the Redox waste concentrators, further refinement of the Purex process condensate recycle and/or reevaporation systems and lower analytical detection capability. The disposal of wastes to an undergound field from the Plutonium Reclamation Facility is discussed and future plans are described. (FMM)

<575>
Healy, J.W., T.J. Hirons, M.M. Thorpe, K.A. Pashman, G.R. Waterbury, and E.B. Fowler (Comp.), Los Alamos Scientific Laboratory, Los Alamos, NM. 1972, December

Transuranic Waste Repository Studies. LA-5127-MS (Vol. 1); 18 p.

The progress of the Los Alamos Scientific Laboratory's effort related to the Transuranic Waste Repositories studies for the period July 1-November 1, 1972 is reviewed. Literature values reporting thermal and radiolytic degradation of certain wastes, and waste storage problems related to products of degradation are discussed. Preliminary data on the chemical characterization of several waste types and their implications in storage of transuranic wastes are reported. The rational for screening stations and monitoring of large volumes of solid waste is developed as well as preliminary radiological considerations for the twenty year storage of transuranic waste. Dose rates and heat loads are probably of small concern with Pu 241 a possible exception, however, package integrity (under shallow earth burial) poses serious problems which are being investigated. (Auth)

<576>
Kirby, H.W., D.E. Blane, and R.I. Smolin, Mound Laboratory, Miamisburg, OH. 1973, February

Process for Removing Radioactive Wastes from Liquid Streams. CONF-721030; Part of Proceedings of the AEC Pollution Control Symposium held in Oak Ridge, Tennessee, October 25-27, 1972, (p. 480-515), 549 p.

A process is under development at Mound Laboratory to remove radioactive waste (principally plutonium 238) from process water prior to discharge of the water to the Miami River. The contaminated water, as normally received, is at a pH between 6 and 9. Under these conditions, plutonium in all its oxidation states is hydrolyzed; however, the level of the radioactive solids varies from about 50 ppM down to about 50 ppB and the plutonium remains in a colloidal or subcolloidal condition. The permissible concentration for discharge to the river is about 50 parts per trillion. Pilot plant tests show that 95-99% of the radioactive material is removed by adsorption on diatomaceous earth. The remainder is removed by passage through a bed of either dibasic or tribasic calcium phosphate. Ground phosphate rock is equally effective in removing the radioactive material if the flow rate is controlled to permit sufficient contact time. Parameters for optimizing the process are now under study. Future plans include application of the process to wastes from reactor fuels reprocessing. (Auth)

<577>
Knoll, K.C., Battelle Memorial Institute, Pacific Northwest Laboratories, Chemistry Department, Richland, WA. Not given

Reaction of High Salt Aqueous Plus Organic Waste with Soil, Interim Report. BNWL-CC-313; 8 p.

A study was made to determine if it would be feasible to put a high salt, acidic aqueous waste mixed with organic compounds into a Z-1A tile field. The factors considered were the extent of adsorption of plutonium and americium by the soil and the effect on the infiltration of the waste into the soil by the organic compounds present. It was concluded that soil has considerable capacity for high salt, acidic waste containing organic compounds and can imbibe it almost as readily as water. These data, obtained from column measurements in the laboratory, would be less favorable than those obtained in the field as the moisture cannot spread horizontally in a column. Uptake of plutonium by the soil was very minor and of americium negligible. (Auth)(RAF)

<578>
Lohse, G.E., Allied Chemical Corporation, Idaho Chemical Programs Operations Office, Idaho Falls, ID. 1972, January

Safety Analysis Report for the ICPP High-Level Solid Radioactive Waste Storage Facilities. ICP-1005; 155 p.

At the Idaho Chemical Processing Plant, radioactive solid wastes resulting from fluidized-bed calcination of extraction-column raffinates and nuclear facilities decontamination solutions are stored in stainless steel bins contained within buried concrete vaults. A safety analysis of the storage facilities indicates that they are capable of withstanding natural occurrences such as earthquakes, tornadoes, high winds, or floods without serious damage or spread of radioactive materials to the environment. A full range of fission

<578> CONT.
products exists in the calcined solids. Total plutonium concentration is 0.009 Ci/kg in fluoride type waste and 0.016 Ci/kg in nonfluoride type waste. In previous studies the rate of leaching of transuranics from calcined solids by water was shown to be very low. (Auth) (ST)

<579>
Mishima, J., and L.C. Schwendiman, Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Program, Richland, WA. 1973, April

Airborne Release of Plutonium and Its Compounds During Overheating Incidents. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 28-32), 152 p.

A study has been in existence for some time to evaluate the amount and distribution in aerodynamic size fractions of plutonium airborne under some conditions found in postulated accidents. Two recent studies are covered here. Data are presented from forty experiments performed in the wind tunnel in the Radioactive Aerosol Release Test Facility to measure releases under various combinations of parameters involving uranium (a plutonium simulant) forms, surfaces, wind speed and the presence or absence of a gasoline fire. The second study involves airborne release during the burning of contaminated waste in the Radioactive Aerosol Release Tank. (Auth)

<580>
Mishima, J., and L.C. Schwendiman, Battelle Memorial Institute, Pacific Northwest Laboratories, Atmospheric Sciences Program, Richland, WA. 1973, April

Fractional Airborne Release of Radioactivity During the Burning of Contaminated Solvents. BNWL-1751 (Part 1); Part of Simpson, C.L., et al, Annual Report for 1972, (p. 26-27), 152 p.

Laboratory scale experiments are being conducted to indicate the airborne release of radioactive materials in the event of a fire involving flammable solvents used in the separation of nuclear materials. The fractional release of materials during the burning of 30 percent normal tributyl phosphate in a kerosene diluent is being measured. The solvent contains realistic amounts of materials representative of those found in contaminated process solvents--uranium, cesium, cerium, zirconium, iodine, and ruthenium. Trace quantities of active isotopes are used to follow the distribution of the materials except in the case of uranium. Release measured thus far under nominal conditions (distillation of the diluent) have been under 1%. (Auth)

<581>
Not given, U.S. Atomic Energy Commission, Division of Operational Safety, Washington, DC. 1973, May

Monitoring, Control and Disposal of Tritium, A Selected Bibliography. TID-3337; 74 p.

References to 351 publications that have appeared in NSA, Volume 21 (1967) through Volume 26 (1972), are contained in the bibliography. The references were retrieved from the NSA data base using the computerized RESPONSA search system and were formatted for publication with indexes by the generalized output program GENOUT. The NSA subject indexing is displayed under each citation to provide information on the contents of the document. The bibliography was prepared to assist in certain Atomic Energy Commission tritium effluent central studies and for the use of others who may have an interest in tritium handling, monitoring and disposal practices within the AEC and private industry. (FHM)

<582>
Not given, Battelle Memorial Institute, Pacific Northwest Laboratories, Nuclear Waste Technology Department, Richland, WA. 1973, August

Overview of High-Level Radioactive Waste Management Studies. BNWL-1758; 42 p.

This report is a summary of activities at the Pacific Northwest Laboratory related to the management of high-level radioactive wastes. Two of the major areas being investigated are waste fixation--converstion of the waste to a stable solid form and advanced disposal concepts--a systematic evaluation of candidate disposal methods. Technology is being developed through the pilot plant scale to incorporate the high-level waste into extremely immobile solid forms. The objective of these forms is to minimize the possible rate of waste release to man's environment should the containment system for the waste be breached. Specific investigations are currently centered on the production of stable, low solubility silicate glasses. Alternative concepts for ultimate disposal of solidified high-level radioactive wastes are being evaluated on a systematic basis. The evaluation includes consideration of technical feasibility, safety, cost, environmental impact, policy conflicts, public acceptance and research and development needs. Waste disposal concepts under evaluation include geologic, seabed, ice sheet and extraterrestrial disposal as well as transmutation (transforming by irradiating certain waste constitutents into elements having more desirable waste management characteristics). As a complement to studies on waste fixation and advanced disposal concepts, studies are being conducted on waste partitioning (separation of radionuclides in waste into different elements or groups of elements according to their suitability for different disposal methods). Application of this technique is useful for some disposal alternatives and it may improve overall waste disposal technology. In addition, radiological evaluations are being conducted to assess by what means radionuclides in waste could contact man, assuming the primary waste containment barrier fails. (ST)

<583>
Not given, Organizatcn for Economic Cooperation and Development, Paris, France. 1973

Management of Radioactive Wastes from Fuel Reprocessing. CONF-721107; Proceedings of a Symposium held in Paris, France, November 27-December 1, 1972, 1266 p.

The 46 papers presented during the various sessions of the symposium as well as the ensuing discussions showed the considerable evolution in the past few years of the methods for the control of gaseous effluent releases and for the treatment and storage of highly-radioactive wastes. Six papers were abstracted separately for the data base. Among the topics discussed are the future

<583> CONT.
implications of some long-lived fission product nuclides discharged to the environment in fuel reprocessing wastes, Kr 85 disposal, study of bituminization as a method of treating high activity wastes, design of an industrial facility for the incorporation into glass of fission products and the storage of highly retroactive glass, disposal in a geologic environment such as clay formation, salt mines and deep underground cavities, and deep-well disposal of tritium containing liquid effluents. (PHM)

<584>
Not given, U.S. Atomic Energy Commission, Technical Information Center, Oak Ridge, TN. 1973, August

Radioactive Waste Management, A Bibliography of Publicly Available Literature Pertaining to the USAEC's Hanford, Washington Production Site. TID-3340; 157 p.

This bibliography contains abstracts of 1098 publicly available technical reports and journal articles which have appeared in Nuclear Science Abstracts from January 1951 through July 1973 pertaining to radioactive waste management at the Hanford site. The abstracts are grouped into the following categories: environs monitoring, ecology, and radioactive surveys; Columbia River studies; ground disposal and soil studies; geology, hydrology, and meteorology; stack disposal; waste storage tanks and corrosion problems; waste fixation and solidification; waste processing and properties; waste management; and miscellaneous. Within the categories, abstracts are arranged by NSA volume and abstract number. A supplement to this bibliography will be issued. (ST)

<585>
Not given, U.S. Atomic Energy Commission, Division of Operational Safety, Washington, DC. 1973, February

Proceedings of AEC Pollution Control Conference held at Oak Ridge, Tennessee, October 25-27, 1972. CONF-721030; 549 p.

Currently the Atomic Energy Commission is spending about ten million dollars per year on actions to remedy or control and abate pollution from AEC facilities. The conference was held to provide increased coordination of technical information and to help avoid unnecessary duplication of effort in resolving common pollution abatement problems at AEC facilities. The following sessions were held: environmental protection policy and requirements, air pollution control, alternatives to open burning, water pollution control, and radioactive waste treatment systems. A discussion of AEC policy and position regarding the implementation of federal, state, and local pollution control standards and requirements by AEC facilities was presented. Radioactive waste treatment systems included those for tritium, plutonium 238, transuranic wastes, and krypton 85 enrichment by thermal diffusion. Sources of releases were stack emissions, processing area releases to the atmosphere, and liquid effluents. Systems for controlling or abating radioactive and nonradioactive releases were discussed.

<586>
Not given, Oak Ridge National Laboratory, Nuclear Safety Information Center, Oak Ridge, TN. 1973

Radioactive Waste Management Practices at ORNL, A Bibliography of Titles, Authors, and Abstracts. ORNL-NSIC; 76 p.

The bibliography lists some 360 reports and articles that have been published at ORNL or by ORNL staff members, including some marked "Proprietary", on the general topic of radioactive waste management practices. Most of the items deal with such practices at ORNL; others deal with practices at other facilities or in a generalized sense. Together they constitute a definitive statement of ORNL waste management position. The bibliography contains sections with abstracts, authors, titles and keywords. (PHM)

<587>
Not given, U.S. Atomic Energy Commission, Technical Information Center, Oak Ridge, TN. 1972, April

Radioactive Waste Processing and Disposal. TID-3311 (Suppl. 3); 592 p.

The 2249 references in this bibliography supplement reports TID-3311, TID-3311(Supplement 1), and TID-3311(Supplement 2). The references were selected from Nuclear Science Abstracts (NSA), Volume 21 (1967) through issue 4 of Volume 26 (1972) by the RESPONSA computerized search technique. The references include NSA abstract number, report number or journal citation, title, author, date of publication, corporate author, page numbers, and subject index terms. Separate personal author, corporate author, report number, and subject indexes follow the references. (ST)

<588>
Not given, Organization for Economic Cooperation and Development, Paris, France. 1972

Disposal of Radioactive Waste. CONF-720453; Part of Proceedings of an Information Symposium on Disposal of Radioactive Waste held in Paris, France, April 12-14, 1972, 290 p.

The basic objectives of the Nuclear Energy Agency (NEA) Information Meeting were technical, health and psychological aspects of radioactive waste disposal. The five principal areas covered were: 1) production and treatment of wastes, 2) radioecology, 3) exposure to ionizing radiation; principles and methods of radiological protection, 4) storage and disposal of wastes, and 5) administration and control. Seventeen papers were presented. (RAF)

<589>
Not given, U.S. Atomic Energy Commission, Technical Information Center, Oak Ridge, TN. 1973, August

Radioactive Waste Management, A Bibliography of Publicity Available Literature Pertaining to the USAEC's National Reactor Testing Station, Idaho. TID-3342; 56 p.

This bibliography contains 272 technical reports and journal articles which have appeared in Nuclear Science Abstracts from January 1951 through July 1973. The articles pertain to radioactive waste management at the National Reactor Testing Station in Idaho. The ecology of the site, monitoring, and all phases of waste storage, treatment,

<589> CONT.
and management are covered. (BBM)

<590>
Not given, U.S. Atomic Energy Commission, Technical Information Center, Oak Ridge, TN. 1973, August

Radioactive Waste Mangement, A Bibliography of Publicly Available Literature Pertaining to the USAEC's Savannah River, South Carolina, Production Site. TID-3341; 36 p.

A bibliography has been compiled of abstracts of all reports and articles pertaining to radioactive waste management at USAEC's Savannah River Production Plant. These papers appeared in Nuclear Science Abstracts from Janaury 1951 through July 1973 and involve ecological studies and monitoring, Savannah River studies, and all phases of waste storage and management. Reports invovle release, storage, and treatment of various radionuclides including plutonium and uranium. (BBM)

<591>
Not given, Organization for Economic Cooperation and Development, Paris, France. 1971, September

Radiation Waste Management Practices in Western Europe. Report of the Steering Committee for Nuclear Energy; 126 p.

This review gives information on: origin and different types of waste; safety aspects with a discussion on the recommendations of the International Commission on Radiological Protection (ICRP); technological and economic considerations with respect to radioactive wastes; specific Western European Waste Management practices of gaseous, liquid and solid wastes; special problem areas such as high-level liquid wastes from chemical reprocessing of irradiated fuel, long-lived alpha wastes, Kr 85 and tritium, and the decommissioning of nuclear installations. Conclusions of this review are: problems of radioactive waste are complex but manageable; high standards of safety and considerations for the human environment are stressed; at present radioecological aspects are not a limiting factor for radioactive waste management; public interest and information are encouraged; optimum development of nuclear energy need not be impeded by problems of radioactive waste management which will have to be dealt with. (RAF)

<592>
Not given, Los Alamos Scientific Laboratory, Health Division, Waste Management Section, Environmental Studies Group, Los Alamos, NM. 1974, February

Transuranic Solid Waste Management Research Programs Quarterly Report for July-September, 1973. LA-5512-PR; 22 p.

The progress during the period of July-September 1973 for three transuranic solid waste management research programs funded by the AEC Division of Waste Management and Transportation is reviewed. The three programs include transuranic solid waste management research and development, the contaminated waste treatment development facility, and the burial grounds evaluation. The interim storage criteria are now ready to be issued for general review. Experiments in radiolysis and container corrosion have been reorganized and expanded to provide information for optimization of interim storage, while waste sorting experiments have begun to determine more accurately the character of wastes being produced at LASL. Several task forces have been organized for the waste treatment facility to evaluate incinerators and determine a satisfactory operational size for the facility. Work has begun on developing a model for the risk analysis of radioactive burial grounds. A questionnaire has been developed to obtain the necessary information for the analysis. (Auth)

<593>
Not given, U.S. Atomic Energy Commission, Technical Information Center, Oak Ridge, TN. 1973, September

Radioactive Waste Management, A Bibliography of Publicly Available Literature Pertaining to the USAEC's Oak Ridge, Tennessee, Site. TID-3343; 85 p.

This bibliography contains abstracts of 448 technical reports and journal articles which have appeared in Nuclear Science Abstracts from 1948 through July 1973 pertaining to radioactive waste management at the Oak Ridge, Tennessee site. The abstracts are grouped according to NSA volume and abstract number in the following categories: Environs monitoring, Ecology, and Radiological Surveys; White Oak Lake and Clinch River Studies; Ground Disposal and Soil Studies; Geology, Hydrology, and Meteorology; Stack Disposal; Waste Storage Tanks and Corrosion Problems; Waste Fixation and Solidification; Waste Processing and Properties, Waste Management; and Miscellaneous. (BBM)

<594>
Tamura, T., Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN. 1972, December

Sorption Phenomena Significant in Radioactive Waste Disposal. Memoir No. 18; Part of Cook, T.D. (Ed.), Proceedings of a Symposium on Underground Waste Management and Environmental Implications held in Houston, Texas, December 6-9, 1971. The Collegiate Press, George Banta Company, Inc., Menasha, Wisconsin, (p. 318-330), 412 p.

Disposal of radioactive liquid wastes poses a particularly vexing problem, because these wastes contain various radionuclides and chemicals used in processing operations which are potentially dangerous, even in low radionuclide concentrations. Sorptive properties of minerals, particularly ion-exchange reactions, have been studied for potential direct application in waste treatment and for the purpose of defining the fate of radionuclides when released to soils and geologic formations. Because most waste streams normally contain stable ion concentrations far in excess of radioactive ions, sorption reactions of interest are those which exhibit high selectivity for the radionuclides. Structural and/or steric factors are generally of highest significance in selective reactions. Micaceous minerals selectively sorb radiocesium from high-sodium, aluminum, or calcium solutions, primarily because of favorable structure. Zeolitic minerals show selectivity for certain ions by excluding other ions whose sizes exceed parameters. Some sorbents show selective sorption reactions under particular pH conditions, thus, alumina and related hydrous oxides selectively sorb radioactive

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<594> CONT.
cobalt and radiostrontium in alkaline sodium systems. In addition to the exchange reactions, sorbent properties, such as flocculation, swelling, and absorption of liquids, and chemical properties of radionuclides are important considerations in waste-disposal operations and management. In practical applications of the sorptive phenomena in waste disposal, it is necessary to know the solution characteristics, sorbent properties, and formation characteristics, as well as the interactions of these factors. In the hydraulic-fracturing technique employed at Oak Ridge, the waste-solution characteristics influence the choice of sorbents used to prepare waste-cement slurries. The high-sodium salt concentration requires attapulgite instead of bentonite, and illite is added to fix radioactive cesium. To immobilize the mix after injection underground, cement is added, but the cement further complicates the reactions and behavior of the clay slurries. The behavoir during injection and ultimate setting of the grout is further influenced by the characteristics of the formation. Each underground-disposal operation will require understanding of the environment into which the waste is to be placed. The final facility and technique should be tailored to meet the requirements of maintaining safe operation and insuring long-term safety for future generations. (Auth)

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GEOGRAPHIC LOCATION INDEX

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NOTE: Our computer counts in an unorthodox manner. You will find BNWL-280 listed after BNWL-1850; everything that begins with the digit two will be listed after everything that begins with the digit one. The machine reads and numbers material beginning at the left instead of the usual way of beginning at the right of a series of digits.

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