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Low-Level Radioactive Waste Technology

A Selected, Annotated Bibliography

Vol. 2

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LOW-LEVEL RADIOACTIVE WASTE TECHNOLOGY: A SELECTED, ANNOTATED BIBLIOGRAPHY

Volume 2

C. S. Fore, N. D. Vaughan, and L. K. Hyder

Ecological Sciences Information Center
Information Center Complex

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for the
DEPARTMENT OF ENERGY

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ABSTRACT

This annotated bibliography of 447 references represents the second in a series to be published by the Ecological Sciences Information Center (ESIC) containing scientific, technical, economic, and regulatory information relevant to low-level radioactive waste technology. The bibliography focuses on environmental transport, disposal site, and waste treatment studies. The publication covers both domestic and foreign literature for the period 1952 to 1979. Major chapters selected are Chemical and Physical Aspects; Container Design and Performance; Disposal Site; Environmental Transport; General Studies and Reviews; Geology, Hydrology and Site Resources; Regulatory and Economic Aspects; Transportation Technology; Waste Production; and Waste Treatment. Specialized data fields have been incorporated into the data file to improve the ease and accuracy of locating pertinent references. Specific radionuclides for which data are presented are listed in the "Measured Radionuclides" field, and specific parameters which affect the migration of these radionuclides are presented in the "Measured Parameters" field. In addition, each document referenced in this bibliography has been assigned a "relevance number" to facilitate sorting the documents according to their pertinence to low-level radioactive waste technology. The documents are rated 1, 2, 3, or 4, with 1 indicating direct applicability to low-level radioactive waste technology and 4 indicating that a considerable amount of interpretation is required for the information presented to be applied. The references within each chapter are arranged alphabetically by leading author, corporate affiliation, or title of the document. When the author is not given, the corporate affiliation appears first. If these two levels of authorship are not given, the title of the document is used as the identifying level. Indexes are provided for (1) author(s), (2) keywords, (3) subject category, (4) title, (5) geographic location, (6) measured parameters, (7) measured radionuclides, and (8) publication description.

This compilation of literature was produced from a specialized data base built to provide information support to technical staff and managers involved in the National Low-Level Waste Management Program. The data base was established and is maintained by the staff of the Ecological Sciences Information Center, Information Center Complex, Information Division, Oak Ridge National Laboratory.

INTRODUCTION

This publication of 447 abstracted references is the second in a series of annotated bibliographies concerning information relevant to the disposal and management of low-level radioactive wastes to be published by the Ecological Sciences Information Center (ESIC), Information Center Complex, Information Division, Oak Ridge National Laboratory. The first volume, ORNL/EIS-133/V1, was published in September 1978 and contained 504 references. The present compilation of literature is the result of efforts by ESIC to provide information support to the Department of Energy's National Low-Level Waste Management Program through EG&G Idaho, Inc., Idaho Falls, Idaho, and its contractors.

The scope of the project centers on disposal site criteria and environmental transport studies emphasizing specific parameters which affect the hydrologic and geologic migration of radionuclides. Emphasis is placed on studies dealing with ^{137}Cs, ^{90}Sr, ^{106}Ru, ^{238}Pu, and ^{3}H. Additional literature selected for inclusion in this publication deals with waste production and treatment, container design and performance, transportation of wastes, health and safety aspects, economics, and environmental and regulatory issues. The publication covers both domestic and foreign literature for the period 1952 to 1979. The literature selected for this bibliography has been assigned to the following ten chapters to aid the reader in locating references of interest: Chemical and Physical Aspects; Container Design and Performance; Disposal Site; Environmental Transport; General Studies and Reviews; Geology, Hydrology and Site Resources; Regulatory and Economic Aspects; Transportation Technology; Waste Production; and Waste Treatment.

The references to the literature are stored in a computer-searchable data file. Each reference in the data base contains a complete bibliographic citation, an informative abstract emphasizing important findings, subject categories describing the general subject area, keywords identifying specific topics in the document, and date and location of data-taking activities. Specialized data fields have been added to improve the ease and accuracy of identifying pertinent references. Specific radionuclides for which data are presented are listed in a field called "Measured Radionuclides." When information is presented on parameters which affect the migration of these radionuclides through the soil and geological formations, the parameters discussed are listed in a field entitled "Measured Parameters." The parameters are also discussed in the abstract along with numeric values, where possible. These fields enable the user to review only those references to documents concerned with the radionuclides and parameters of interest.

Each referenced document is assigned a "relevance" number to facilitate sorting documents according to their pertinence to low-level radioactive waste technology. Documents are rated 1, 2, 3, or 4 with 1 indicating direct applicability to low-level radioactive waste technology and 4 indicating that a considerable amount of interpretation is required for the information presented to be applied. The "relevance" number does not reflect the quality of the document, only its applicability to low-level waste technology.

Measured Parameters

The following is a list of specific parameters that have been selected for inclusion in the Low-Level Radioactive Waste Technology Data Base. Data on these parameters are extracted from the literature and included in the abstract. These data are flagged in a separate field, labeled "Measured Parameters," to increase precision in locating pertinent references.

Abrasion Resistance
Adsorption Rate
Calcium Carbonate Content
Clay Content
Compressive Strength
Density
Depth to Water Table
Diffusion Coefficient
Dispersion Coefficient
Distribution Coefficient
Eh
Emanation Rate
Erosion Rate
Evaporation Rate
Flow Rate
Grain Size Distribution
Heat Capacity
Hydraulic Conductivity
Hydraulic Gradient
Hydraulic Head
Hydraulic Velocity
Infiltration Rate
Injection Pressure
Ion Exchange Capacity
Leaching Rate
Mean Precipitation
Migration Rate
Moisture Content
Moisture Potential
Percent Adsorption
Percolation Rate
Permeability
Permeability Coefficient
pH
Porosity
River Flow Rate
Sedimentation Rate
Selectivity Coefficient
Specific Conductance
Storage Coefficient
Stratigraphic Unit Thickness
Temperature
Thermal Conductivity
Thermal Expansion
Total Ion Concentration
Total Organic Carbon Content
Transmissivity
Volumetric Water Content
Waste Volume

Citation Form

The references within each chapter are arranged alphabetically by leading author, corporate affiliation, or title of the document. When the author is not given, the corporate affiliation will appear first. If these two levels of authorship are not given, the title of the document is used as the identifying level. The following indexes are provided to aid the reader in locating references of interest: (1) author(s), (2) keywords, (3) subject category, (4) title, (5) geographic location, (6) measured parameters, (7) measured radionuclides, and (8) publication description.

As a result of computer limitations in indicating superscripts and subscripts in the standard manner, certain conventions have been established in this 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 Y(E-3) (E denoting exponent) means 10^3 or Y^{-3}.

4. For units of measurement, such as centimeters, meters, and feet, M3 means M^3.

Services

The Ecological Sciences Information Center provides a number of specialized services to governmental, industrial, academic, and foreign requestors. These services include identifying, acquiring, organizing, indexing, abstracting, processing, storing, and maintaining information. Customized literature searches, as well as copies of specific published documents referenced in the bibliography, are provided upon submission of requests. Annotated and indexed bibliographies are published whenever a particular need is shown. Specialized data bases can also be created if a specific subject area has not previously been covered.

ESIC provides service to a large population of researchers involved in the environmental concerns of energy technology. These services are made available at no charge to the project's sponsoring agency or agencies and to their contractors. Requests received from others will be assessed a minimum fee of $30, which covers the charges for most services. The fees will be charged through the National Technical Information Service in Springfield, Virginia. All inquiries for information services should be addressed to:

Ecological Sciences Information Center
Attention: Cathy Fore
Oak Ridge National Laboratory
P.O. Box X, Building 2001
Oak Ridge, Tennessee 37830

Phone: 615/574-7769 or
FTS 624-7769

Acknowledgments

Appreciation is due to R. B. Fitts and K. J. Notz, Jr., for reviewing the bibliography. Staff members of the Computer Services Group of the Information Sciences and Operations Department, Information Center Complex, were responsible for the computer production of this document. Several of the bibliographic entries were abstracted and indexed by the staff of Dames and Moore, White Plains, New York.

SAMPLE REFERENCE

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

1 — Chapter Heading
2 — Record Number (Sequential Number of Reference)
3 — Author(s)
4 — Corporate Affiliation
5 — Document Title
6 — Relevance Number
7 — Publication Description
8 — Publication Date
9 — Abstract
10 — Abstractor's Initials
11 — Comments
12 — Measured Parameters
13 — Measured Radionuclides
14 — Keywords

[1]DISPOSAL SITE

[2]<000>

[3]Erdal, B.R., R.D. Aguilar, B.P. Bayhurst, W.R. Daniels, C.J. Duffy, F.O. Lawrence, S. Maestas, P.Q. Oliver, and K. Wolfsberg, [4]Los Alamos Scientific Laboratory, Los Alamos, NM.

[5]Sorption-Descrption Studies on Granite. 1. Initial Studies of Strontium, Technetium, Cesium, Barium, Cerium, Europium, Uranium, Plutonium, and Americium. [6](2)

[7]LA-7456-MS; 62 pp. [8](1979, February)

[9]Distribution ratios were determined for sorption-desorption of radioactive tracers between the Climax Stock granite (quartz monzonite porphyry) obtained at the Nevada Test Site and a water prepared to be reasonably representative of the natural composition of water in equilibrium with the Climax Stock granite. The measurements were formed at 22 C and 70 C under atmospheric oxygen conditions. Elements given in order of increasing distribution coefficient at ambient temperature are provided. The effects of surface area and mineralogy on sorption were also investigated. The sorption ratio increases slowly with time presumably due to the slow interaction of the rock surface with the groundwater. Surface alterations presumably are also the reasons for the observation that it is more difficult to remove Cs, Ce, Eu, Pu, and Am from the rock than it is to sorb these elements. The sorption ratios for all elements studied, except Ce and Eu, scale with surface area or particle size and increase with temperature. This presumably indicates that Ce and Eu do not follow an ion-exchange or sorption mechanism. No appreciable sorption of Tc(+7) and U(+6) was observed. Permeability and porosity measurements were also made on consolidated cores. [10](RAP)

[11] Sorption ratios of all elements measured are given in graphic and tabular form.

[12] Distribution Coefficient; pH

[13] Sr 85; Tc 95m; Cs 137; Ba 133; Ce 141; Eu 152; U 237; Pu 237; Am 241

[14] SORPTION; DESORPTION; GRANITES; ROCKS; TRACERS; TEMPERATURE; SURFACE PROPERTIES; MINERALS; PERMEABILITY; POROSITY; LABORATORY STUDIES; CATION EXCHANGE CAPACITY; PARTICLE SIZE; GROUND WATER; EQUATIONS; MINERALOGY

<1>
Steele, W.V., Los Alamos Scientific Laboratory, Los Alamos, NM.

Determination of Relative Hydraulic Conductivity from Moisture Retention Data Obtained in the Bandelier Tuff. (3)

LA-7625-MS; 8 pp. (1979, January)

A method for calculating unsaturated hydraulic conductivity from measured values of matrix potential and saturation ratio is applied to data for the Bandelier tuff at a radioactive waste disposal site at the Los Alamos Scientific Laboratory. The method requires that the measured data satisfy a particular log-log relationship. The coefficient of correlation using the predictive formula in actual measurements is highly significant at matric potentials lower than -10 kPa (-0.1 bar). The decrease of the relative hydraulic conductivity with decreasing saturation ratio is more rapid for crushed tuff than undisturbed tuff. (Auth) (PAP)

Hydraulic Conductivity

HYDRAULIC CONDUCTIVITY; MOISTURE CONTENT; TUFFS; EQUATIONS; DISPOSAL SITES; THEORETICAL STUDIES

<2>
Archambault, J., J. Lemoine, and V. Nugent (Translator).

Underground Storage Conditions for Radioactive Wastes. (3)

ORNL-tr-4638; Retention and Migration of Radioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962, (pp. 21-23) (ORNL-tr-4638). (1963)

The prime concern when using underground storage of any type is that no pollution of the water table occurs either on a long-term or short-term basis. This prerequisite may be met by storing the wastes in a closed hydrological basin in a tropical dry climate; by using water-tight drums or through stabilization in solid or insoluble substances; by injecting the waste with cement into porous layers of a syncline, schistose layers or salt cavities; and by fixation of the radionuclides in the soil. In the short-term fixation in soils and use of natural caves is not practical because there is uncertainty as to integrity of the sediens. Injections into porous media at great depths is not practicable due to the gas at such depths. Better solutions are: storage in abandoned tunnels, injections into schistose series, and placement in salt deposits. (NSP)

BURIAL; CAVES; CAVITIES; DRUMS; GEOLOGY; SALT DEPOSITS; SCHISTS; WASTE DISPOSAL; WASTE STORAGE; WASTES, RADIOACTIVE; HYDROLOGY; CEMENTS; WELLS, INJECTION; SOLIDIFICATION; SOILS; HAZARD ANALYSIS; FIXATION; REVIEWS

<3>
Barbreau, A., and S.D. Blalock, Jr. (Translator), Atomic Energy Commission, Radiation Control and Radioactive Products Service.

A Device Designed to Study Radioisotope Retention by Soft Earth Material, According to Permeabil[illegible] (8)

ORNL-tr-[illegible]; Retention and Migration of Radioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962. University Press of France, Paris, (pp. 317-32[illegible]) (ORNL-tr-4644). (1963)

A device for taking permeability measurements on semi-consolidated or unconsolidated materials is described. Permeability is determined by water flow at different flow rates and a permeability coefficient is calculated using Darcy's formula. Distribution coefficients were also determined in the apparatus, as were autoradiographic values. (NSP)

PERMEABILITY; DISTRIBUTION COEFFICIENT; MEASUREMENTS; METHODS; AUTORADIOGRAPHY; INSTRUMENTS; LABORATORY STUDIES

<4>
Belter, W.G., U.S. Atomic Energy Commission, Washington, DC.

New Developments in the U.S. Atomic Energy Commission's Ground Disposal Program. (3)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29 1961, (pp. 12-16), 635 pp. (TID-7628). (1962, March)

This paper mentions briefly that studies on ion exchange and sorption have been done at Oak Ridge National Laboratory. Evidence is cited that vermiculite can remove strontium under selected conditions of pH and phosphate additions. Cesium removal was also found to be enhanced by high pH in the presence of vermiculite. (CAB)

Brief mention of cesium and strontium sorption by soils. (DE/CAB)

CLINOPTILOLITE; VERMICULITE; SOILS; STRONTIUM; CESIUM; UPTAKE; pH; PHOSPHATES; ION EXCHANGE; SORPTION; LABORATORY STUDIES

<5>
Blanchard, R.L., R. Kahn, and G.G. Robeck, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN.

Laboratory Studies on Ground Disposal of Oak Ridge National Laboratory Intermediate-Level Liquid Radioactive Wastes. (2)

ORNL-2475; 38 pp. (1958, March)

Radioactive waste and groundwater solutions were passed through columns of local Conasauga Shale to determine the sorptive behavior of the radionuclides. Cesium 137, the major radioactive constituent of the basic waste solution, was adsorbed very effectively with a shale/solution distribution ratio of 500. A small fraction of ruthenium 106, the only other radionuclide present in relatively large concentration, was adsorbed per unit weight of shale, but

<5>

CHEMICAL AND PHYSICAL ASPECTS

<5> CONT.
this adsorption occurred even when the radionuclide had previously passed through 200 feet of shale. The ruthenium and small amounts of cobalt 60 and antimony 125 present were removed by coprecipitation with lead dioxide after the addition of sodium hypochlorite. By combining coprecipitation with adsorption on shale columns, it was possible to obtain decontamination factors of 2 x 10(E+3) for gross beta, 3 x 10(E+3) for gross gamma, 4 x 10(E+4) for cesium, and 2 x 10(E+2) for ruthenium. Because of these decontamination factors, the lead dioxide precipitation combined with the hydroxide precipitation now in use, followed by passage of the supernatant solution through a shale column, is recommended. In addition, this alternative to seepage pit disposal would provide a more positive control of the usual environmental problems of external radiation and biological uptake. (AUTH)

This experimental study is applicable to deciding the nature of liquid waste treatment prior to shallow land burial. (DE/HT)

Ion Exchange Capacity

Cs 137; Co 60; Sb 125; Ru 106

GROUND WATER; SORPTION; SHALES; SOILS; CLAYS; PRECIPITATION, CHEMICAL; ADSORPTION; WASTES, RADIOACTIVE; WASTES, INTERMEDIATE-LEVEL; LABORATORY STUDIES

<6>
Bradley, D.F., and J.C. Corey, Savannah River Laboratory, Aiken, SC.

Mathematical Models of Bedrock Performance. (2)

DP-1439; Technical Assessment of Bedrock Waste Storage at the Savannah River Plant, (pp. IV-1 - IV-83), 287 pp. (1976, March)

Three waste systems are treated by means of mathematical analysis. In the first system all radioactivity is in a liquid waste phase, in the second it is sorbed on a stable solid waste phase and in the third it occurs initially in a solid phase that dissolves very slowly. Fundamentally the models are based on material balances taking the cavern, which includes the waste but not the rock, as the system. Determination of the concentration of an isotope leaving the rock and entering the biosphere was made by assuming that the rock is a large, unidirectional ion exchange column. The length of this column is the length of the critical path which the waste would utilize to attain the biosphere. No dispersion (plug flow) is assumed along the critical path because it would not have a strong effect on the total quantity of activity entering the biosphere. The adsorption effect is evaluated by assuming slow enough flow rates to maintain equilibrium at all times between the waste and the host rock. In crystalline rock the most likely critical path is assumed to be the lateral distance to the river. Less likely paths are assumed to be either downward flow to a fracture zone located about 700 feet beneath the caverns or the distance from the caverns to the Tuscaloosa aquifer. In Triassic rock the more probable critical path is the minimum expected distance to crystalline rock underlying the Triassic cavern. The dispersion of cesium and plutonium vary with the generic rock type and the waste system. In crystalline rock cesium is assumed to be completely soluble in the liquid phase. The maximum concentration of Cs-137 and total quantity of Cs-137 entering the biosphere would be virtually negligible whereas the maximum concentration of Cs-135 entering the biosphere would be about 100 MPC and the total quantity of Cs-135 entering the biosphere would be nearly equal to the original amount in the waste. If cesium is adsorbed on a stable solid waste phase with a distribution coefficient of 10(E+3), the maximum concentration of Cs-135 entering the biosphere is estimated to be about 75% of the original Cs-135 in the waste. In Triassic rocks, assuming the cesium is dissolved in the liquid, the maximum concentrations and total quantities of both Cs-135 and Cs-137 entering the biosphere would be negligible. If waste is stored in crystalline rocks and plutonium Pu-239 is assumed to be soluble in the liquid phase, then the maximum concentration entering the biosphere is estimated to be about 2000 times MPC and the total quantity entering the biosphere is about 10% of the initial quantity. If the Pu-239 exists in the stable solid phase with a distribution coefficient of 10(E+5) then maximum estimated concentration and total quantity entering the biosphere are greatly reduced to values of less than 0.4 times MPC and 1 Ci, respectively. If Triassic rocks are selected as the host material the maximum concentration and total quantity entering the biosphere are even smaller, with respective values of less than 10(E-100) times MPC and 1 uCi. Calculations show that: 1) soluble non-radioactive but toxic nitrate-nitrite waste will be the most difficult to reduce below MPC on entering the biosphere, 2) dilution of this material in crystalline rocks will not reduce the concentration below MPC before entry into the biosphere and 3) dilution of this material from a cavern in Triassic rocks would reduce the concentration to less than 10% MPC. (JH)

The approach is useful in assessing shallow land burial for low-level waste despite the fact that thir chapter deals with high-level waste stored in bedrock. (DE/JH)

MODELS, MATHEMATICAL; AQUIFERS; DISPERSIVITY; DISTRIBUTION COEFFICIENT; BIOSPHERE; ISOTOPES; BEDROCK; HYDRODYNAMICS; WASTES, LIQUID; WASTES, SOLID; WASTES, HIGH-LEVEL; STORAGE, GEOLOGIC; THEORETICAL STUDIES

<7>
Brindley, G.W., Pennsylvania State University, Department of Geosciences and Materials Research Laboratory, University Park, PA.

Sorption and Fixation of Large Cations by Shale Formations. (3)

Y/OWI/SUB-77/18268, CONF-770789; Waste-Rock Interactions, Proceedings of the National Waste Terminal Storage Program Conference, University Park, PA, July 6-7, 1977, (pp. 33-38), 92 pp. (Y/OWI/Sub-77/18268, CONF-770789), (1977, August 20)

Large cations such as Cs+ are preferentially sorbed and partially fixed by fine-grained 2:1 type layer silicates such as micas, vermiculites, smectites, and various mixed-layer minerals. Since these minerals are common constituents of many shale formations, these formations may provide

CHEMICAL AND PHYSICAL ASPECTS

<7> CONT.
suitable location for the burial of radioactive waste containers. However, the usual investigations of cation sorption and fixation must be extended to the conditions likely to develop in the vicinity of buried radioactive waste. Prior to possible leakage from buried containers, elevated temperatures around the burial site will develop leading to hydrothermal modification of the surrounding mineralogy. A range of temperature and of mineralogy must be envisaged. If and when leakage occurs, an outward diffusion of radioactive ions will occur by solvation in the fluids in the shale. The ratio of radioactive ions/normal ions will diminish outwards from the source. At distances near the source, high temperature modifications of the clay minerals and high concentrations of radioactive cations may lead to saturation of the fixation capacity. At greater distances, little or no thermal modification of the clay minerals and lower concentrations of ions will permit maximum sorption and fixation. The minerals studied to date include one phlogopite, four vermiculites, and two illites. The procedure was treatment 4 times with 0.001 M CsCl solution and once with 0.05 M CsCl. The amount sorbed was then measured by atomic absorption methods. Then fixation was determined using a solution mixed with NaBO3 at Cs/Na = 1/600. Cesium was fixed at greater than 1/600, indicating a strong preference for Cs; this may be explained by the lower hydration energy of Cs versus Na. Samples have also been leached with strong HCl solutions in an effort to move the Cs. (Auth) (LKH)

Only the abstract is given.

SHALES; SEDIMENTARY ROCKS; CESIUM; SILICATES; CLAYS; MICA; VERMICULITE; SELECTIVE; SORPTION; FIXATION; WASTES, RADIOACTIVE; STORAGE, GEOLOGIC; LEAKAGE; THERMAL PROPERTIES; HYDROTHERMAL ALTERATIONS; RADIONUCLIDE MIGRATION; ILLITE; PHLOGOPITE; LABORATORY STUDIES; WASTE-ROCK INTERACTIONS

<8>
Erdal, B.R., R.D. Aguilar, B.P. Bayhurst, W.R. Daniels, C.J. Duffy, P.O. Lawrence, S. Haestas, P.Q. Oliver, and K. Wolfsberg, Los Alamos Scientific Laboratory, Los Alamos, NM.

Sorption - Desorption Studies on Granite. 1. Initial Studies of Strontium, Technetium, Cesium, Barium, Cerium, Europium, Uranium, Plutonium, and Americium. (2)

LA-7456-MS; 62 pp. (1979, February)

Distribution ratios were determined for sorption-desorption of radioactive tracers between the Climax Stock granite (quartz monzonite porphyry) obtained at the Nevada Test Site and a water prepared to be reasonably representative of the natural composition of water in equilibrium with the Climax Stock granite. The measurements were performed at 22 C and 70 C under atmospheric oxygen conditions. Elements given in order of increasing distribution coefficient at ambient temperature are: U(+6), Sr, Tc(+7), Ba, Ce(+3), Cs, Eu(+3), Pu, and Am. At 70 C the order is: Tc(+7), Sr, Ce(+3), Eu(+3), Ba, Cs, Pu, and Am. The effects of surface area and mineralogy on sorption were also investigated. The sorption ratio (R(d) = activity per g of solid/activity per ml of water) increases slowly with time presumably due to the slow interaction of the rock surface with the groundwater. Surface alterations presumably are also the reasons for the observation that it is more difficult to remove Cs, Ce, Eu, Pu, and Am from the rock than it is to sorb these elements (desorption ratio greater than sorption ratio). The sorption ratios for all elements studied, except Ce and Eu, scale with surface area or particle size and increase with temperature. This presumably indicates that Ce and Eu do not follow an ion-exchange or sorption mechanism. No appreciable sorption of Tc(+7) and U(+6) was observed. Permeability and porosity measurements were also made on consolidated cores. (RAF)

Sorption ratios of all elements measured are given in graphic and tabular form.

Distribution Coefficient; pH

Sr 85; Tc 95m; Cs 137; Ba 133; Ce 141; Eu 152; U 237; Pu 237; Am 241

SORPTION; DESORPTION; GRANITES; ROCKS; TRACERS; TEMPERATURE; SURFACE PROPERTIES; MINERALS; PERMEABILITY; POROSITY; LABORATORY STUDIES; CATION EXCHANGE CAPACITY; PARTICLE SIZE; GROUND WATER; EQUATIONS; MINERALOGY

<9>
Erdal, B.R., R.D. Aguilar, B.P. Bayhurst, P.Q. Oliver, and K. Wolfsberg, Los Alamos Scientific Laboratory, Los Alamos, NM.

Sorption-Desorption Studies on Argillite. 1. Initial Studies of Strontium, Technetium, Cesium, Barium, Cerium, and Europium. (3)

LA-7455-MS; 72 pp. (1979, March)

Distribution ratios were determined for sorption-desorption of radioactive tracers between Eleana argillite available from the Nevada Test Site and a water prepared to be representative of the natural groundwater composition. A batch technique and calculational methods were developed for all measurements. The residues from the sorption measurement were employed for the desorption experiments using the same technique. The measurements were performed at 22 C and 70 C under atmospheric oxygen conditions, with a particle size range of 106 to 850 um. The order of increasing distribution coefficient by element at both temperatures is Tc, Sr, Cs, Ba, Eu, and Ce. The effects of surface area and mineralogy were also investigated. The sorption ratio (R sub d = activity per g of solid/activity per ml of water) increases slowly with time presumably due to the slow interaction of the rock surface with the groundwater. Surface alteration presumably is also the reason for the observation that it is more difficult to remove the tracers from the rock than it was to sorb them. (RAF)

Distribution Coefficient

Sr 85; Cs 137; Ba 133; Ce 141; Eu 152; Tc 95m

SORPTION; DESORPTION; SHALES; STRONTIUM 85; TECHNETIUM 95m; CESIUM 137; BARIUM 133; CERIUM 141; EUROPIUM 152; TRACERS; GROUND WATER; DISTRIBUTION COEFFICIENT; MINERALS; TEMPERATURE; PARTICLE SIZE; LABORATORY STUDIES; CATION EXCHANGE CAPACITY; SURFACE PROPERTIES; EQUATIONS; pH; CORES; TIME FACTOR

<10>

CHEMICAL AND PHYSICAL ASPECTS

<10>
Glenn, J.L., and K.O. Van Atta, U.S. Geological Survey, Portland, OR.

Relations Among Radionuclide Content and Physical, Chemical, and Mineral Characteristics of Columbia River Sediments. (2)

USGS Open File Report; 125 pp. (1971)

The radionuclides discussed in this report were produced by neutron activation of elements in Columbia River water that was used to cool the once-through nuclear reactors in the Hanford area near Pasco, Washington, prior to their final shutdown early in 1971. After return of the low-level radioactive cooling waters to the Columbia River, some radionuclides were attached to sediment particles and some particles were incorporated in the stream bed. This report presents data on radionuclides in size separates of streambed sediments and describes relations among radionuclide content, particle size, cation exchange capacity, carbon and nitrogen content, and mineralogy. Cation exchange capacity varies inversely with particle size. For medium sands to clays, the regression of the logarithm of cation exchange capacity on the logarithm of geometric-mean particle diameter is linear and has a regression coefficient of -0.6. Mean cation exchange-capacity values for medium sands from seven Columbia River locations are 2.8 (plus or minus 1.7) meq/100 grams; mean values for clay are 40.8 (plus or minus 5.1) meq/100 grams. No statistically significant difference in cation exchange capacity was noted between locations at the upper and lower ends of the study reach. Clay minerals comprise 70-80% of all components in both the less-than-two and the 2-8 micron size separates. The dominant clay minerals are illite, montmorillonite, and mixed-layer clays in roughly equal proportions; chlorite and kaolinite in about 2 to 1 proportions comprise 10% or less of the average clay mineral suite. Petrographic analyses of sand that was divided into 5 size separates and gravel that was unsized show that the dominant components are rock fragments, feldspars, and silica-group constituents. Nearly 2/3 of all rock fragments are volcanic rocks or volcanic glass. Maturity indices are correspondingly low. Chromium 51, Zn 65, Sc 46, Mn 54, Co 60, in decreasing order of concentration are the gamma-emitting radionuclides identified in Columbia River size separates. (JHT)

Extensive tabular data are presented.

Ion Exchange Capacity; Clay Content; Grain Size Distribution

Cr 51; Zn 65; Sc 46; Mn 54; Co 60

SORPTION; BIOTITE; CHEMICAL ANALYSIS; CONTAMINATION; DIFFUSION; DILUTION; DISTRIBUTION; DRAINAGE; DRAINAGE BASINS; DRAINAGE CHARACTERISTICS; DRINKING WATER; FISSION PRODUCTS; FRESHWATER SYSTEMS; GEOCHEMISTRY; HYDROLOGY; IGNEOUS ROCKS; ION EXCHANGE; ION EXCHANGE CAPACITY; MINERALS; MODELS; NUCLEAR FACILITIES; ORGANIC COMPOUNDS; PARTICLE SIZE; POLLUTION, WATER; ROCKS; SAMPLING; SILTS; SOILS; CLAYS; SANDS; SPECTROSCOPY; STREAMS; SURFACE WATERS; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; LABORATORY STUDIES

<11>
Nakanson, T.E., and E.S. Gladney, Los Alamos Scientific Laboratory, Los Alamos, NM.

Ecological Investigation of Mercury in Mortandad Canyon. (8)

LA-6898-PR; Progress Report, Biomedical and Environmental Research Program of the LASL Health Division, January-December, 1976. (pp. 87-88) (LA-6898-PR). (1977, July)

The behavior of mercury in the environment, its distribution, transport and potential significance in food webs, was examined using a newly developed flameless atomic absorption procedure. The procedure has a sensitivity of about 10 ng mercury per sample. Initial results for soil samples from Mortandad Canyon indicate Hg concentrations above background (12 plus or minus 9 ppb). Stream channel samples averaged 74-99 ppb and stream bank samples 120-170 ppb. Initial results indicate that mercury is well mixed to depths of 30 cm in soils and is preferentially concentrated in stream bank soils. In addition, some evidence was found to indicate that Hg is relatively more mobile than Cs 137. (CAB)

Discussion of mobility of mercury is of interest for shallow land burial of toxic wastes. (DR/CAB)

Cs 137

CONTAINMENT TRANSPORT; FOOD CHAINS; ABSORPTION; MERCURY; DISTRIBUTION; WASTES, NONRADIOACTIVE; SAMPLES; STREAMS; SOILS; LABORATORY STUDIES; SOIL TRANSPORT

<12>
Hawkins, D.B., U.S. Atomic Energy Commission.

Mineral Reaction Studies at National Reactor Testing Station. (1)

TID-7648; Use of Inorganic Exchange Materials for Radioactive Waste Treatment, D.E. Janison, et al (Eds.), Proceedings of a Working Meeting, Washington, DC, August 13-14, 1962. U.S. Atomic Energy Commission, Division of Technical Information, Washington, DC, (pp. 151-175), 238 pp. (TID-7648). (1963, January)

Work on determining mineral reactions at the National Reactor Testing Station (NRTS) is presented. A reconnaissance study using lignite, benotite, rock phosphate, playa deposit sediment, with montmorillonite and clinoptilolite-bearing vitric tuff was made to ascertain the ability of these materials to decontaminate low-level liquid radwastes. Cribs in these materials were being considered as a disposal strategy. Clinoptilolite and lignite were the best ion-exchangers with clinoptilolite being superior. It has a high distribution coefficient for both Cs and Sr which does not change significantly as a function of pH. Lignite has similar distribution coefficients to clinoptilolite over a narrow pH range of 5-7, thereafter the coefficients decrease as a function of pH and the lignite begins to decompose. Breakthrough curves for tritium using lignite, alluvium, and clinoptilolite were also determined. Another study, still in progress, is the determination of the ability of the alluvium to remove Sr 85, Cs 137, Co 60, Ce 144, and Ag 110 before breakthrough to the ground water table. The

<12> CONT.
grain size distribution of the alluvium was estimated. The variables chosen for the experiment, which is a 2(12) factorial design include: HF, H3PO4, Ca(NO3)2, HCl, MgCl2, Na2SO4, pH, column length, flow rate, particle size, temperature, and type of material. Only the Sr was completely removed and all others were fixed in varying degrees, in the preliminary experiments. Cerium is removed from solution by a precipitation as a sodium rare earth double sulfate. Also, Co can be removed by an anion exchange resin. In the future, synthetic clays and zeolites will be studied. (EDV)

Distribution Coefficient; pH

Sr 85; Cs 137; Co 60; Ce 144; Ag 110

ALLUVIUM; BENTONITE; BREAKTHROUGH DISTRIBUTION; CLINOPTILOLITE; DECONTAMINATION; DISTRIBUTION COEFFICIENT; FIXATION; GROUND WATER; ION EXCHANGE; LIGNITES; CRIBS; WASTE DISPOSAL; WASTES, LIQUID; WASTES, LOW-LEVEL; MONTMORILLONITE; pH; RADIONUCLIDES; CLAYS; ZEOLITES; LABORATORY STUDIES; SOLIDIFICATION; ENCAPSULATION

<13>
Levi, H.W., and H. Hickeley, Hahn-Meitner Institut fur Kernforschung, Berlin, German Federal Republic.

Studies on Ion Diffusion in Vermiculite.

CONF-670512; STI/PUB-156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 161-168), 666 pp. (1967, June)

Ion mobilities in vermiculite as affected by ion fixation were studied. Cesium is the most important radioactive ion fixed in vermiculite. The release of Cs 137 from Cs 137 saturated vermiculite by several cations (Li, Sr, K) was studied as well as the isotopic exchange with nonradiogenic Cs. The fraction of unexchanged Cs 137 was measured as a function of time. Isotopic Cs exchange experiments showed 90% of the Cs 137 in the vermiculite to be fixed for time periods as long as three months and at temperatures as high as 100 degree C. Isotopic exchange of Na in Na-vermiculites was completed in a few minutes. This indicated that the immobility of Cs was a purely kinetic phenomenon. The fixed Cs fraction was smaller than 90% when the initial Cs content of the vermiculite was decreased. Exchange runs with other cations resulted in a considerably higher degree of Cs release depending upon the nature of the exchanging ion. Alkaline earths, which are also of interest in nuclear waste disposal, were not fixed in vermiculite. In mixed Cs/alkaline earth-vermiculites, the Cs ions were found to be fixed just as in pure Cs-vermiculites. The alkaline earth mobilities, however, were considerably reduced. It may thus be possible to immobilize various radionuclide ions (such as Sr 90) in suitable soils by mixing them with cations fixed like Cs. (MT)

An experimental study of ion mobility in vermiculite with relevance toward immobilizing nuclides that might leak from shallow land burial sites. The study unfortunately does not include data on the effects of pH variation and low pH solutions. (DR/MT)

Ion Exchange Capacity

Na 22; Cs 137; Sr 85; Ba 133

VERMICULITE; ION EXCHANGE; FIXATION; CESIUM; STRONTIUM; BARIUM; CLAYS; ALKALINITY; DIFFUSION; SODIUM; RADIONUCLIDE MIGRATION; SOILS; LABORATORY STUDIES

<14>
Miyake, Y., and K. Saruhashi, Geochemistry Research Association, Tokyo, Japan; Meteorological Research Institute, Tokyo, Japan.

Disposal of Radioactive Waste into Deep Seas. (3)

Abstract, p. 42.

An equation is provided for calculation of concentration limits of radionuclides in seawater (Csw), assuming a daily uptake of seafood by man of 100 g/d, an upper limit of radiation dose to man of 5 mrem/person/yr., and that wastes enter bottom water immediately on arrival at the bottom and mix homogeneously from bottom to surface. The results give Csw values for H 3, Co 60, Sr 90, Cs 137, Ra 226, and Pu 239 of 2 X 10(E-12), 6 X 10(E-17), 3 X 10(E-17), 1.5 X 10(E-15), 7 X 10(E-19), and 6 X 10(E-19) Ci/cu cm, respectively. The allowable limit on annual disposal of radioactive waste into the Pacific is equal to the decay constant of the radionuclide times its Csw times 7 X 10(E+23) cu cm (the total volume of water in the Pacific). However, natural radionuclides and those already present from nuclear tests, etc. must also be taken into account in calculating disposal limits. Background values of H 3, Sr 90, Cs 137, Ra 226, and Pu 239 in Pacific surface waters are 1 X 10(E-18), 2 X 10(E-16), 3 X 10(E-16), 7 X 10(E-17), and 5 X 10(E-19) Ci/cu cm, respectively. Sr 90 and Ra 226 backgrounds exceed Csw values. (LKH)

Only abstract is given.

Total Ion Concentration

H 3; Sr 90; Cs 137; Ra 226; Pu 239; Co 60

SEA DISPOSAL; WASTES, RADIOACTIVE; EQUATIONS; DOSE RATE; MAXIMUM PERMISSIBLE CONCENTRATION; RADIONUCLIDE MIGRATION; RELEASE LIMITS; THEORETICAL STUDIES

<15>
Haesser, C.B., U.S. Geological Survey, Washington, DC.

Geochemical Studies Pertaining to Ground Studies of Radioactive Wastes. (3)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 237-247), 635 pp. (TID-7628). (1962, March)

Studies of the effectiveness of vermiculite, glauconite, crandallite, and anhydrite in scavenging radiocesium at various pH values were conducted. Vermiculite scavenges cesium

<15>

CHEMICAL AND PHYSICAL ASPECTS

<15> CONT.
between pH values as low as 3 and as high as 12.4. Maximum ion exchange was attained in some samples after a few hours, but in others up to several weeks was required to reach maximum exchange rates. The exchange capacity of the crandallite sample studied was about 6-10 meq/100 g of active phosphate material for Sr and 2 meq/100 g for Cs. For montmorillonite the values were 50 meq/100 g at the interlayer sites and 80 meq/100 g at the edge sites. The exchangeable sites remaining in the clay were found to be 34 meq/100 g, giving a total of 124 meq/100 g. Glauconite removes strontium and cesium at pH's from 3 to 10 with an increase in uptake occurring at higher pH values. Strontium is removed by crandallite from mildly acid to alkaline solution mainly by precipitation, especially in the presence of aluminates. Cesium reacts much less strongly with crandallite. Anhydrite was found to remove strontium by precipitation at a slow rate and cesium not at all. (CAB) (CSV)

Marginally applicable. Not too concerned with natural subsurface conditions. (DH/CAB)

Ion Exchange Capacity

Sr; Cs

VERMICULITE; GLAUCONITE; CRANDALLITE; ANHYDRITE; CLAYS; pH; UPTAKE; ION EXCHANGE CAPACITY; WASTES, RADIOACTIVE; GEOCHEMISTRY; SAMPLES; LATTICE; LABORATORY STUDIES

<16>
Routson, R., G. Jansen, and A. Robinson,
Battelle-Pacific Northwest Laboratories,
Richland, WA.

Sorption of Technetium 99, Neptunium 237, and Americium 241 on Two Subsoils from Differing Weathering Intensity Areas. (2)

BNWL-1889; 15 pp.(1975, May)

Distribution coefficients (Kd values) were determined on subsoils from Washington and South Carolina for Am 241, Np 237, and Tc 99 as a function of equilibrium solution concentrations of calcium (Ca^{++}) and of sodium (Na^{+}). Kd values decreased in all cases with increasing solution concentrations of Ca^{++} and Na^{+}. For the South Carolina subsoil Kd values ranged from 1.0 to 67 for Am 241 as a function of Ca^{++}, 1.6 to 280 for Am 241 as a function of Na^{+}, 0.43 to 0.66 for Np 237 as a function of Ca^{++}, and 0.16 to 0.25 for Np 237 as a function of Na^{+}. For the Washington soil Kd values were greater than 1200 for Am 241 and ranged from 0.76 to 2.37 as a function of Ca^{++} and from 3.19 for Np 237 as a function of Na^{+}. Kd values for Tc 99 were essentially 0 at all $NaHCO_3$ concentrations on the South Carolina subsoil. (Auth)

Distribution Coefficient

Tc 99; Np 237; Am 241

NEPTUNIUM; AMERICIUM 241; TECHNETIUM; SOILS; SORPTION; DISTRIBUTION COEFFICIENT; CONCENTRATIONS; LABORATORY STUDIES

<17>
Savannah River Laboratory, Aiken, SC.

Volume Reduction of Plutonium-Contaminated Soil. (2)

DPST-75-125-1; Savannah River Laboratory Quarterly Report, Waste Management, January-March 1975, (pp. 52-57), 84 pp. (DPST-75-125-1).(1975, January-March)

In a laboratory study, simple water washing was demonstrated to classify soil from burial-ground plutonium waste trenches which contains approximately 3000 curies in approximately 100,000 cubic meters (20 nCi/gram) into two distinct fractions: 1) Clay-silt (60 nCi/gram) that retains 95% of the total plutonium but comprises only 1/3 of the total soil that could otherwise require storage in durable containers for eventual transport to a national repository, and 2) sand (1 nCi/gram) that retains only 5% of the plutonium and comprises 2/3 of the total soil. The soil would be kept wet throughout excavation and processing to avoid airborne radioactivity. The tests indicate that commercial scrubbing and classifying equipment would decrease the plutonium activity in the sand sufficiently that the sand could be returned to the burial trenches. For the laboratory tests, the soil was from a trench filled with plutonium waste in 1968. A gamma pulse height analysis showed 93 nCi of Pu 238 per gram. This was the only significant alpha emitter found. Various agitation times and various wash flows (all with continued agitation) were tested to determine their effects upon plutonium partitioning between sand in the flask and the effluent slurry of clay-silt. The effects of the scrubbing are summarized on several graphs, and it was found that the pre-wash scrubbing (agitation) did substantially increase the rate of clay-silt plutonium elution, with all tested pre-wash scrubbing times. (JET)

Grain Size Distribution

Pu 238

SORPTION; ALPHA PARTICLES; DISPOSAL SITE; LABORATORY STUDIES; SEPARATION PROCESSES; SITE EVALUATION; SOILS; CLAYS; SANDS; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; VOLUME REDUCTION; PLUTONIUM

<18>
Strickert, R., A.M. Friedman, and S. Fried,
Argonne National Laboratory, Argonne, IL.

The Sorption of Technetium and Iodine Radioisotopes by Various Minerals. (3)

CONF-780622; American Nuclear Society Annual Meeting, Proceedings of a Symposium, San Diego, CA, June 18-22, 1978, (pp. 365-366) (CONF-780622); Transactions of the American Nuclear Society 28:365-366.(1978, June)

To investigate alternative mechanisms for geological retention of radioactive I and Tc, measurements were made of the absorption of pertechnetate, iodide, and iodate ions from solutions by various common minerals using tracer amounts of Tc 95m and I 131 and column flow and batch techniques. Results showed that only a few percent of Tc and I were sorbed by tuffs from Los Alamos and the Nevada Test Site, or by basalt from Idaho

<18> CONT.
Falls; granites, dolomites, and shales absorbed generally less that 10% of the Tc or I. Ninety-nine percent absorption occurred with minerals containing Cu, Pb, or iron sulfide (bournonite, galena, chalcopyrite). There was evidence that reduction of the pertechnetate anion occurs when sorbed by Cu, Pb, or Fe minerals. Sulfide compounds containing metal ions in the highest oxidation state absorbed TcO4 poorly (less than 5%). Iodide was strongly absorbed by metalliferous minerals; Ag minerals sorbed 99% of the iodide tracer and less than 2% of the pertechnetate tracer. Oxidation state of the metal ion had no effect. Absorption of iodate ions coincided with that of iodide, although this may be due to the reduction of iodate. Sorption mechanisms in the minerals examined are related to the mineral structure itself rather than to dissolved or colloidal material present in solution. Absorption rate at room temperature is slow; with bournonite, TcO4 tracer sorption reached equilibrium in about 60 hrs, while tracer required 120 hours. These experiments demonstrate that Tc and I can be absorbed by selected minerals that contain potentially reducing or coprecipitating components. (LKH)

Tc 99m; I 131

TECHNETIUM; IODINE; TRACERS; ANIONS; RADIONUCLIDE MIGRATION; CHEMICAL PROPERTIES; TECHNETIUM COMPOUNDS; IODINE COMPOUNDS; ROCKS; MINERALS; TUFFS; SORPTION; BASALTS; GRANITES; DOLOMITE; SHALES; ABSORPTION; BOURNONITE; GALENA; CHALCOPYRITE; METALS; REDOX REACTIONS; IMMOBILIZATION; WASTE MANAGEMENT; WASTE DISPOSAL; LABORATORY STUDIES; WASTES, RADIOACTIVE

<19>
Takahashi, K., C. Kesushiro, and T. Machida, Kyoto University, Kyoto, Japan.

Tests for Behaviors of Radioactive Iodine Gas in Soils. Part 4. (J)

Bulletin of the Institute of Atomic Energy, Kyoto University, pp. 48; ORNL-tr-4555; 3 pp. (1976)

An adsorption model for radioactive iodine gas in soils has been created. Adsorption per unit mass has been divided into a reversible part and irreversible part, and time variations for both are given. The model is defined mathematically, and is tested using samples of standard sand for molecular iodine and mountain sand for methyl iodide. Test environment is dry air at room temperature. Calculated values are projected from the test values. Values for Kd, equivalent to a distribution coefficient, and for Ka (the quantity of irreversible adsorption per unit mass times rate of irreversible adsorption) obtained by the unsteady flow method for I 2 are 0.58 l/g and 1.2 x 10(E-3) l/g min, respectively. Distribution coefficient (Kd) is determined to have a range of 2.8-0.8 l/g. There seem to be large test errors in quantity of irreversible adsorption per unit mass and rate of irreversible adsorption, but if their respective values are assumed to be 25 ug/g and 5 x 10(E-5) l/ug min, there is approximate agreement with the observed Ka. (LKH)

Distribution Coefficient; Adsorption Rate; Percent Adsorption

I 131

ADSORPTION; GASES; LABORATORY STUDIES; ORGANIC COMPOUNDS; HALOGENS; RADIOCHEMISTRY; SANDS; SOILS; THEORETICAL STUDIES; ISOTOPES; DESORPTION; MODELS, MATHEMATICAL; EQUATIONS; IODINE 131

<20>
Tamachi, T., C. Kesushiro, and K. Takahashi, Kyoto University, Kyoto, Japan.

Tests for Behaviors of Radioactive Iodine Gas in Soils. Part 3. (J)

Bulletin of the Institute of Atomic Energy, Kyoto University, pp. 43; ORNL-tr-4554; 3 pp. (1976)

Adsorption tests for radioactive methyl iodide (CH3I) and molecular iodine in soil samples were performed. Samples were of mountain soil and standard sand (properties given in report) packed in test columns. Methods of production of the CH3I gas and analysis techniques are discussed. Tests were conducted at various temperatures and humidities by passing radioactive CH3I at 7-78 ug/l through the soil columns. Results show that adsorption varies with concentration of gas, and decreases where temperature and humidity are high. The ion exchange capacity ranged from 0.29 to 0.36 meq/g. For I2, 100% adsorption was observed when load was below single molecular film capacity (160 ug/g). For CH3I, adsorption was less than 10% of the load which was below molecular film capacity (80 ug/g). Quantities of air sweep desorption, of solution leach, and of remaining substance in the samples were obtained. Most of the total CH3I adsorption was desorbable by air sweep. Under humid conditions, air sweep desorption decreased to about 70%, and at high temperature it was less than 50%. Adsorption in mountain soil was about 1/10 that of standard sand, which corresponds to the respective specific surface areas of the samples. The saturation adsorption of standard sand is very low compared with the mountain soil. (LKH)

Percent Adsorption; Ion Exchange Capacity; Permeability Coefficient

I 131

ADSORPTION; GASES; LABORATORY STUDIES; ORGANIC COMPOUNDS; HALOGENS; RADIOCHEMISTRY; SANDS; CLAYS; SOILS; CONCENTRATIONS; ISOTOPES; LEACHING; DESORPTION; IODINE 131

<21>
Tamachi, T., K. Takahashi, and T. Horibe, Kyoto University, Engineering Department, Kyoto, Japan.

Tests for Behaviors of Radioactive Iodine Gas in Soils. Part 1. (J)

Bulletin of the Institute of Atomic Energy, Kyoto University, pp. 55; ORNL-tr-4552; 2 pp. (1973)

Tests for behavior of radioactive iodine gas were conducted using three types of

<21>

CHEMICAL AND PHYSICAL ASPECTS

<21> CONT.
soils--river sand from the Uji Gawa River, mountain soil from Uji Itsugamoshine, and standard sand from Toyoura. Tests were conducted at room temperature and at 100 degrees C, and at humidities of less than 10%, 50-60%, and 90-100%. Results are tabulated in the text. In general, the higher humidity, the less adsorption -- which may be due to water covering soil grains and reducing surface area for adsorption. Quantities of irreversible adsorption for all samples are approximately equal, regardless of the test conditions. (LIE)

Percent Adsorption

I 131

ADSORPTION; GASES; LABORATORY STUDIES; HALOGENS; RADIOCHEMISTRY; SANDS; CLAYS; SOILS; DESORPTION; ISOTOPES

<22>
Tamura, T., Oak Ridge National Laboratory, Oak Ridge, TN.

Strontium Reactions With Minerals. (3)

TID-7629; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 187-195), 635 pp. (1962, March)

Laboratory tests were run to determine the efficacy of various minerals in removing strontium from simulated waste solutions. Four mechanisms of removal were examined: 1) ion exchange as an absorption process in clinoptilolite and clay minerals, 2) ion exchange as an adsorption process characterized by the reaction of alumina, 3) metasomatic replacement as characterized by CaCO3-phosphate reactions, and 4) precipitation reactions with natural vermiculites and clinoptilolite in contact with phosphated waste. Alumina was found to remove strontium by adsorption, the reaction being pH-dependent, while vermiculite and clays strongly absorb strontium. Tests indicate that addition of limited amounts of phosphate promotes removal of strontium from solution by vermiculite in a metasomatic replacement reaction. Removal of strontium by natural vermiculites and clinoptilolite was improved by addition of phosphate ions at higher pH values. (CAB)

Relevant to types of geologic environments that would be most beneficial for sorption of strontium. (DR/CAB)

Sr

ABSORPTION; ADSORPTION; VERMICULITE; pH; ION EXCHANGE; ALUMINUM COMPOUNDS; MINERALS; CLINOPTILOLITE; PRECIPITATION, CHEMICAL; CLAYS; LABORATORY STUDIES

<23>
Tamura, T., Oak Ridge National Laboratory, Oak Ridge, TN.

Sorption Phenomena Significant in Radioactive-Waste Disposal. (1)

Memoir No. 18; Underground Waste Management and Environmental Implications, T.D. Cook (Ed.), Proceedings of a Symposium, Houston, TX, December 6-9, 1971. (pp. 318-333). (1972)

At the Oak Ridge National Laboratory (ORNL) low-level wastes are treated with lime-soda to remove strontium and cesium at 83 and 86% levels respectively. With an increase in the lime-ash addition, the 90Sr strontium will be removed. Medium-level waste is disposed into a bedded shale formation by the hydraulic-fracturing technique. Many ion adsorption equations have been derived for the adsorption by minerals. One of the common features is that the concentration of the radionuclide and its stable counterpart is usually very low compared to the concentration of dissolved ions. For example, in low-level liquid waste stable strontium is 1/2500 of the molar sum of the cations. Soils, as well as the different chemical quality of the waste solutions, effect ion adsorption. Montmorillonite has a capacity of 100 meq/100 g. This capacity is a result of exchange properties associated with the octahedral layers and isomorphic substitution. Vermiculite has a similar capacity to that of montmorillonite but its isomorphic substitution is related to the tetrahedral layers. Another type of substitution is due to the ionizable ions, hydrogen, present at the edges of the clay mineral edges. While in montmorillonite and vermiculite this kind of exchange accounts for only 5% of the total capacity, in kaolinite it makes up to 50% of the total and 100% of the total in sesquioxides. Ionization substitution is pH dependent, where above 7 there are substantial increases in capacities. The distribution coefficient of vermiculite and kaolinite show decreased sorption when a NaCl solution is used (52,000 vs 2,700 and 250 vs 90, respectively). Such a decrease is explained by sodium ions competing for exchange sites. This decrease is not evidenced by illite due to crystal structure. Edge-lattice fixation was suggested as a suitable mechanism for illitic minerals. Strontium adsorption in natural systems is much lower than cesium due to the competition of calcium for exchange sites. However, heated alumina and limonite exhibit high distribution coefficients. Also, by increasing the pH of the natural water to 10, adsorption is increased. It has been suggested that the Gouy-Chapman electric double-layer theory adequately explains the exchange capacity of the activated alumina. The theory was also used to conclude that strontium adsorption by vermiculite at pH 10 is due to the existence of hydroxyl species. Plutonium in soils has been studied very little and work is now proceeding on the absorption of plutonium from water systems. Consideration of the rock-fluid or sediment-fluid interaction is discussed for low-level waste disposal in permeable formations and medium-level waste disposal by hydraulic fracturing. Some leaching data is also included. (NDV)

Ion Exchange Capacity; pH; Distribution Coefficient; Effective Porosity; Bulk Density

ADSORBENTS; ALLUVIUM; CALCIUM COMPOUNDS; CATIONS; CLAYS; CONTAINMENT; DISPOSAL SITE; EQUATIONS; GEOCHEMISTRY; GEOLOGIC STRATA; GROUND WATER; HYDROLOGY; IMMOBILIZATION; ION EXCHANGE CAPACITY; KAOLINITE; LEACHING; MONTMORILLONITE; PREDICTIONS; RADIONUCLIDE MIGRATION; SALT DEPOSITS; SANDSTONES; SHALES; SOILS; VERMICULITE; WASTE DISPOSAL; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, RADIOACTIVE; LABORATORY STUDIES; THEORETICAL STUDIES

CHEMICAL AND PHYSICAL ASPECTS

<20>
Tamura, T., Oak Ridge National Laboratory, Oak Ridge, TN.

Earth Sciences. (3)

ORNL-5509; Environmental Sciences Division Annual Progress Report for Period Ending September 30, 1978, (pp. 92-101), 197 pp. (1979, April)

Activities of the Earth Sciences Section in FY 1978 included: laboratory and field leaching studies and laboratory characterization of ash/slags and feed coals for the purpose of generating information to be used in the land disposal of wastes produced by the coal industry (the Stored Solids Study); development of a simple and rapid assay technique to estimate biological activity in a denitrification reactor; development of mathematical models relating to impacts of nuclear and coal technologies; and experimental comparison of batch and chromatographic techniques for determination of distribution coefficients (Kd). One of the modeling studies related to geologic storage of radioactive waste. In investigating salt domes along the Gulf of Mexico, it has been found that water flows to the surface through fractures in the caprock overlying the domes. To assess the feasibility of salt domes as radioactive waste repositories, groundwater flow in and around them must be investigated. A preliminary assessment using a simple analytical approach has therefore been performed. Primitive formulae for computing the flow field in the area around the dome and for estimating flow rate to the surface have been derived; application of these formulae to a hypothetical salt dome has been made to establish the possible upper limit of flow rate to the surface. In another study, Kd and selectivity coefficients of two radionuclides (Sr 85 and Bi 63) determined by chromatographic technique under conditions of unsaturated flow have been compared experimentally with values determined by the batch equilibrium method. Conasauga shale was layered in a dry powered form into channel chromatographic plates. Strips of blotter paper were used to deliver the eluting solution [0.12 N $Ca(NO_3)_2$] containing tracer levels of the radionuclide to the horizontal plates. Water movement at 1 cm increments along the chromatograph was determined gravimetrically and radiometrically with tritiated water-labeled solutions. A coupled-equations model was developed to determine Kd values and selectivity coefficients. The model has five variables: the water content, the Darcy velocity, the dispersivity, the selectivity coefficient relating the unknown initially sorbed species to Ca, and the selectivity coefficient relating Ca to the tracer (Sr 85 or Bi 63). Water content and Darcy velocity were obtained experimentally; dispersivity was determined from independent measurements of tritiated water along the chromatographic column, and the first selectivity coefficient by batch equilibrium measurements. Thus, the second selectivity coefficient could be calculated from the model. Because dispersivity measurements were the largest source of error, the maximum and minimum values were used in calculating the selectivity and distribution coefficients. These values were compared with those determined by the batch equilibrium method; the results compare very well, with the selectivity coefficients for Sr and Bi tending to be only slightly greater using the chromatographic method. Kd values for Bi 63 were 5.3-8.6 by chromatographic and 6.5 by batch equilibrium method; selectivity coefficients were 6.9-10.5 versus 10.2. For Sr 85, Kd's were 2.0-3.6 by chromatographic and 2.4 by batch equilibrium method; selectivity coefficients were 1.0-3.2 versus 1.0. (Auth) (ERB)

Selectivity Coefficient; Distribution Coefficient

Sr 85; Bi 63

LEACHING; DENITRATION; ASHES; COAL; METHODS; MODELS; MODELS, MATHEMATICAL; ENVIRONMENTAL IMPACTS; NUCLEAR POWER; DISTRIBUTION COEFFICIENT; STORAGE, GEOLOGIC; WASTE STORAGE; WASTES, RADIOACTIVE; SALT DOMES; GROUND WATER; FRACTURES; CAP ROCK; HYDRAULIC VELOCITY; SELECTIVITY COEFFICIENT; STRONTIUM 85; BISMUTH 63; CHROMATOGRAPHY; UNSATURATED ZONE; SHALES; SEDIMENTARY ROCKS; TRACERS; LABORATORY STUDIES; THEORETICAL STUDIES; SITE SELECTION

CONTAINER DESIGN AND PERFORMANCE

<25>
Probst, W.E., U.S. Energy Research and Development Administration, Transportation Branch, Washington, DC.

The Changing Nature of Nuclear Transport. (A)

IAEA-SR-10/28; Transport Packaging for Radioactive Materials, Proceedings of a Seminar, Vienna, Austria, 1976, (pp. 3-9).(1976, August)

This is a review of the changes in the nuclear transport industry. Major emphasis is placed on verification programs aimed at determining the adequacy of package testing and design programs. The paper identifies problem areas such as (1) the lack of public understanding and acceptance of the safety regulations, (2) transport safeguards, (3) defining the technical basis for safety regulations, (4) increasing numbers of nuclear material shipments, (5) development of spent fuel casks capable of handling high neutron levels, (6) reassessment and validation of radiation dose standards, (7) quality control during package fabrication, (8) correlation of engineering analysis with scale model testing and full scale testing and (9) effects of transportation stress on the integrity of the contents in the package. (auth) (JC)

Major emphasis is placed on identifying problem areas in the transportation of nuclear materials. (DH/JC)

TRANSPORTATION; NUCLEAR MATERIALS; MODELS; RADIATION DOSE; SAFETY; STANDARDS, FEDERAL; PACKAGING; CASKS; DESIGN; REVIEWS

<26>
Calaus, D.E., Rockwell International, Rockwell Hanford Operations, Richland, WA.

States Report, Radioactive Waste Packaging Study. (2)

RHO-ST-16; 69 pp.(1977, December)

This report presents criteria for the packaging of low-level TRU waste (LLTW), intermediate-level TRU waste (ILTW), and cladding waste to ensure that the containers and contents will be compatible with the handling equipment and environments encountered from the time they are filled through final emplacement. This study considers only commercially generated TRU wastes, excluding high-level, spent fuel elements, and gaseous wastes. Proposed criteria are: (1) containers for LLTW should meet the requirements of a 7A(25) package and conform to DOT specification numbers 17C or 17H, and not exceed 55 gallons volume or 800 lbs weight; (2) ILTW and cladding waste containers should not exceed an outside diameter of 24 in., an overall length of 8.5 ft., or a gross weight of 12,000 lbs.; (3) maximum surface radiation levels of packages should be 10 mR/hr for LLTW, 15 R/hr for ILTW, and 2000 R/hr for cladding waste; (4) maximum heat emissions allowed are 5 watts for LLTW, 25 watts for ILTW, and 2000 watts for cladding wastes; (5) container design must be adequate for safe handling; (6) there must be no significant removable surface radioactive contamination of the package; (7) internal pressure maxima are 10 psi for LLTW, while ILTW and cladding must meet ASME Pressure Vessel Code Sec. III, Div. 1. There are also requirements for criticality, waste package contents, waste package identification, and maintenance of quality control records. (LEH)

PACKAGING; WASTES, TRANSURANIC; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; CLADDING; TRANSPORTATION; CONTAINERS; STANDARDS, FEDERAL; DESIGN; PRESSURE EFFECTS; CRITICALITY; BURIAL; QUALITY ASSURANCE; WASTE DISPOSAL; REVIEWS

<27>
Colombo, P., and R.E. Neilson, Brookhaven National Laboratory, Department of Nuclear Energy, Nuclear Waste Management Research Group, Upton, NY.

Properties of Radioactive Wastes and Waste Containers: Progress Report No. 6, July-September 1977. (1)

BNL-NUREG-50778; 42 pp.(1978, January)

The results of a literature survey on the corrosion of steel in soil environments as it applies to the integrity of steel drums and mild steel vaults used for radioactive waste are presented in this report. The effect of the physical and chemical properties of the soil as they relate to the rate of the corrosion of steels was explored. The results of the literature survey suggest that the corrosion rates of ferrous alloys are influenced primarily by soil moisture and chemistry while alloy microstructural and compositional considerations are of secondary importance. It was observed, however, that as a steel is made more resistant to uniform corrosion it becomes more vulnerable to pitting corrosion. The general concepts of corrosion are discussed. The physical properties of the soil environment which are discussed include aeration and moisture content. Chemical properties affecting corrosion which are discussed include dissolved inorganic constituents, organic matter, and pH. Tests and criteria for assessing soil aggressiveness with respect to corrosion include resistivity, total acidity, redox potential, and polarization of the metal. (JC)

Good review of soil parameters which can be measured to determine relative aggressiveness of soil. (DH/JC)

DRUMS; STEELS; CORROSION; LABORATORY STUDIES; SOILS; ALLOYS; RESISTIVITY; CLAYS; MOISTURE CONTENT; CONTAINER INTEGRITY; ORGANIC COMPOUNDS

<28>
Kleinschmidt, R.S., Harvard University, Department of Sanitary Engineering, Cambridge, MA.

Optimum Flow Characteristics of Tanks for Decay of Pile Cooling Water Activity and Storage of Fuel Elements. (A)

TID-7517 (Part 1); Sanitary Engineering Aspects of the Atomic Energy Industry, Atomic Energy Commission Papers, December 1955, (pp. 60-96) (TID-7517, Part 1).(1955, December)

Large tanks are used to store fuel elements removed from nuclear reactors. Here, water serves as a shield against radioactivity, as well as a coolant of heat given off from fuel elements and as dilutant of an radioactivity

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CONTAINER DESIGN AND PERFORMANCE

<28> CONT.
released from a defective fuel element in storage. Practice is (1) to recirculate and filter for clarification and decontamination of the water or (2) to permit continuous in and out flow of purified water. Again short circuiting should be avoided as an economy measure. This means the tank should have the most favorable flow characteristics possible for its size. The temperature of this water is not high as in the case of reactor coolant water. In the investigation of detention tanks the so called "flow-through curve" is a most useful analytical tool. Ideally, such a curve provides a statistical distribution of the flow-times of individual water molecules in passage through the tank. Actual flow-through curves can only approximate such a distribution since the tracer molecules or ions do not necessarily follow pathlines that are identical with those of water molecules or particles of waste. Moreover, limitations are imposed by imperfections in the sensitivity and precision of the tracer detection apparatus. However, these non-ideal conditions may ordinarily be controlled so that the error is negligible from a practical viewpoint. A flow-through curve obtained with a good tracer and detection apparatus provides useful information relating to the detention characteristics of a tank. With a knowledge of the statistical distribution of flow-times of individual particles it is possible to calculate the reduction in activity of any radioactive isotope of specified half-life in passage through the basin. (Auth)

TANKS; FUEL ELEMENTS; FILTERS; DECONTAMINATION; COOLANTS; TRACERS; IONS; PARTICLES; DILUTION; WASTE STORAGE; WASTES, SOLID; TRACERS; EVAPORATION; INSTRUMENTS; MODELS; EQUIPMENT; PLASTICS; LABORATORY STUDIES; RADIOACTIVE DECAY; STATISTICS; SHIELDED CONTAINERS; THEORETICAL STUDIES

<29>
Kniazeveyez, B.G., and J.E. Ash, TERA Corporation, Berkeley, CA; Fiberglass Design, Benicia, CA.

Is the Steel Drum the Answer?. (T)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.R. Boghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 6, (pp. 593-604), 1218 pp. (1979)

Present low-level radioactive waste packaging is dominated by the use of 55-gallon drums, while larger sizes are being utilized because of economic incentives. The use of steel with its inherent corrosion tendencies results in potential problems at the burial site. The use of advanced fiberglass has a price penalty when compared with the 55-gallon drum, it benefits make it an attractive waste burial material. Fiberglass covered drums or containers offer a number of advantages over aluminum, steel, plastic, and wood for the storage of nuclear waste. The effective life span of the fiberglass container is at least 50 years. Fiberglass resin is a radiation barrier, offering shielding properties to minimize surface dose rates. Fiberglass is water resistant and minimizes any leaching of waste into the soil over significant periods of time. It provides structural integrity and can be designed to withstand the compressive loads encountered in earth burial operations (a 1/8-in. FRP fiberglass can withstand a pressure of 100 psi). Fiberglass has a high corrosion resistance. It can be used in association with fire retardant or self-extinguishing resins to operate continuously at 300 F. It has high strength-to-weight ratios as compared to concrete and steel; a fiberglass mat laminate has a strength-to-weight ratio of 300,000 compared with 230,000 for steel. Fiberglass is electrically nonconductive and is a thermal insulator. It has a smooth durable outer finish of solded gelcoat for ease of decontamination and ultraviolet protection. The threshold exposures for significant damage to the fiberglass resins proposed for waste containers are high; typical resins which would be used are Mineral Filled Polyester [2 X 10(E+9) rad threshold] and Aromatic Amine-Cured Epoxy Polymer [10(E+10) rad threshold]. Finally, fiberglass meets Department of Transportation requirements. The key to a fiberglass nuclear waste container is the design integrity achieved through the quality of the materials used; i.e., tensile strength for 1/8 in. of fiberglass can vary from 8,000 to 500,000 psi depending upon the type of glass and resin specified. Hand lay-up, chopper gun applications have been tried by some nuclear facilities to cover wooden boxes. This method was employed chiefly because the fabricators and designers thought it was the cheapest alternative. In multilayer applications, the chopper gun method typically uses much more fiberglass, labor, and resin than other methods; thus creating a more costly part. The secret to successful fiberglass design is to employ high quality materials such as woven roving or mat, which yield a lower cost part with two to four times the material strength. Using such a method, the fiberglass alternatives to the 55-gallon drum as a nuclear waste container are virtually unlimited. (Auth) (LKH)

A table of physical properties of fiberglass laminates made of polyester resin and various glass compositions is included.

FIBERGLASS; DRUMS; CONTAINERS; WASTES, LOW-LEVEL; RESINS; PHYSICAL PROPERTIES; CHEMICAL PROPERTIES; TENSILE STRENGTH; CORROSION; EVALUATION; THERMAL PROPERTIES; LEACHING; REVIEWS

<30>
Merline, R.J., D.L. Ush, and K. Peralta, Rockwell International, Atomics International Division, Rocky Flats Plant, Golden, CO.

Radioactive Waste Package Development at the Rocky Flats Plant. (2)

IAEA-SR-10/26; Transport Packaging for Radioactive Materials, Proceedings of a Seminar, Vienna, Austria, 1976, (pp. 153-161) (IAEA-SR-10/26). (1976, August)

Current federal regulations require that alpha contaminated wastes (specific activity greater than 10 nCi/g) be contained in containers which can be placed in retrievable storage for twenty years after which the external surface of the package must be contamination free and capable of being rehandled. The paper reviews Rocky Flats's package development progress in light of these requirements. The average annual volume of plutonium contaminated wastes produced at the facility exceeds 3500 cu m. These wastes are

<30> CONT.
transported after interim storage on site, to the surface storage facility at INEL. These wastes are mostly frequently transported in 215 liter steel drums lined with 0.23 minimum thickness polyethylene liner. This liner is molded from a cross-linkable resin and is designed for stiffness. This stiffness permits stacking even if corrosion of the steel drum occurs. Real-time aging experience with 0.15 cm steel and 0.23 cm polyethylene indicates a life time in excess of 20 years. Alternative liners considered include (1) a thermally formed open-head liner (0.08-0.20 cm thick) (2) a blow-molded closed head-liner (0.10-0.20 cm thick) and (3) a fiber glass reinforced polyester resin (0.15 cm thick). Wastes are also packaged in plywood boxes 3 cu m capacity, walled on the exterior with 0.32 to 0.65 cm fiberglass reinforced polyester. (JT)

A review of the historical and current package developments for Pu 239 wastes generated at the Rocky Flats Plant. (DH/JT)

PACKAGING; WASTES, RADIOACTIVE; PLUTONIUM; CONTAMINATION; LINERS; WASTE VOLUME; STANDARDS, FEDERAL; RETRIEVABILITY; DRUMS; STEELS; RESINS; ECONOMICS; POLYETHYLENE; REVIEWS

<31>
New Problems Arise for Nuclear Waste Storage. (N)

Chemical and Engineering News, 7 pp. (1978, June 12)

New findings have shown that the heat generated by the decay of high-level waste may increase the leach rate of calcines and borosilicate glass. Reprocessed waste canisters are expected to have 5 kw heat production 10 years after reprocessing. Spent fuel assemblies are expected to generate 0.5 kw. This heat could raise the temperature of salt formations to 400 degrees C. Leach tests at 300 degrees C and 300 atm on borosilicate glass showed complete destruction of the glass within 2 weeks and extensive chemical reactions between the wastes in the glass and the leaching solution. Similar experiments on calcine gave similar results. The DOE and the Swedish State Power Board are beginning a joint study on effects of heat on granite formations. Concern is that heat may cause expansion and cooling contraction with resultant cracking leading to increased ground water flow. Heaters have been placed in an abandoned iron mine and stress monitors set up in adjacent rock. (PTG)

A report on an article about the problems that radioactive decay heat may pose on leaching properties of calcine and borosilicates. (DH/PTG)

WASTES, HIGH-LEVEL; GLASS; SILICATES; CALCINE; TEMPERATURE; LEACHING; GRANITES; SALT DEPOSITS; GROUND WATER; FUEL REPROCESSING; WASTE MANAGEMENT; FIELD STUDIES

<32>
Rose, D.E., R. Hart, T. Wright, D. Weaver, and R.P. Stearns, SCS Engineers, Long Beach, CA.

Study of Engineering and Water Management Practices that Will Minimize the Infiltration of Precipitation into Trenches Containing Radioactive Waste. (T)

ORP-LV-78-5; 91 pp. (1978, June)

The results of a study of engineering and water management practices to limit infiltration of water into radioactive waste burial trenches is presented. The study, commissioned by the U.S. Environmental Protection Agency, emphasized the comparison of barriers to minimize or eliminate percolation of water into disposal trenches, methods to stabilize the ground surface at disposal sites, and procedures to minimize the perpetual care and maintenance at these sites. Trench and site construction alternatives are discussed with respect to expected benefits, potential drawbacks, approximate costs per specified reference disposal trench, and applicability of the method. Trench caps and covers are discussed with respect to advantages, disadvantages, expected longevity of barrier, applicability of option, and the approximate cost per specified reference trench. A multilayer cover is stated to provide the best overall improvement and consists of a surface layer of gravel, a protective layer of soil, an impervious cap, and compacted soil directly over the solid waste cell. The general philosophies governing monitoring and maintenance are discussed in detail and a recommendation for installation of relatively inexpensive soil moisture cells to detect anomalous moisture accumulations in burial trenches is made. (JC)

Although some of the information provided in the general background section of the report is incorrect, the review of infiltration barriers, trench construction alternatives, and trench grouting is quite thorough. (DH/JC)

TRENCHES; BURIAL; LINERS; CLAYS; CONCRETES; ASPHALTS; SOILS; GROUTING; MONITORING; MAINTENANCE; SEAL MATERIALS; SITE SELECTION; WASTE MANAGEMENT; MOISTURE; DISPOSAL SITE; COST BENEFIT ANALYSIS; WASTES, SOLID; WASTES, RADIOACTIVE; CAPPING; SEALING; REVIEWS

<33>
Weinstein, C.Z., Technigaz, France.

Confinement Chamber for Radioactive Products or Wastes. (S)

French Patent No. 2,209,983; WLH-2395(FR); 27 pp. (1977, January 18)

This paper describes a design for a confinement chamber for either low-level liquid or high-level solid wastes. It is designed to eliminate current problems due to container corrosion and leakage, contamination of coolant water or air, the power consumption of forced cooling, and the expense of thick-walled self-supporting stainless steel containers. The system is composed basically of two concentric chambers of thin corrugated stainless steel, surrounded by a supporting concrete casing. A cooling system using naturally convecting fluid may surround one or both chambers. (LSH)

Document translated by the Frank C. Farnham Company, Philadelphia, Pennsylvania for Wound Laboratory, Mississburg, Ohio.

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<33> CONT.
MATERIAL; CONTAINERS; TANKS; WASTE STORAGE;
WASTES, HIGH-LEVEL; WASTES, LOW-LEVEL; WASTES,
LIQUID; WASTES, SOLID; DESIGN; COOLANT SYSTEMS;
STEELS; COOLANTS; WASTE MANAGEMENT; REVIEWS

DISPOSAL SITE

<34>
Adams, L.E., D.H. Jenke, and P.T. Dickman, EG and G Idaho, Inc., Idaho Falls, ID.

Environmental Surveillance Report for the Idaho National Engineering Laboratory Radioactive Waste Management Complex -- Annual Report, 1978. (2)

TREE-1357; 50 pp.(1979, June)

This report presents the results of monitoring and surveillance activities conducted at the INEL Radioactive Waste Management Complex (RWMC) during 1978. The surface radiation survey of the Subsurface Disposal Area (SDA) found background radiation to be 0.05 mR/hr at 0.9 m above surface. Areas with readings greater than 1 mR/hr included a small area near Pit 15, locations surrounding Trench 58, and the Soil Vault Area (SVA). The decommissioned SL-1 reactor was also surveyed, with no readings above 1 mR/hr. Thermoluminescent dosimeter surveys of the RWMC perimeter revealed exposures of 67-1566 mR over the 6-month exposure periods; average background was 129 mR/yr. Exposures near Pit 15 were 21.5 times background, while Trench 58 and the SVA measured 8 times background. Air sampling using 16 high-volume air samplers and 6 constant air monitors showed a noticeable radiation peak in late March, corresponding to fallout from a Chinese nuclear test; other minor peaks reflected RWMC operational activities and/or variations in weather patterns. Of 648 filters analyzed in 1978 all but 2 had radionuclide concentrations less than 1% of uncontrolled area Radiation Concentration Guide (RCG) limits. These two contained Am 241 at 36% and 89% RCG (about 10(E-13) uCi/ml). Soil samples collected at 25 surface locations within the SDA revealed the highest contamination to be in the northeast sector of the area; commonly detected isotopes were Co 60, Hf 181, Cs 137, Ru 103, Zr 95-Nb 95, and Ce 141. Twenty-eight surface water samples were collected from runoff locations on the Transuranic Storage Area (TSA) pond, Transuranic Disposal Area (TDA) pond, and occasionally from Pit 15 when standing water was present. Fourteen additional samples were taken from the Big Lost River northwest of the RWMC. The most common gamma isotope detected in the samples was Cs 137 (22 of 82 samples; maximum concentration 12.00 X 10(E-9) uCi/ml. Other common isotopes were Cs 134, Ce 144, Co 60, and Ru 106 (maximum concentrations 3.90 X 10(E-9), 7.30 X 10(E-9), 16.00 X 10(E-9), and 18.00 X 10(E-9) uCi/ml, respectively). All values were less than 1% of uncontrolled area RCG limits. Subsurface water samples exhibited minute quantities of H 3 (6.0 X 10(E-7)-1.9 X 10(E-6) uCi/ml), attributable to Idaho Chemical Processing Plant and Test Reactor Area operations. Other routine studies continued in 1978 included subsurface moisture monitoring and TSA monitoring. Special studies and projects conducted or initiated in FY 1978 included: faunal and floral characterization studies and radionuclide analysis, soil moisture exclusion studies, Intermediate Level Transuranic Storage Facility monitoring, dust sampling, phase-lag studies of basalt and interbed permeability beneath the RWMC, and lysimeter studies. (LKH)

Cs 137; Cs 134; Ce 144; Co 60; Ru 106; H 3; Am 241

DISPOSAL SITE; MONITORING; SITE SURVEILLANCE; BACKGROUND RADIATION; PITS; TRENCHES; REACTORS; AIR QUALITY; FALLOUT; RADIOACTIVITY; ARTICLES 201; SOILS; SAMPLES; COBALT 60; HAFNIUM 181; CESIUM 137; RUTHENIUM 103; ZIRCONIUM 95; NIOBIUM 95; CERIUM 141; SURFACE WATERS; GROUND WATER; PONDS; RIVERS; CESIUM 134; CERIUM 144; RUTHENIUM 106; TRITIUM; MOISTURE; BIOTA; RADIONUCLIDES; UPTAKE; FIELD STUDIES; LABORATORY STUDIES; MEASUREMENTS; ECOLOGICAL STUDIES

<35>
Albrecht, E., K. Kuhn, and P. Perzl, Gesellschaft fur Strahlenforschung mbH, Munich, German Federal Republic.

Disposal of Radioactive Wastes by Storage in a Salt Mine in the Federal Republic of Germany, Part 1. (2)

CONF-700905; STI/PUB/264; Developments in the Management of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Aix-en-Provence, France, September 7-11, 1970. International Atomic Energy Agency, Vienna, Austria, (pp. 753-759) (CONF-700905, STI/PUB/264).(1970, September 7-11)

Disposal of low- and intermediate-level radioactive wastes in the Asse salt mine in Lower Saxony has been accomplished in an extensive program of scientific research and technical development. Two-hundred litre drums of waste were emplaced in salt mine chambers in various configurations at a depth of 750 meters. Transportation and handling techniques within the mine were evaluated and safety monitoring of the operation was carried on at all times. Operations to date have not encountered any significant complications or radioactive contamination problems. (CAB)

Not really shallow land burial because of depths at which containers are disposed. (DS/CAB)

CONTAINERS; MINES; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; SALT DEPOSITS; DRUMS; WASTE VOLUME; WASTES, SOLID; WASTE STORAGE; SAFETY; MONITORING; STORAGE, GEOLOGIC; REPOSITORY; FIELD STUDIES

<36>
Appich, T.H. Jr. (Translator), Company for Radiologic and Environmental Research, Inc., Munich, German Federal Republic.

Answer to Some Questions in Connection with the Research Project Entitled "AVR Fuel Element Embedment". (3)

ORNL-tr-0468; 16 pp.(1977, April 14)

Answers to questions about the waste storage and test facility at the Asse mine are given. The mine facility is owned by the Federal Republic of Germany and is operated by the Company for Radiologic and Environmental Research. Asse is a research and test facility and as such is not for permanent storage. However, the tests being performed will require a minimum of 20 yrs. Even after the tests are finished the waste will not be transferred to permanent storage at Gorleben or elsewhere. Other areas that are geologically and hydrologically favorable are being surveyed. Authorizations for the operation of the facility, transport of wastes, and handling of radwastes come from

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<36> CONT.
various laws existing under the German Atomic Law Act. Weakly radioactive and medium-level waste are to be stored in Asse. This includes AVR fuel element graphite pellets. Up to now 78,000 vessels of low-level wastes and 1,300 vessels of medium-level waste are stored in the mine. For the safety of the personnel and environment dose measurements are taken and general regulations are followed. Carnallitite is not considered a problem. The graphite spheres are medium-level wastes and contain 1/100 of the activity value of high-level radwastes. They are spent fuel which does not contain enough uranium to make reprocessing feasible. An alarm system is on site for any safety problems. (HDV)

Appendices giving definitions and permissible activity for each category of waste are included.

CONTAINMENT; DISPOSAL SITE; FIELD STUDIES; INFORMATION; FUEL ELEMENTS; MINES; NUCLEAR FACILITIES; REPOSITORY; SITE SURVEILLANCE; SALT DEPOSITS; STORAGE, GEOLOGIC; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL

<37>
Applied Nucleonics Company, Inc., Los Angeles, CA.

Technical Information Summary: Soil Grouting. (N)

Non-Private Publication by The Technical Staff, Applied Nucleonics Company, Inc., Santa Monica, CA. (1977, January)

The first stage of a feasibility study to employ cement or chemical grouting to replace an impervious envelope around liquid radioactive waste tanks at Hanford for secondary containment during waste retrieval is described in this report. This report presents an introductory section on the process of grouting, reprints from the Journal of the Soil Mechanics and Foundations Division, a grouting bibliography, promotional commercial brochure material, a grouting feasibility discussion, and conclusions and recommendations. The discussions are directed towards contaminant migration prevention. (JC)

Although the application discussed in this report is for liquid waste tanks, in some instances application to fill low-level radioactive waste trenches or provide peripheral grout curtains may prove feasible. (DM/JC)

TRENCHES; BURIAL; WASTES, RADIOACTIVE; SOILS; GROUTING; CEMENTS; SANDS; GRAVELS; RESINS; POLYMERS; POROSITY; WASTES, SOLID; RETRIEVABILITY; BIBLIOGRAPHIES; TANKS; WASTES, LIQUID; WASTES, RADIOACTIVE; RADIONUCLIDE MIGRATION; FIELD STUDIES

<38>
Apt, K.E., and W.J. Lee, Los Alamos Scientific Laboratory, Los Alamos, N

Environmental Surveillance at Los Alamos During 1976. (N)

LA-5977-PR; 87 pp. (1975, May)

The results of the routine monitoring of radiation levels and levels of radioactive and nonradioactive contaminants in the environs at and around the laboratory are presented for 1976. Analyses were conducted on atmospheric, water supply, surface and ground water, sewage treatment plant effluent water, soil, and sediment samples. Radiochemical analyses for gross alpha, beta, gamma, plutonium 238/239, cesium 137, and tritium were conducted on all samples. Uranium concentration in all samples was determined by fluorometric analyses. Sampling of airborne contaminants was conducted on both a daily and weekly basis. Analyses were compared to appropriate standards. The only measureable radioactivity above background beyond Laboratory boundaries was from airborne tritiated water. The dose to the 1[illegible],000 residents of Los Alamos County was calculated to be 0.28 mrem and represents the only measurable dose from laboratory operations to the population within an 80 km radius of the laboratory. Two inadvertent releases of radioactive material occurred on site during 1976 which were associated with one industrial waste sewer. Contamination resulting from both incidents was successfully removed and no exposures to on or off-site personnel are known to have occurred. Most of the radioactivity in each incident was due to plutonium 238. Other isotopes detected include strontium 89, strontium 90, and cesium 137. (RT)

A summary of the environmental radioactivity around the Los Alamos Scientific Laboratory. The majority of the data is not directly applicable to shallow land burial of radioactive waste. (DM/JT)

Pu 238; Pu 239; U; Y 138; H 3; Sr 89; Sr 90; Cs 137

MONITORING; ENVIRONMENT; RADIOACTIVITY; SEDIMENTS; SOILS; MEASUREMENTS; ALPHA PARTICLES; BETA PARTICLES; TRITIUM; PLUTONIUM; URANIUM; CESIUM; WINDS; PRECIPITATION, METEOROLOGICAL; TEMPERATURE; METEOROLOGY; EFFLUENTS, AIRBORNE; RADIONUCLIDE MIGRATION; LABORATORY STUDIES

<39>
Arthur, W.J., D.E. Halford, O.D. Markham, and D.W. Janke, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID; EG and G Idaho, Inc., Idaho Falls, ID.

Radiation Doses to Small Mammals at the Idaho National Engineering Laboratory Radioactive Waste Management Complex. (N)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 10-11) 2 pp. (IDO-12088). (1979, April)

A project to estimate radiation doses received by small mammals at the Subsurface Disposal Area (SDA) of the INEL Radioactive Waste Management Complex was initiated in October, 1977. A 296-point grid of thermoluminescent dosimeter packets (TLD-700) was set up to provide above-ground radiation exposure estimates. Packets will be removed at four-month intervals and analyzed, the results being used to create a radiation exposure contour map of the area. Deer mice (PEROMYSCUS MANICULATUS) and Ord's kangaroo rats (DIPODOMYS ORDII) are being live trapped

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<39> CONT.
in and around the SDA, implanted with TLD chips, and released for later recapture. Radiation doses to the animals will be compared to that of the capture area, and the possibility of seasonal differences will be checked. Tissues are being collected from animals with higher than background doses in conjunction with another study. Radiation doses received by pygmy rabbits (SYLVILAGUS IDAHOENSIS) and mountain cottontail rabbits (SYLVILAGUS NUTTALLII) in the SDA are also being estimated using the same method. Information from these studies will help determine what proportion of the small mammals inhabiting the INEL Subsurface Disposal Area are burrowing into or near pits and trenches containing radioactive waste. Animals burrowing near buried waste should have radiation doses significantly higher than ambient exposures. Burrowing may also affect the long-term integrity of shallow burial sites. (LKE)

MAMMALS; RADIATION DOSE; EXPOSURE RATE; BURROWING ANIMALS; PITS; TRENCHES; WASTES, LOW-LEVEL; WASTES, SOLID; FIELD STUDIES; ECOLOGY; ECOLOGICAL STUDIES

<40>
Arthur, W.J., and O.D. Markham, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Ecology Studies at the Idaho National Engineering Laboratory Radioactive Waste Management Complex. (3)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 28-29) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 78-92; 371 pp. (IDO-12087).(1978, December; 1979, April)

In September 1977, studies were initiated at the INEL Radioactive Waste Management Complex to determine the impact of radwaste disposal operations on the flora and fauna of the area, and the possible role of these ecosystem components in radionuclide uptake and transport. Animal species utilization of the area is being estimated by tri-weekly driving transects. Tissue samples are being collected from several species of rodents and birds inhabiting the area and analyzed for fission and activation products, Po 210, Pu 239, 240, and Am 241. Data is also being collected on invertebrates. Prey remains and fecal samples from the local predators are being collected and analyzed to estimate radionuclide transport in the food chain. A 296-point grid system was established over the RWMC and vicinity to provide permanent environmental sampling stations. On each grid a 1 m radius circle will be observed for presence and type of soil burrowing. Estimates will be made of the amount of soil burrowed (in g/ha), and where burrow samples are collected over waste trenches or pits, a radionuclide analysis will be conducted. A vegetation sampling program will be conducted to obtain data on floral species present, biomass, percent ground cover, and to determine whether plants play a role in uptake and movement of radionuclides in the ecosystem. Only plants growing within the Subsurface Disposal Area will be studied, as these are the ones most likely to be contaminated. Vegetation samples will be collected and analyzed for transuranic, mixed fission, and mixed activation products, and this data will be related to biomass to estimate the total radioactivity in the vegetation that is available for environmental transport. Preliminary information obtained from these studies will be available for an environmental impact statement to be drafted in 1979. (LKE)

Po 210; Pu 239; Pu 240; Am 241

DISPOSAL SITE; PITS; TRENCHES; BIOTA; BIRDS; BURROWING ANIMALS; ECOSYSTEMS, TERRESTRIAL; ENVIRONMENTAL IMPACT STATEMENTS; ENVIRONMENTAL EXPOSURE PATHWAY; ENVIRONMENT; FOOD CHAINS; GRASSES; INSECTS; PLANTS; RADIONUCLIDE MIGRATION; FIELD STUDIES; SAMPLING; METHODS; FISSION PRODUCTS; ACTIVATION PRODUCTS; ECOLOGY; RADIONUCLIDES; BIOLOGICAL STUDIES; TRANSURANICS; WASTE DISPOSAL; UPTAKE

<41>
Barraclough, J.T., U.S. Geological Survey, Idaho Falls, ID.

Liquid Waste Disposal at the Idaho National Engineering Laboratory and Resultant Waste Plumes in the Snake River Plain Aquifer. (2)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (p. 67) 72 pp. (IDO-12088).(1979, April)

Plumes of several waste components in the Snake River Plain Aquifer at INEL have been monitored and mapped periodically from as early as 1958. Most of this waste comes from a reactor fuel reprocessing facility where H 3, Sr 90, Cs 137, I 129, Na, Cl, and thermal effluents are injected through a 183 m deep disposal well, and from liquid waste leaching ponds near reactor test facilities, where wastes containing H 3, Sr 90, Cs 137, Co 60, Cr 51, Na, and Cl percolate downward to form perched water bodies and enter the aquifer. H 3 has been dispersed over an area of about 72 sq km in the aquifer and has migrated about 12 km downgradient. The Sr 90 plume is about 8 sq km in area and extends about 2.5 km from the discharge site. Cs 137 has not been detected in the aquifer, and may have been immobilized by ion exchange in the sediments. A thermal plume covers about 5 sq km of the aquifer, and Cl and Na plumes about 39 sq km. I 129 is dispersed over about 8 sq km and has migrated about 8 km downgradient from the discharge site. Concentrations of these waste products are low relative to drinking water. This study has produced extensive field data which are available for analyzing solute migration phenomena in groundwater. Numerical solute transport modeling techniques are available to predict the migration of these materials in the future. (LKE)

H 3; Sr 90; Cs 137; I 129

AQUIFERS; GROUND WATER; WASTES, RADIOACTIVE; WASTES, LIQUID; TRITIUM; STRONTIUM; CESIUM; IODINE; SODIUM; COBALT; CHROMIUM; CHLORINE; PERCHED WATER; RADIONUCLIDE MIGRATION; FIELD STUDIES; WELLS, INJECTION; HOLDING PONDS; PONDS; WASTE DISPOSAL

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Barraclough, J.T., and R.G. Jensen, U.S. Geological Survey, Idaho Falls, ID.

Hydrologic Data for the Idaho National Engineering Laboratory, Idaho, 1971-1973. (7)

IDO-22055; USGS Open File Report 75-318; 28 pp. (1975, July)

Chemical and radioactive waste disposal at the Idaho National Engineering Laboratory (INEL) is through seepage ponds and deep injection wells. A program of water level and water quality monitoring is observation wells was instituted. Water level changes were mapped and the migration of radionuclides and chemical wastes were delineated in the Snake River Plain Aquifer and in four perched water bodies beneath the site. Results showed that wastes have migrated a maximum of five miles from the disposal point. The average water table gradient is about 5 ft/mi to the south - southwest. Within the INEL boundaries, the depth below the land surface to the regional water table ranges from 200 ft in the northwest to 900 ft in the southwest. Transmissivity of the aquifer is high, generally ranging from 1 million to 100 million (gal/d)/ft. Mapping of waste plumes indicated that strontium 90 decreased to below detection limits within 1,000 feet as a result of sorption. Cesium 137 undergoes strong sorption and has not been detected in ground water. Chromium 51 migrated 0.25 miles in 3 months and was dissipated mainly by radioactive decay. Tritium concentrations are greatest beneath seepage ponds and decrease gradually outward. A close correlation was observed between discharges to the seepage ponds and concentrations in the aquifer with a lag time on the order of months. Migration of wastes was greatest toward the south. Recharge to the aquifers originated from seepage ponds, injection wells, and lake, and the three intermittent streams which flow onto the INEL site, especially from the Big Lost River in the southwestern part of the area. (CAB) (CSF)

Traces the migration of radionuclides in the subsurface from seepage ponds and deep well injection. Applicable to movement of such wastes from shallow land burial sites. (DS/CAB)

Transmissivity; Hydraulic Gradient; Depth to Water Table; Migration Rate

H 3; Sr 90; Co 60; Cr 51; Cs 137

SEEPAGE PITS; DILUTION; PERCHED WATER; ABSORPTION; PONDS; WELLS, INJECTION; RADIOACTIVE DECAY; RADIONUCLIDE MIGRATION; AQUIFERS, UNCONFINED; WASTES, RADIOACTIVE; MONITORING; WATER TABLE; DISPOSAL SITE; HYDROLOGY; GROUND WATER; FIELD STUDIES

<43>
Barraclough, J.T., and J.B. Robertson, U.S. Geological Survey, Idaho Falls, ID.

Current Distributions of Liquid Radioactive and Chemical Wastes in the Snake River Plain Aquifer at the Idaho National Engineering Laboratory Site. (3)

IDO-12079; Summaries of the Idaho National Engineering Laboratory Site Ecological Information Meeting, O.D. Markham (Ed.), (p. 10), 68 pp., (IDO-12079). (1975, July 10)

The Idaho National Engineering Laboratory Site is located on the eastern Snake River Plain, which is a large graben or downwarped structured basin covering 10,000 square miles in southeastern Idaho. The rocks underlying the plain consist of numerous thin basaltic lava flows and interbedded sediments. The thickness of the plain is unknown but deep electrical-resistivity soundings suggest it may be several thousand feet. Beneath most of the plain is a vast ground-water reservoir--the Snake River Plain Aquifer. The Snake River Plain Aquifer is recharged by percolation from irrigation, seepage from streams, and direct precipitation. The flow of ground water is to the south-southwest at relatively high velocities of 5 of 15 feet per day. The water table in the aquifer slopes at an average gradient of five feet per mile. Industrial and low-level radioactive liquid wastes at the INEL Site have been discharged to the Snake River Plain Aquifer since 1952. The movement and distribution of these wastes have been monitored. The waste discharge to the aquifer contained small quantities of tritium, Sr 90, Cs 137, Co 60, chloride, hexavalent Cr various acids and bases, and heat. Tritium and chloride have dispersed over a 15-square mile area of the aquifer in low but detectable concentrations and have migrated as much as 5.5 miles downgradient from discharge points. Lateral dispersion has diluted and spread the waste products rapidly. The movement of cationic waste solutes, particularly Sr 90 and Cs 137, has been significantly retarded owing to sorption phenomena, principally ion exchange. Cesium-137 has not shown detectable migration in the aquifer, and Sr 90 has migrated only about 1.5 miles from a discharge well. The Sr 90 plume covers an area of 1.5 square miles of the aquifer. (Complete Text)

WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, INDUSTRIAL; DISTRIBUTION; SITE SURVEILLANCE; ROCKS; BASALTS; SEDIMENTS; GROUND WATER; AQUIFERS; WATER TABLE; MONITORING; TRITIUM; STRONTIUM 90; CESIUM 137; COBALT 60; CATIONS; CHLORIDES; CHROMIUM; ACIDS; BASES; THERMAL PROPERTIES; RADIONUCLIDE MIGRATION; CONTAMINANT TRANSPORT; DISPERSION; SORPTION; RETARDATION FACTOR; ION EXCHANGE; FIELD STUDIES

<44>
Barraclough, J.T., J.B. Robertson, V.J. Janzer, and L.G. Saindon, U.S. Geological Survey, Water Resources Division, Idaho Falls, ID.

Hydrology of the Solid Waste Burial Ground, as Related to Potential Migration of Radionuclides, Idaho National Engineering Laboratory. (1)

IDO-22056; USGS Open File Report 76-71; 185 pp. (1976, August)

The solid waste burial ground at Idaho National Engineering Laboratory (INEL) has been utilized since 1952 for burial of contaminated wastes containing activation and fission products and since 1954 for storage and burial of transuranic wastes. Baseline data concerning geologic and hydrologic conditions at the site in 1969 were used as a basis for setting up a program in 1970 to monitor and further expand knowledge of the geologic, hydrologic and geochemical conditions at the site. This program was aimed at identifying any changes brought about by past operations at INEL and

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monitoring the environment to identify any changes which might occur in the future. Four observation wells were drilled approximately 50 feet below the level of the regional water table (600 ft). Six shallow observation wells were cored within the burial ground to depths of about 240 feet. The latter penetrated 2 major sedimentary layers interbedded with basalts on the assumption that the sediment would have the most dominant geochemical and hydraulic influences on migrating waste solutes. Water samples were collected from the Snake River Plain aquifer and chemical and radiochemical analyses performed on these as well as on basalt chips from various horizons and sediments from the surficial, 110-foot and 240-foot sedimentary layers. Fifty samples out of 491 tested for radiochemical waste products contained such products in concentrations greater than twice their own standard deviations. These results indicate that isotopes derived from buried waste or fallout were present in these samples. Similar results were obtained from tests run on water samples obtained from the observation wells. The evidence points to waste migration down to the 110-foot sedimentary layer and possibly to the 240-foot layer and laterally to exterior observation wells outside the fenced burial ground. The possibility that samples were contaminated during collection is discussed. The selected rock cuttings and sediment samples were analyzed for certain hydrogeologic parameters and characteristics. Median grain size of all the analyses was 0.066 mm. Values for clay content ranged from 5.0 to 52.6% with a mean of 22%; values were 13.4 to 80.9% for silt, 0 to 25.6% for sand, and 0 to 25.0% for gravel. Bulk density of sedimentary samples from the INEL burial ground wells showed values of 1.34 to 2.41 g/cm cm. Porosity of the samples ranged from 20.6 to 53.4%. Moisture content varied from 3.15 to 45.7%. The water table in the aquifer beneath the burial ground is at a depth of about 580 ft. Specialized field tests of the Snake River Plain indicated an average horizontal permeability of about 20 darcies (equivalent to a hydraulic conductivity of about 55 ft/day) and vertical permeability of about 6 darcies (equivalent to a hydraulic conductivity of about 15 ft/day). The basalt demonstrated a ratio of horizontal conductivity to vertical conductivity of 3.7 to 1.0. For sedimentary strata, vertical hydraulic conductivities ranged from 1.6 x 10(E-7) to 3.0 m/day. Cation exchange capacity major minerals ranged from 1.1 to 45 meq/100 g with an average of 15.6 meq/100g. (CAB) (CSY)

Very useful case study of radionuclide migration from shallow land burial, although drilling and sampling methods were later found to be responsible for the contamination. (DR/CAB)

Hydraulic Conductivity; Volumetric Water Content; Clay Content; Grain Size Distribution; Density; Porosity; Depth to Water Table; Ion Exchange Capacity; Mean Precipitation

Co 60; Sr 90; Cs 137; Ba 140; Pu 238; Pu 239; Pu 240; Am 241; Co 57; H 3

WASTE DISPOSAL; RADIONUCLIDE MIGRATION; BOREHOLES; GEOPHYSICAL SURVEYS; HYDROLOGY; BASALTS; DRILLING; ADSORPTION; SAMPLING; LOGGING, WELL; SITE SURVEILLANCE; SOILS; CLAYS; TOPOGRAPHY; PERCHED WATER; LOGGING, GAMMA; PARTICLE SIZE; RUNOFF; EVAPORATION; GROUND WATER; FIELD STUDIES; LABORATORY STUDIES

<85>
Battelle-Pacific Northwest Laboratories, Richland, Wa.

Hanford Atomic Products Operation, January - December 1969. (2)

Radiological Health Data and Reports 12(12):683-662.(1971, December)

Environmental radioactivity data for the Hanford Atomic Products Operation are summarized for 1969. Water samples were collected from the Columbia River above the production reactors at Priest Rapids Dam and below the reactors at the Richland water plant intake, McNary Dam, and Bonneville Dam. In 1969, the average flow-rate at Priest Rapids was 3,830 cu m/s which was slightly higher than other years. Annual average concentrations of some radionuclides at the Richland intake were as follows: 1900 pCi/l H 3, 8 pCi/l I 131, less than 8.3 pCi/l Ru 106, less than 8.3 pCi/l Tc 99, less than 0.5 pCi/l Sr 90, and less than 1 pCi/l total alpha. For 1966-68, these values were 1500-1700, 7.0-18, less than 5, less than 11, 1 or less, and less than 1.3, respectively. The average H 3 value in 1969 at Richland was the same as at Priest Rapids Dam, where fallout is the only source of this nuclide. The most concentrated radionuclides found at the Richland intake were H 3, Na 24, (1600 pCi/l), Mn 56 (1000 pCi/l), Cu 64 (1700 pCi/l), and Np 239 (1100 pCi/l). River transport rates of selected nuclides in the Hanford area are given. Concentrations of P 32 in whitefish from the Columbia River were lower in 1969 than expected, based on the P 32 levels in the river; average P 32 was 34 pCi/g wet wt, as opposed to 140 pCi/g wet wt in 1968. Radionuclides found in groundwater near disposal sites are mainly H 3 and Ru-Rh 106; Co 60 and Tc 99 occur at low concentrations, while Sr 90 has been detected only at a few disposal sites. Gaseous I 131 concentrations at Richland and Pasco average 0.01 pCi/cu m, representing 1 mrem annual thyroid dose per person. Total atmospheric beta reached 1 pCi/cu m in the summer, due to nuclear testing. Radionuclide dosages to the population are calculated for drinking water, game birds, fish, shellfish, milk and produce, and from external radiation and nuclear fallout. Average annual doses for Richland residents in 1969 were 15 mrem bone, 4 mrem whole body, 19 mrem GI tract, and 23 mrem thyroid (infant); maximum doses were 180, 18, 40, and 60, respectively. All doses were less than 9% of standards. (LKH) (NDV)

Total Ion Concentration; River Flow Rate

I 131; Ru 106; Tc 99; Sr 90; H 3; Na 24; Mn 56; Cu 64; Np 239; P 32; Rh 106

REACTORS; POLLUTION, WATER; POLLUTION, AIR; GROUND WATER; RIVERS; DOSE RATE; FALLOUT; WASTES, RADIOACTIVE; BIRDS; FISH; MONITORING; FIELD STUDIES; ECOLOGICAL STUDIES; REVIEWS

<86>
Bierschenk, W.H., Hanford Laboratories Operation, Richland, Wa.

Observational and Field Aspects of Ground Water Flow at Hanford. (1)

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<a6> CONT.
Ground Disposal of Radioactive Wastes, H.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959. University of California, Berkeley, CA, (pp. 147-156), 168 pp. (1961, July)

A general discussion on the movement of groundwater at Hanford is presented. Some 200 ft of glaciofluviatile sand and gravel underlie the waste disposal site. Below this formation is an 800 ft silt, sand and gravel formation, known as the Ringold. The permeability of the glaciofluviatile sediments ranges from 10,000 gpd/sq ft to greater than 60,000 gpd/sq ft, while the permeability of the Ringold ranges from 100 to 600 gpd/sq ft. Since 1944 discharge to the ground from the processing plants at Hanford has been 35 billion gallons of effluents. This has created two ground water mounds in the area. Also resulting from the influx of the effluent is a ground water divide, which is roughly concave to the south and encloses the disposal sites on the west, north, and east. The rate of groundwater movement is about 1.5 to 2. ft/day for the Ringold aquifer with a permeability of 300 gpd/sq ft and hydraulic gradient of 20 ft/mile. For the glaciofluviatile sediments the rate is 7 ft/day. About 180 years are required for the ground water to travel approximately 20 miles to the river. More studies are needed to further define and understand aquifer characteristics. (HDV)

Stratigraphic Unit Thickness; Permeability; Waste Volume; Hydraulic Gradient

AQUIFERS; CONTAMINATION; DISPOSAL SITE; GRAVELS; GROUND WATER; HYDRODYNAMICS; PERMEABILITY; HYDROLOGY; RADIONUCLIDE MIGRATION; SANDS; SEDIMENTS; SILTS; WASTE DISPOSAL; WASTE VOLUME; WASTES, LIQUID; WASTES, RADIOACTIVE; FIELD STUDIES

<a7>
Blanchard, R.L., D.H. Montgomery, H.P. Kolde, and G.L. Gels, U.S. Environmental Protection Agency, Eastern Environmental Radiation Facility, Office of Radiation Programs, Montgomery, AL; U.S. Nuclear Regulatory Commission, Atlanta, GA; U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH.

Supplementary Radiological Measurements at the Maxey Flats Radioactive Waste Burial Site, 1976 to 1977. (2)

EPA-520/5-78-011; 33 pp. (1978, September)

Radiological studies were conducted at Maxey Flats, KY in 1976 and 1977 in order to obtain additional information on evaporator effluents and radioactivity on and around the site. Samples of tomatoes and milk from nearby farms were analyzed. Tomatoes contained less than 0.2-6.5 pCi/kg fresh wt of H3 and 18.2-19.5 dpm/g C of C 14. Milk from cows in the area had less than 0.2-3.6 pCi/l H 3, 18-19.8 pCi/l C 14, and 2-7 pCi/l Sr 90; H 3 levels in milk from cows drinking Rock Lick Creek water were lower in 1976 than in 1975, indicating radioactivity in surface runoff from the site has decreased. H 3 in tomatoes was essentially constant between 1974-75 and 1976, due to continued operation of the evaporator. H 3 discharged by this means since 1973 is probably greater than 10,000 Ci. Evaporator operation was reduced to 40 hr per week after the sampling period was completed. Thirteen auger-cutting samples from depths of 1.5-3.5 m below the surface near trenches 10, 15, 35, 41, 115, and 195 contained only small amounts of radioactivity which decreased sharply with depth. Values (in pCi/g) were less than 0.03-3.7 for Co 60, less than 0.02-2.27 for Cs 137, 1.3-3.8 for Ra 226, 0.05-2.6 for Pu 238, and less than 0.002-0.17 for Pu 239. Most of this radioactivity is attributable to surface contamination and disturbance of the soil by burial operations. Analysis of a test well sample showed that more than 99.8% of the radioactivity present was associated with particulate matter, with the smallest size fraction containing the highest concentration. Possible modes of transport of this radioactivity, particularly Pu, are discussed, including incorporation in a mobile organic complex. Other data provided include radionuclide concentrations in evaporator stack effluent and recommended decontamination factors for the evaporator system. Under the current 40 hr/wk schedule, radiation dose to the limiting receptor is approximately 0.8 mrem/yr of H 3 (total body); all other radionuclides contribute less than 0.1 mrem/hr. Further studies are suggested. (LKE)

Grain Size Distribution; Total Ion Concentration

Co 60; Cs 137; Ra 226; Pu 238; Pu 239; H 3; C 14; Sr 90

WASTES, LOW-LEVEL; EVAPORATION; TRITIUM; RUNOFF; TRENCHES; SURFACE CONTAMINATION; RADIONUCLIDE MIGRATION; COMPLEXES; EFFLUENTS, AIRBORNE; DOSE RATE; FOODS; SOILS; SAMPLES; SITE SURVEILLANCE; SAMPLING; MEASUREMENTS; CONCENTRATIONS; RADIONUCLIDES; EVAPORATORS; FIELD STUDIES

<a8>
Bradley, E.P., and J.C. Corey, Savannah River Laboratory, Aiken, SC.

Preliminary Safety Analysis. (3)

DP-1438; Technical Assessment of Bedrock Waste Storage at the Savannah River Plant, (pp. V-1 - V-21), 287 pp. (1976, November)

An analysis of risks associated with bedrock storage is divided into: a) the cavern filling period and b) the period following sealing of the cavern. During the cavern filling period an earthquake or explosion could have catastrophic effects because immediate sealing might be impossible. At SRP, if all activity were in the liquid phase, 100,000 curies each of Cs-137 and Sr-90, 2700 curies of Pu-239 and 700 curies of Cs-135 would probably enter the Tuscaloosa aquifer which would produce dangerous conditions for an extensive period of time. Spillage of sludge or supernate is rated as much less consequential. Following sealing of the cavern the principal radiological consequence is the release of extremely long lived I-129 and the potential accident presenting the greatest risk after cavern sealing is withdrawal of water. However, other hazards such as earthquakes, explosions in the cavern and flow through unsealed fractures have also been considered. (JW)

Principles involved are applicable to shallow land burial but relevancy of this article is diminished for it deals with bedrock storage at deeper levels. (DH/JW)

<48> CONT.
BEDROCK; DIFFUSION; CONVECTION; STRONTIUM; PLUTONIUM; DRAWDOWN; WASTE STORAGE; SLUDGES; WASTES, LIQUID; WASTES, RADIOACTIVE; CAVES; STORAGE, GEOLOGIC; THEORETICAL STUDIES

<49>
Bradley, R.F., and J.C. Corey, Savannah River Laboratory, Aiken, SC.

Geology and Hydrology of the Plant Site. (2)

DP-1438; Technical Assessment of Bedrock Waste Storage at the Savannah River Plant, (pp. I-9 - I-71), 287 pp. (1976, November)

The areal extent, population and transportation facilities of the Savannah River Plant in South Carolina are described. Soil erosion rates and general geological setting are known for the region encompassing the site. Known hydrologic parameters include: a) the flow rate of the major rivers in the area, b) variations in flow velocities of groundwater from waste tanks to different streams, c) discharge volumes of plant streams, d) heads in different host rocks, e) permeability, f) transmissivity, g) porosity, and h) dispersion characteristics. Gases, liquids, and rocks from various depths were chemically analyzed to determine the source and age of the water. Core samples were treated with 1N NaOH for 30 days at 95 degrees C to determine the effect of waste on rock properties. Physical properties of the rocks are briefly summarized and show average compressive strengths of 6000 to 16000 psi, deemed large enough to construct a cavern. (JW) (LKE)

Describes the site and the general geological setting of the area as it relates, for the most part, to hydrological parameters which have received the most emphasis in this section. The hydrological and geological information generated for this report are pertinent to studies of shallow land burial. (DR/JW)

Hydraulic Head; Erosion Rate; Storage Coefficient; Transmissivity; Porosity

HYDROLOGY; GEOLOGY; SEDIMENTS; RECHARGE; PRECIPITATION, METEOROLOGICAL; TRANSMISSIVITY; STORAGE COEFFICIENT; PERMEABILITY; ION EXCHANGE; DRAWDOWN; AQUIFERS; PIEZOMETRIC HEAD; CHLORINE; SULFUR; OXYGEN; HELIUM; FRACTURES; POROSITY; IGNEOUS ROCKS; METAMORPHIC ROCKS; GEOLOGIC FORMATIONS; WASTE VOLUME; RIVERS; EROSION; ENVIRONMENT; LABORATORY STUDIES

<50>
Carter, T.J., and G.A. Reuter, Ontario Hydro, Toronto, Ontario, Canada.

Ontario Hydro Waste Storage Concepts and Facilities. (1)

CONF-761020; Waste Management 76, R.G. Post (Ed.), Proceedings of a Symposium, Tucson, AZ, October 3-6, 1976, (15 pp.) (CONF-761020). (1976)

Waste storage concepts and facilities at Ontario Hydro are outlined. To handle the low- and medium-level wastes produced by their heavy water reactors a Radioactive Waste Operations site was established within the Bruce Nuclear Power Development on Lake Huron. The site includes a 19 acre Storage Site and a Radioactive Waste Volume Reduction Facility (RWVRF) consisting of a radioactive incinerator and waste compacter. At present only 8.5 acres of the site has been developed and will be adequate until 1980. The Atomic Energy Control Board (AECB) regulates and licences waste management operations and Ontario Hydro has established criteria to meet AECB requirements. These requirements are: storage facilities are to be located in low seismic areas away from population centers and drinking water supplies; radiation dose to members of the public are to be 1% of the ICRP dose limits; two "control envelopes" are required for storage facilities and the waste package is not a barrier; all wastes are to be stored retrievably; no liquids are to be stored in this facility; all surface and subsurface drainage is to be controlled and monitored. The RWOS is underlain by bedrock of interbedded silty to sandy dolomites and sandstones that have a permeability of 10(E-3) to 10(E-4) cm/sec. Overlying the bedrock is a few feet of granular, very dense soil which is overlain by very dense gray glacial till some 30 ft thick. The permeability of the till is 10(E-6) to 10(E-7) cm/sec. A brown, compact till containing gravel and cobbles overlies the gray till and averages 5 ft thick. A 3 ft layer of top soil rests on the brown till. The water table is 25 ft below the site. The seal envelope for the in-ground facilities are reinforced concrete structures. For above-ground facilities two independent structural concrete barriers are used. Surface drainage, leakage detection, and radiological aspects are covered. The facilities are also described in detail. At present, the cost of waste storage is 0.7 mills/kWh and only tritium escape has been a problem. (RDV)

Stratigraphic Unit Thickness; Permeability Coefficient; Depth to Water Table

AQUIFERS, CONFINED; BEDROCK; BENTONITE; BURIAL; COMPACTION; CONTAINER INTEGRITY; CONTAINMENT; COST BENEFIT ANALYSIS; DISPOSAL SITE; DOSE RATE; DRINKING WATER; ENVIRONMENT; GEOLOGY; GRAVELS; GROUND WATER; HYDROLOGY; PERMEABILITY; REVIEWS; RETRIEVABILITY; SANDS; SILTS; SOILS; STORAGE, ABOVEGROUND; STORAGE, GEOLOGIC; WASTE DISPOSAL; WASTE STORAGE; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WATER TABLE; WELLS; DRAINAGE

<51>
Colombo, P., A.J. Weiss, and A.J. Francis, Brookhaven National Laboratory, Department of Nuclear Energy, Nuclear Waste Management Research Group, Upton, NY.

Evaluation of Isotope Migration-Land Burial, Water Chemistry at Commercially Operated Low-Level Radioactive Waste Disposal Sites, Quarterly Progress Report, No. 5, April-June 1977. (1)

BNL-NUREG-50739; 39 pp. (1977, December)

In the fifth quarterly progress report on the trench leachate studies at the commercial low-level radioactive waste burial sites, additional data on the organic constituents in the trench leachate at Maxey Flats is presented. Identification of organics in trench leachate samples from nine different trenches was achieved by combined gas

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<51> CONT.
chromatography-mass spectrometer analysis. Samples were collected and handled in the laboratory under strict anoxic conditions. The predominant kinds of compounds found in most of the samples include alcohols, aliphatic and aromatic acids, adipates, phthalates, and tributyl phosphate. The organic compounds are being studied in this investigative program to ascertain the effect of these substances on the mobility of radionuclides in the disposal environment. Based on the review of the analytical results, it is postulated that the concentrations of organic carbon and nitrogen in the leachate provide a favorable environment for the proliferation of microorganisms. Under the observed anoxic conditions, the breakdown of organic compounds yields CO2, low molecular weight organic acids, alcohols, ketones and esters. The presence of electron acceptors such as nitrate and sulfate anions can support the growth of some aerobic bacteria. Concentrations of dissolved organic carbon in both organic and inorganic form are presented in tabular form. Gas chromatograms are presented as figures with keys supplied in tabular form. (JC)

Good hard data on dissolved organic carbon and gas chromatograph results on trench leachate for a specific site. (DE/JC)

TRENCHES; LEACHATES; ORGANIC COMPOUNDS; BURIAL; MICROORGANISMS; SOLVENTS; DECONTAMINATION; ENVIRONMENT; LABORATORY STUDIES

<52>
Colombo, P., A.J. Weiss, and A.J. Francis, Brookhaven National Laboratory, Process Technology Division, Department of Applied Science, Upton, NY.

Evaluation of Isotope Migration-Land Burial, Water Chemistry at Commercially Operated Low-Level Radioactive Waste Disposal Sites, Quarterly Progress Report No. 2, July-September 1976. (1)

BNL-NUREG-50666; 20 pp.(1977, May)

In this quarterly progress report, additional data on the identification of organic compounds present in trench water from several trenches at the Maxey Flats commerical low-level radioactive waste disposal site are presented. The organic compounds were extracted from trench water by the use of amberlite XAD-2 resin and by liquid-liquid extraction with methylene chloride. Detailed descriptions of extraction procedures are included in the text. Gas chromatographic analyses were performed for preliminary compound identification. This procedure was followed by gas chromatography-mass spectrometry identification with a dodecapole mass spectrometer and comparison with standard spectra found in several chemical data base libraries. The results of these analyses are presented in tabular form. For reporting purposes, major components are described as having peak heights greater than 5 cm while minor components are described as having peak heights of less than 5 cm of gas chromatographic attenuation setting 8(E-12) amps/sv. Major components which were preliminarily identified, include toluene, methyl isobutyl ketone, o-creosol, biphenyl, and tributyl phosphate. (JC)

Represents some of the most comprehensive organic trench water chemistry performed to date at any shallow land burial site even though the results are preliminary in nature. (DE/JC)

TRENCHES; LEACHATES; CHEMICAL ANALYSIS; ORGANIC COMPOUNDS; BURIAL; SAMPLES; METHODS; WASTES, LOW-LEVEL; LABORATORY STUDIES

<53>
Colombo, P., A.J. Weiss, and A.J. Francis, Brookhaven National Laboratory, Process Technology Division, Department of Applied Science, Upton, NY.

Evaluation of Isotope Migration-Land Burial, Water Chemistry at Commercially Operated Low-Level Radioactive Waste Disposal Sites, Quarterly Progress Report No. 4, January-March 1977. (1)

BNL-NUREG-50695; 20 pp.(1977, September)

This quarterly progress report presents the results of a radiochemical and inorganic chemical analytical program performed on samples taken from trenches at the Maxey Flats Low-Level Radioactive Waste Burial Site. In September of 1976, the Brookhaven investigative team sampled nine trenches at the disposal site, four of which had been sampled during the previous field effort in April of 1976. Only four of the original sampled trenches had sufficient liquid present in the trench sump to permit sampling. Eight liter samples were collected under anoxic conditions and stored in special collection bottles at approximately 4 degrees C for shipment and storage. Field measurements included color, temperature, pH, and specific conductance. The sample processing procedures are discussed and presented in schematic form. Results of both field and laboratory analyses are presented in tabular form. Analytical procedures for radiochemistry are also detailed. (JC)

Although the data presented are from nine of the over 40 trenches present at the site, the data represent a good start at defining the source term for the Maxey Flats Site. Many more analyses are expected in future field trips. (DE/JC)

Specific Conductance; Total Ion Concentration; pH; Temperature

H 3; Cs 134; Cs 137; Co 60; Am 241; Pu 238; Pu 239; Pu 240

TRENCHES, LEACHATES; CHEMICAL ANALYSIS; SAMPLES; FILTRATION; BURIAL; DISPOSAL SITE; WATER; WASTES, LOW-LEVEL; HYDROLOGY; GEOLOGY; METHODS; ALPHA PARTICLES; BETA PARTICLES; FIELD STUDIES

<54>
Colombo, P., A.J. Weiss, and A.J. Francis, Brookhaven National Laboratory, Process Technology Division, Department of Applied Science, Upton, NY.

Evaluation of Isotope Migration - Land Burial, Water Chemistry at Commercially Operated Low-Level Radioactive Waste Disposal Sites, Quarterly Progress Report No. 3, October - December 1976. (1)

<58> CONT.
BNL-NUREG-50670; 21 pp.(1977, June)

This report describes anoxic procedures developed to prevent the formation of undesirable ferric hydroxide precipitates when collecting and filtering trench water samples. These procedures were applied to the collection of samples at the Barey Flats disposal site in September 1976. The system consists of plastic tubing, a peristaltic pump, an inert gas cylinder with a pressure regulation valve, sample bottles, a bypass valve, air barrier coils, and a waste tank. Samples collected and filtered in this way did not undergo precipitation up to 5 months after sampling. (LEH)

EQUIPMENT; FILTRATION; METHODS; SAMPLING; PRECIPITATION, CHEMICAL; IRON COMPOUNDS; WATER; TRENCHES; LABORATORY STUDIES

<55>
Committee on Radioactive Waste Management, Panel on Hanford Wastes, National Research Council, Commission on Natural Resources, Washington, DC.

Low-Level Wastes. (3)

Radioactive Wastes at the Hanford Reservation: A Technical Review. National Academy of Sciences, Washington, DC, Ch. 4, (pp. 51-72), 269 pp.(1978)

The management of low-level wastes at the Hanford Reservation is reviewed. Low-level wastes include: condensate from fuel processing at the Purex plant; liquid entrained into ventilating air of waste-tank systems and recovered after ion exchange; cooling water from reactor and chemical operations; liquid that has been percolated into the ground either intentionally or accidentally; gaseous wastes in stack effluents; solid trash and failed or obsolete equipment; and obsolete reactors and processing plants which must be decommissioned. Large quantities of liquid radwastes come from the cooling processes and these liquids are percolated into the ground where the nuclides are sorbed. If the concentration were to be lowered to MPC levels for all but two nuclides the capital expenditure would be $1.5 billion and yearly expenses would be $1 billion. For all nuclides to be at their MPC capital expenditure would be $35 billion with yearly operating costs at $3 billion. Wastes with less than 5 x 10(E-5) uCi/ml are placed in open ponds and wastes with greater radioactivity are discharged to cribs. In the unsaturated zone all the Pu is within 6 m beneath the point of release; Cs 137 is sorbed entirely; small concentrations of Sr 90 have escaped sorption and about 90% of Ru 106 has been sorbed in the zone. The pattern of nuclide distribution in the saturated zone appears to be relatively stable, only changing slightly from 1973 to 1976. Gaseous wastes have a small impact so anticipated shutdowns of producing facilities may not be required. More than 140,000 cu m of solid waste have been buried. Low-level wastes at Hanford do not constitute an appreciable radiation hazard at present. Monitoring equipment is adequate for detecting accidental releases, and remedial action for accidents is automatic or can be instituted quickly. (RDV)

SORPTION; ACCIDENTS; BURIAL; CONTAMINATION; CONTAINMENTS; CRIBS; DISPOSAL SITE; GROUND WATER; MAXIMUM PERMISSIBLE CONCENTRATION; MONITORING; RADIONUCLIDE MIGRATION; PONDS; SATURATED ZONE; UNSATURATED ZONE; WASTE MANAGEMENT; WASTES, GASEOUS; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, SOLID; REVIEWS

<56>
Corman, N.B., Savannah River Laboratory, Aiken, SC.

Improvement in Operating Incident Experience at the Savannah River Burial Ground. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 8, (pp. 787-798), 1214 pp. (CONF-770512).(1979)

Operating incidents that have occurred during the 20-year operating period 1955-1975 at the Savannah River burial ground have been analyzed. The incidents can be categorized as those causing airborne contamination, waterborne contamination, or vegetation contamination through penetration of plant roots into contaminated soil. Typically, the incidents involved fractional curies of activity and resulted in minor contamination over the immediate area. Incidents in which radioactivity was dispersed by means of airborne material were the most numerous, comprising 75 out of 111 incidents. They involved burial of contaminated equipment (with loss of some adhering contaminated particulate matter or liquids), sandblasting to decontaminate reusable equipment, and burning contaminated organic solvents. No equipment burial incidents have occurred since 1969, due to better wrapping of equipment before shipment, burial only under favorable weather conditions, careful handling to avoid dropping or otherwise damaging the wrapped equipment, water fogging to confine loose particulates to the burial trench during handling, and improved operating personnel experience. As a result of cumulative improvements, only one airborne contamination incident occurred after 1969. Sandblasting and solvent burning have been discontinued. Eight radioactive waste fires have occurred; all were minor incidents, and only two produced detectable contamination over small areas within the burial ground. Spontaneous combustion was the probable cause in 7 of the fires. Only two instances of waterborne contamination are recorded; both resulted from trench flooding. There have been 9 organic solvent spills, all before 1969, and all contamination was confined to the immediate area. Ten incidents of radiation uptake by vegetation growing in the burial ground were observed. In each case, radioactive vegetation was removed to a burial trench along with the contaminated soil. Essentially all of these incidents were due to insufficient soil cover over early trench burials. There were ten instances of unintentional burial of materials. No activity releases resulted; consequences were primarily in the form of increased radiation exposure to operating personnel. The frequency of operating incidents has decreased from 5/yr overall to 2/yr in the last six years, due mainly to revised procedures and additional experience of operating personnel. (LKH)

DISPOSAL SITE; BURIAL, SHALLOW; ACCIDENTS;

<56>

DISPOSAL SITE

<56> CONT.
WASTES, LOW-LEVEL; WASTE TREATMENT; WASTE MANAGEMENT; PIPES; EFFLUENTS, AIRBORNE; EFFLUENTS, LIQUID; CONTAMINATION; SOLVENTS; ORGANIC COMPOUNDS; INFUSION; PARTICLES, AIRBORNE; DECONTAMINATION; METHODS; TRENCHES; FLOODING; UPTAKE; PLANTS; EXPOSURE, OCCUPATIONAL; REVIEWS; FIELD STUDIES; ECOLOGICAL STUDIES

<57>
Couser, K.E., Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN.

Movement of Ruthenium in the ORNL Waste-Pit System. (U)

Retention and Migration of Radioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962, (pp. 229-241). (1963)

The amount and concentration of fission products released to the ORNL waste-pit system increased in 1959. Of particular interest was the radionuclide Ru 106 which was found in concentrations of 90 mc/ml. An estimate was made of the concentration and quantity of Ru 106 that could be released to the pits without creating undue hazards in the Clinch River. By calculation, 2m,000 curies of ruthenium per year, along with the annual release of the remaining radionuclides, would be 100% of the calculated maximum permissable concentration (MPC). A dilution factor of 3.9 x 10(E+5) was used to determine the probable average concentration of the radionuclides released to the river in 1958. No fission products have been detected in observation wells beyond the streams bordering the waste-pit system and this is collaborated by lack of nitrates, which were introduced into the pits, on the other side of the streams. By comparing average concentrations, the calculated reduction in Ru 106 due to dilution, decay, and sorption was 98% in 1959. It was also found that concentration increases when quantity of wastes increase and as the concentration of Ru 106 increases in the pit. When a pit is empty it was found that the Ru 106 concentration dropped off in accordance with an exponential function. It took an average of 87 days for the concentration to drop from 10,000 mc/ml to 5,000 mc/ml. Hence it is assumed that Ru 106 can be released in quantities of 2m,000 curies or a total of 5 million gallons of seepage per year. Also it is expected that 95% reduction in concentration will occur due to dilution, decay, and sorption. A final assumption is that the nuclide will remain in the dispersed liquid phase and not be reconcentrated by the silt in the river water. From calculation, not more than 350,000 curies in 3.7 million gallons of seepage should be released to the pit system. (MDV)

Ru 106

SORPTION; CONCENTRATION FACTORS; CONTAMINATION; DILUTION; ENVIRONMENT; FIELD STUDIES; FISSION PRODUCTS; GROUND WATER; HAZARD ANALYSIS; EQUATIONS; MAXIMUM PERMISSIBLE CONCENTRATION; MONITORING; RADIONUCLIDE MIGRATION; RELEASE LIMITS; SEEPAGE PITS; WASTE DISPOSAL; WASTES, LIQUID; WASTES, RADIOACTIVE

<58>
Dames & Moore, White Plains, NY.

Development of Monitoring Programs for Energy Research and Development Administration Owned Radioactive Low-Level Waste Burial Sites. (U)

Final Report U.S. ERDA Contract No. E(49-1)3759. (1976, July)

The primary objective of the study was the development of generic monitoring programs applicable to ERDA owned low-level waste burial sites. To assist in defining these monitoring programs, models were developed to simulate the movement of waterborne radionuclides in the subsurface as a function of site characteristics, geometry and time. Available information regarding the hydrogeologic and radiochemical characteristics of the sites was compiled before initiating monitoring programs. The five ERDA owned sites are the Oak Ridge National Laboratory at Oak Ridge, Tennessee, the Savannah River Plant at Barnwell, South Carolina, the Hanford Works at Hanford, Washington, the Idaho National Engineering Laboratories at Idaho Falls, Idaho and the Los Alamos Scientific Laboratory at Los Alamos, New Mexico. Published and unpublished reports concerning the five ERDA owned facilities were reviewed and evaluated. Evaluation consisted of quantifying those factors which determine overall adequacy of data by assigning a weighted integer factor and a parameter at a site. Mathematical models were developed of time-dependent hydraulic and mass transport flow patterns to assist in predicting future migration patterns of radionuclides through soil and/or rock. This information was in turn used to develop programs for both saturated and unsaturated zone monitoring which were designed to intercept radionuclides before they reach selected site boundaries. The monitoring programs consist of four basic steps: 1) location of a line of primary monitoring stations, 2) determination of proper sampling frequencies at the primary sampling stations, 3) location of a line of secondary sampling stations, and 4) designation of those radionuclides to be monitored. Using these basic steps the monitoring program is tailored to suit the physical conditions existent at each site. (CAB)

Comprehensive discussion of radionuclide migration from radioactive waste burial grounds. (DH/CAB)

Total Ion Concentration; Depth to Water Table

MONITORING; SAMPLING; BURIAL; RADIONUCLIDE MIGRATION; MODELS, MATHEMATICAL; HYDROLOGY; GEOLOGY; SATURATED ZONE; UNSATURATED ZONE; THEORETICAL STUDIES

<59>
Denham, D.H., Battelle-Pacific Northwest Laboratories, Richland, WA.

Radiological Status of the Ground Water Beneath the Hanford Project-January to June 1969. (U)

BNWL-1233; 20 pp. (1969, November)

Measurements of Ru 106 and H 3 concentrations were used to detect the movement of

DISPOSAL SITE

<59> CONT.
contamination at the Hanford Reservation. The radionuclides indicated a southeasterly movement of the contamination. In the unconfined aquifer, Cr 51 was found to be less than 100 pCi/ml; H 3, 300 pCi/ml; Sr 90; 0.03 pCi/ml; Cs 137, 0.3 pCi/ml; and Co 60, 0.6% pCi/ml. The H 3 contamination of the confined aquifer was 360 pCi/ml, 98 ft below the water table. The general quality of the ground water in the area was degradated by the presence of the radionuclides and also NO3- which was above the recommended limit of 45 ppm. (MDV)

H 3; Ru 106; Cr 51; Co 60; Sr 90; Cs 137

AQUIFERS, CONFINED; AQUIFERS, UNCONFINED; BETA PARTICLES; GROUND WATER; pH; SITE SURVEILLANCE; URANIUM COMPOUNDS; MONITORING; FIELD STUDIES

<59>

760-771). (1970, September 7-11)

The transport and handling of low- and intermediate-level wastes at the Asse salt mine are discussed. Most of the methods and techniques are tailored to fit those conditions existing at this specific mine. The influence of local conditions on radiation hazards to personnel, contamination hazards to personnel and the mine, and long-term environmental safety are considered. Acceptance conditions for low- and intermediate-level wastes and the transport and emplacement of these wastes are also discussed briefly. (CAB)

Not directly related to shallow land burial because of depths at which containers are disposed. (DS/CAB)

WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; MINES; SALT DEPOSITS; DISPOSAL SITE; HAZARD ANALYSIS; SAFETY; STORAGE, GEOLOGIC; FIELD STUDIES

<60>
Denham, D.H., Battelle-Pacific Northwest Laboratories, Richland, WA.

Radiological Status of the Ground Water Beneath the Hanford Project, July to December 1969. (3)

BNWL-1392; 23 pp. (1970, May)

An evaluation of the status of groundwater contamination resulting from disposal of plant effluents at the Hanford Reservation was made. The Ru 106 and H 3 concentrations showed the detectable contamination to be migrating southeastward in the unconfined groundwater. Concentrations of Chromium 51 and uranium were measured as less than 200 pCi/ml and less than 0.5 pCi/ml. During the last half of 1969 the concentrations of Cs 137 and Sr 90 were less than 0.03 pCi/ml and 0.05 pCi/ml, respectively. The H 3 concentration in the confined aquifer was 2.5 pCi/ml. However it was suspected that there may have been inter-aquifer transfer so the tritium concentration was not representative of the confined aquifer. Also the NO3- was measured and it was found to be greater than 45 ppm in some places. As a result of the shutdown of C Reactor in the spring, radionuclide concentrations dropped significantly in 100 Area. In general, the ground water has been somewhat degradated by the disposal of plant effluents. (MDV)

H 3; Ru 106; Cr 51; Co 60; Sr 90; Cs 137

AQUIFERS, CONFINED; AQUIFERS, UNCONFINED; BETA PARTICLES; CATIONS; DIFFUSION; DILUTION; DISPOSAL SITE; DOSE RATE; DRINKING WATER; GROUND WATER; HYDROLOGY; ION EXCHANGE; PIEZOMETRIC WELL; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, RADIOACTIVE; WELLS; MONITORING; FIELD STUDIES

<61>
Diefenbacher, H., J. Heil, H. Krause, and W.C. Schuchardt, Karlsruhe Nuclear Research Centre, Karlsruhe, German Federal Republic.

Disposal of Radioactive Wastes by Storage in a Salt Mine in the Federal Republic of Germany, Part 2. (4)

STI/PUB/268; Management of Low- and Intermediate-Level Radioactive Wastes, Proceedings of an IAEA Symposium, Aix en Provence, France, September 7-11, 1970, (pp.

<62>
Douglas, P.L., U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, NV.

Radiological Survey at the Inactive Uranium Mill Site Near Riverton, Wyoming. (5)

ORP/LV-77-2; 23 pp. (1977, June)

A radiological survey of the inactive uranium mill site near Riverton, Wyoming was conducted September 30-October 2, 1975, to determine the extent of air- and water-borne contamination from the tailings pile. Measurements of differential gamma exposure rates were made at the ground surface and plotted on a map as isolines. By this method, 860 acres, exclusive of the tailings pile, were found to have above-background gamma levels (8 uR/hr). Areas to the east and northeast of the site which are cultivated were found to have differential exposure readings above background (up to 10 uR/hr) to depths of 20-30 cm, indicating that more tailings have been deposited in these areas than the survey shows. Survey isolines for differential exposures of 40 uR/hr and 10 uR/hr encompassed 30 and 99 acres, respectively. Water sampling for Ra 226 yielded values from 0.96 to 0.078 pCi/l near the site; background was assumed to be 0.22 pCi/l, based on a measurement in Riverton. An indoor Rn progeny (working level) survey of two residences near the site and a background in Riverton yielded slues of 0.0029, 0.0055, and 0.0009, respectively. None of the Ra or Rn samples exceeded Federal safety guidelines. (LKH)

Total Ion Concentration

Ra 226; Rn 222

URANIUM; TAILINGS; EXPOSURE RATE; RADIATION, GAMMA; RADIUM; RADON; PARTICLES, AIRBORNE; POLLUTION, SOIL; POLLUTION, WATER; RADIATION HAZARDS; SITE EVALUATION; SITE SURVEILLANCE; WASTES, INDUSTRIAL; WASTES, RADIOACTIVE; WASTES, SOLID; WASTES, LOW-LEVEL; FIELD STUDIES

<63>

DISPOSAL SITE

<63>
Duguid, J.O., Battelle Columbus Laboratories, Columbus, OH.

Assessment of Department of Energy Low-Level Radioactive Solid Waste Disposal Storage Activities. (U)

BMI-1980; 97 pp.(1977, November)

This report presents the results of a survey of fifteen Department of Energy (DOE) low-level radioactive solid waste disposal/storage facilities. The facilities include those operated at Los Alamos Scientific Laboratory, the Pantex Plant in Amarillo, Texas, Sandia Laboratory, Idaho National Engineering Laboratory, the Nevada Test Site, Feed Materials Production Center at Fernald, Ohio, National Lead Co. at Niagara Falls, New York, Oak Ridge National Laboratory, Paducah Gaseous Diffusion Plant in Kentucky, the Portsmouth Gaseous Diffusion Plant in Ohio, the Weldon Spring facility in Missouri, Hanford Reservation, and the Savannah River Plant. Information on rainfall, surficial geology, primary permeability, bedrock, depth to water table, depth to existing confined aquifers, surface water proximity, surface materials and principal release pathways is presented in tabular form and discussed in the text. Discussions of existing facilities, operating practices, buried/stored volumes and activities (curies) are included. Future DOE programs related to shallow land burial are discussed including the shallow land burial abstracting program, site selection criteria development, waste form criteria development, future operational criteria, systems analysis, and a proposed demonstration facility. Recommendations for future research and site improvements are presented. (JC)

Contains some of the only published information on the DOE disposal-storage facilities at Pantex-Amarillo, Texas, Sandia Laboratories, New Mexico, Feed Materials Production Center at Fernald, Ohio, National Lead Co. at Niagara Falls, the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Portsmouth Gaseous Diffusion Plant, Ohio, and the Weldon Spring, Missouri facility. (DH/JC)

WASTES, RADIOACTIVE; BURIAL; WASTE DISPOSAL; STORAGE, GEOLOGIC; SITE SELECTION; PACKAGING; PITS; WASTES, TRANSURANIC; WASTES, LOW-LEVEL; WASTES, SOLID; GEOLOGY; HYDROLOGY; AQUIFERS; GROUND WATER; ENVIRONMENTAL EXPOSURE PATHWAY; WASTE VOLUME; PONDS; HOLDING PONDS; FIELD STUDIES

<64>
Dyer, N.S., U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC.

Environmental Surveys of Two Deepsea Radioactive Waste Disposal Sites Using Submersibles. (U)

CONF-760310; STI/PUB/433; IAEA-SM-207/65; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (pp. 317-338), 828 pp. (IAEA-SM-207/65, CONF-760310, STI/PUB/433).(1976)

In 1970-75 the manned submersible ALVIN and the unmanned submersible CURV III were used to investigate two disused U.S. nuclear waste disposal sites, one at a depth of 2000 m off the Maryland-Delaware coast, the other near the Farallon Islands off California, with two subsites at 900 and 1700 m. Exact depths and locations of observed waste packages are given. Extensive hydrostatic implosion of containers was observed in both Pacific subsites, which demonstrates a need for pressure equalization devices on waste packages intended for deepsea disposal. Corrosion and blistering of containers was also common, especially at the Atlantic site, although no evidence of breaching solely from external corrosion was found. Analysis of sediment samples from the 900 m Pacific site showed Pu 239, 240 contamination from 2 to 25 times higher than the maximum expected background due to weapons testing fallout. Cs 137 contamination at the Atlantic site was 3 to 70 times the maximum possible fallout concentration. A direct relationship between waste packages and sediment contamination was established. Possible mechanisms for vertical redistribution of contaminants are suggested, including bioturbation at the two Pacific sites and burial of leachate by lateral sediment transport at the Atlantic site. Preliminary current studies indicate the presence of weak but directional currents at the 1700 m Pacific subsite and stronger currents (10-22 cm/sec) at the Atlantic site. The high biological diversity and presence of commercially exploited demersal food fish at the 900 m Pacific site, along with its proximity to a fishing zone, suggest the exclusion of this site from further use as a radioactive waste dump. (LKE)

Sedimentation Rate; Flow Rate

Pu 239; Pu 240; Cs 137; Pu 238

SEA DISPOSAL; PLUTONIUM; CESIUM; CONTAMINATION; LEACHING; BIOTA; CONTAINERS; FISH; INSPECTION; LEAKAGE; MARINE SYSTEMS; POLLUTION, WATER; WASTE DISPOSAL; SEDIMENTS; RADIOACTIVITY; WASTES, HIGH-LEVEL; WASTES, LOW-LEVEL; CHEMICAL ANALYSIS; SAMPLES; SITE SELECTION; PACKAGING; RADIONUCLIDE MIGRATION; SITE SURVEILLANCE; FIELD STUDIES

<65>
Evans, A.G., W.L. Carter, and R.C. Reinig, Savannah River Laboratory, Aiken, SC.

Guides Limiting the Releases of Radionuclides by the Savannah River Plant. (U)

Health Physics 15:57-65.(1968)

The Savannah River Plant has developed Plant Release Guides to define the amount of various radionuclides that can be released to the environs in air and water. Releases are held to the lowest practicable level within Plant Operating Guides based on careful operation, and are well below the Radiation Protection Guides recommended by the Federal Radiation Council for neighboring populations. The process by which guides were established and maintained is examined. (Auth) (DD)

Yields very little information outside of its very specific subject. Virtually no measured data. (DH/DD)

ENVIRONMENT; REVIEWS; EXPOSURE RATE; EFFLUENT GASES; HANDBOOKS; HAZARD ANALYSIS; MAXIMUM PERMISSIBLE CONCENTRATION; POPULATIONS; CONTAMINATION; MONITORING

DISPOSAL SITE

<66>
Evenson, L.E., D.P. Olson, D.K. Halford, and O.D. Markham, University of Idaho, Department of Veterinary Sciences, Moscow, ID; Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Systemic Effects of Radiation Exposure on Rodents Inhabiting Liquid and Solid Radioactive Waste Storage Areas. (2)

IDO-12008; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.). Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1979, (pp. 12-13) 72 pp. (IDO-12000); IDO-12007; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.). (pp. 99-107) 371 pp. (IDO-12007).(1978, December; 1979, April)

A study has been conducted of deer mice (PEROMYSCUS MANICULATUS) inhabiting a dry radioactive leaching pond at the Test Reactor Area (TRA) and a solid radioactive waste burial site in the Radioactive Waste Management Complex (RWMC). Objectives of this study were: (1) to determine whether radiation exposure at the sites results in pathologic changes in the hemtopoietic systems of deer mice, (2) to examine vital and reproductive organs of mice for the presence of tumors and other pathologic lesions resulting from radiation exposure, and (3) to identify possible lymphocyte chromosome damage due to radiation exposure. Experimental and control mice were trapped in 1977 and 1978 using Longworth traps placed on a grid developed as part of a population study. Hematological studies of animals from the TRA site, control site, and a laboratory control colony showed no significant differences between populations and, therefore, there were no pathologic changes to the hemtopoietic system attributable to radiation exposure. There were no significant differences in histopathologic lesions in the tissues between populations. Animals killed in 1977 with diethyl ether showed a high proportion of liver and kidney damage among all populations. As a result, sodium pentabarbital was used as an anesthetic during 1978. (LKH)

ANIMALS; UPTAKE; PONDS; HOLDING PONDS; DISPOSAL SITE; FIELD STUDIES; LABORATORY STUDIES; POPULATIONS; RADIATION EFFECTS; METHODS; BIOLOGICAL STUDIES

<67>
Federal Water Pollution Control Administration, Cincinnati, OH.

Radium 226 and Radon 222 Concentrations in Central Florida Ground Waters. (3)

PB-260 211; 37 pp.(1966, January)

One hundred and five water wells in central Florida were sampled for Rn 222 and Ra 226 by the FWPCA at the request of the Florida State Board of Health. Sampling was carried out to measure ground water contamination by radionuclides released by mining of U-bearing phosphate deposits, fertilizer spoil piles, and waste water ponds. Phosphate is mined from the Bone Valley Formation (Pliocene), which is derived from and underlain by the Hawthorne Formation (Miocene). The Hawthorne is the confining layer for the principal artesian aquifer of central Florida; the top of the aquifer is in the Tampa Limestone (Miocene). Local recharge occurs where sinkholes penetrate the Hawthorne; these may also act as access routes for pollutants. Radon concentrations ranged from 23-46,600 pCi/l and radium from 0-76 pCi/l; means were 1260 and 1.2 pCi/l, respectively. A correlation exists between Rn and Ra concentrations, but cannot be defined at present. Analyses for U, Th, Pb 210, Po 210, and certain inorganic compounds were performed on selected samples. Two municipal water supplies and 12 private wells exceeded the 3 pCi/l Public Health Service Drinking Water Standard for Ra 226. Three wells were greater than 10 pCi/l, one being used by a food processing plant. (LKH)

Total Ion Concentration

Ra 226; Rn 222; U; Th; Pb 210; Po 210

PHOSPHATES; POLLUTION, WATER; GROUND WATER; AQUIFERS; ARTESIAN BASINS; WASTES, LIQUID; WASTES, SOLID; WASTES, RADIOACTIVE; RADIUM; RADON; WELLS; FIELD STUDIES

<68>
Fenimore, J.W., Savannah River Laboratory, Aiken, SC.

Status Report: Borehole Monitoring of Radioactive Waste Trenches 1965-1975. (2)

DPST-76-256; 15 pp.(1976, March)

This report describes the results of ten years of borehole monitoring of radioactive waste trenches at Savannah River Laboratory Burial Ground 643-G. Eleven boreholes were drilled in 1960, and radiation levels were measured annually using a geiger tube lowered into the wells and radioassay of well cuttings. Wells 643 and 648 monitor scrap metal; the other wells pass through protective clothing, glassware, discarded filters, contaminated construction materials, and the like, which are in direct contact with the soil. Activity in well 646 dropped to background within 3 years, and the casing on 648 failed soon after construction, flooding the borehole. Of the remaining, analysis of cuttings shows Sr 89, 90 in 8 wells, Cs 137 in 6, Ce 144 in 5, Co 60 in 3, and Ru 106 in 1 well. In 1975, 642, 644, 649, 6410, 6412, and 6413 continued to register over 6000 c/s Thyac; 646 and 6413 were over 80,000 c/s. 6411 read 2700 c/s; the remaining wells had all decayed below 600 c/s. Wells 641, 642, 645, 649, 6410, 6411, and 6412 had initial peaks below the trench bottom in 1960. All except 6411 had declined to background by 1975. (LKH)

An extensive number of graphs are used to present the data.

Total Ion Concentration

Sr 89; Sr 90; Co 60; Cs 137; Ru 106; Ce 144

BURIAL; TRENCHES; WASTES, RADIOACTIVE; WASTES, SOLID; CESIUM; CERIUM; STRONTIUM; COBALT; RUTHENIUM; BOREHOLES; RADIOACTIVITY; LEACHING; MONITORING; WELLS; FIELD STUDIES

<59>

DISPOSAL SITE

<59>
Patterson, J.E., Savannah River Laboratory, Aiken, SC.

Borehole Monitoring of Radioactive Waste Trenches. (2)

CONF-770512: Management of Low-Level Radioactive Waste, E.W. Carter, A.A. Moghissi, and B. Kahn (Eds.). Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 10, (pp. 1179-1192), 1214 pp. (CONF-770512).(1979)

To detect leaching and migration of radionuclides from low-level radioactive waste buried in the Savannah River Plant solid waste burial ground, eleven dry wells are monitored annually. The SRP burial ground is underlain by sand, clayey sand, sandy clay, and clay beds. These sediments are saturated with groundwater beginning at a depth of about 12 m and extending down into the crystalline basement rocks. Several artesian aquifer systems exist in the unconsolidated sediments, but the upper section, where wastes are buried, is an unconfined water-table aquifer which drains by gravity flow to the nearest surface stream. Tracer tests show that rainfall infiltrates the unsaturated zone at a rate of about 2 m/yr and moves horizontally through the water table aquifer about 11 to 12 m/yr. Well monitoring began in 1964 in the unused 11-hectare south section of the burial ground. Essentially all solid wastes buried between 1953 and 1970 are in this section. The wastes packaged in cardboard boxes were buried in unlined trenches 6m x 6 m in cross section by several hundred meters long and covered with at least 1.2 m of earth. Monitoring wells are 10 cm in diameter; 5-cm galvanized steel casings, closed at the bottom, were installed in the holes, and the casings sealed in the holes with dry bentonite. Assay of cuttings from the eleven wells showed radiostrontium to be present in 8 of these wells (0.2-128 pCi/gm), radiocesium in 6 wells (0.8-27,000 pCi/gm), Ce 144 in 5 wells (2-8630 pCi/gm), Co 60 in 3 wells (80-65,200 pCi/gm), and Ru 106 in 1 well (928 pCi/gm). These radionuclides were the only ones detected in the cuttings. Radiation profiles determined in the wells from 1965 to 1976 show that all peaks have remained nearly constant, with essentially no downward shift that would indicate migration. Seven wells initially showed radionuclides in the zone below the bottom of the backfilled trench. Most of these peaks decayed to background levels in the several years following installation. The most prominent persistent peak below a trench is at well HW 11. This peak shows no indication of continued movement. Based on these results, the bulk of these radionuclides have remained in place after burial. The intensity of the principal radiation peak in 5 of the 11 wells has either remained constant or decreased very slightly. At the remaining wells, peaks have decreased markedly in intensity as the radionuclides have decayed. (LKH)

Hydraulic Velocity

Cs 137; Sr 89; Sr 90; Ce 144; Co 60; Ru 106

DISPOSAL SITE; MONITORING; WELLS; RADIONUCLIDE MIGRATION; SOILS; SANDS; CLAYS; SEDIMENTS; AQUIFERS, UNCONFINED; UNSATURATED ZONE; WASTES, SOLID; STRONTIUM; CESIUM; CERIUM 144; COBALT 60; RUTHENIUM 106; TRENCHES; FIELD STUDIES; PRECIPITATION, METEOROLOGICAL; HYDRAULIC VELOCITY

<75>
Fix, J.J., and P.J. Blumer, Battelle-Pacific Northwest Laboratories, Richland, WA.

Radiochemical Analyses of Game Birds Collected from the Hanford Environs, 1971-1975. (3)

BNWL-2089; 31 pp.(1977, July)

Data from radiochemical analyses of game birds (pheasants, geese, ducks, and coots) collected from 1971 through 1975 at the Hanford site are presented. Total numbers of each type collected in the 5-year period were 80 pheasants, 90 geese, 356 ducks, and 11 coots. Maximum concentrations in pheasants of the radionuclides measured were (in pCi/gm muscle tissue, wet wt): K 40 = 2.9, Co 60 = 0.1, Zn 65 = 0.6, Sr 90 = 0.08, and Cs 137 = 5.6. Only the Sr 90 and Cs 137 values were attributed to Hanford operations. The 50-yr internal dose commitment from eating 500 gm of pheasant meat containing these Sr and Cs concentrations would be 0.3 mrem total body (0.2 mrem Cs 137 and 0.1 mrem Sr 90) and 0.3 mrem bone (Sr 90). Analyses of geese gave maximum values of 9.5 pCi/gm K 40, 0.2 pCi/gm Co 60, 1.3 pCi/gm Zn 65, 0.92 pCi/gm Sr 90 (analysis for 1972 only), and 1.9 pCi/gm Cs 137. Only Zn 65 activity observed in geese during 1971 and 1972 was attributed to Hanford operations. Ingestion of 5 kg of goose meat containing the maximum observed Zn 65 and Cs 137 would give a 50-yr internal dose commitment of 0.05 mrem total body from Zn 65 and 0.3 mrem total body from Cs 137. The duck data were separated into two components for analysis: (1) ducks collected from the Columbia River, and (2) ducks collected from onsite ponds. The maximum observed concentrations of Co 60, Sr 90, and Cs 137 were in ducks collected onsite. Maximum Zn 65 concentrations were in ducks collected near the Columbia River in 1971. Livers of ducks collected at some onsite ponds were analyzed for U and Pu. The majority of the analyses were positive (U = 0.2 pCi/gm max., Pu = 1.0 pCi/gm max.). However, the contribution from Hanford is uncertain because of the lack of similar data representing expected levels due to fallout. Fifty-year internal dose estimates based on consumption of 500 gm of duck meat containing the highest observed concentrations of Co 60 (1.8 pCi/gm), Zn 65 (15 pCi/gm), Sr 90 (0.3 pCi/gm), and Cs 137 (120 pCi/gm) would be 0.6 mrem total body and 1.1 mrem bone. The dose impact from eating 60 gm of duck livers containing U or Pu would be less than 0.01 mrem to any organ of the body. Maximum radionuclide concentrations observed in coots (in pCi/gm) were K 40 = 6.2, Co 60 = 0.2 (1978 only), Zn 65 = 0.6 (1971 only), Sr 90 = 0.1, and Cs 137 = 0.6. A 50-yr internal dose commitment from ingesting 500 gm of coot meat containing the maximum Sr 90 and Cs 137 concentrations would be 6.5 mrem total body and 8.4 mrem bone. Natural background at Hanford is about 100 mrem/yr, or a 50-yr dose of 5000 mrem. (Auth) (LKH)

Total Ion Concentration

K 40; Co 60; U; Pu; Zn 65; Sr 90; Cs 137

BIRDS; FOODS; DUCKS; GEESE; COOTS; PHEASANTS; WATERFOWL; POTASSIUM 40; COBALT 60; ZINC 65; STRONTIUM 90; CESIUM 137; DOSE COMMITMENTS; RADIATION DOSE; MAN; ENVIRONMENTAL EXPOSURE PATHWAY; URANIUM; PLUTONIUM, UPTAKE; INGESTION; RADIONUCLIDES; FALLOUT; BACKGROUND RADIATION; DISPOSAL SITE; EFFLUENTS; EMISSIONS;

DISPOSAL SITE

<70> COST.
CONCENTRATIONS; ECOLOGICAL STUDIES; BIOLOGICAL STUDIES; FIELD STUDIES

<71>
Fix, J.J., S.C. Leete, and P.E. Brannon, Battelle-Pacific Northwest Laboratories, Richland, WA.

Radionuclide Concentrations in Selected Foodstuffs and Wildlife from the Hanford Environs, 1971-1975. (3)

PNL-2383; 28 pp. (1977, November)

Data from radiochemical analyses of foodstuffs (excluding game birds) collected from 1971 through 1975 in the Hanford environs are presented. Foodstuffs analyzed included milk, beef, chicken, eggs, leafy vegetables (spinach, leaf lettuce, turnip greens, and mustard greens), fish, deer, and oysters from Willapa Bay. Maximum concentrations of the measured radionuclides were as follows: milk - 9900 pCi/L K 40, 7.6 pCi/L Sr 90, 24.7 pCi/L I 131; beef - 2.8 pCi/g (wet wt) K 40, 0.013 pCi/g Sr 90, 0.19 pCi/g Cs 137; chicken muscle - 2.8 pCi/g K 40, 0.014 pCi/g Sr 90, Cs 137 not detectable; chicken eggs - 1.6 pCi/g K 40, 0.012 pCi/g Sr 90, 0.04 pCi/g Cs 137; green leafy vegetables - 5.6 pCi/g K 40, 0.055 pCi/g Sr 90, 0.2 pCi/g Cs 137; whitefish - 10.0 pCi/g K 40, 36 pCi/g P 32, 5.6 pCi/g Zn 65, 0.5 pCi/g Cs 137, 0.190 pCi/g Sr 90; deer muscle - 2.9 pCi/g K 40, 1.8 pCi/g Cs 137; Willapa Bay oysters - 2.6 pCi/g K 40, 7.1 pCi/g Zn 65, 0.06 pCi/g Cs 137. In general, occurrence of Sr 90 and Cs 137 in samples is attributed to fallout. Iodine 131 in milk showed higher concentrations after Chinese nuclear tests. Zinc 65, observed in milk, oysters, and fish, and P 32, observed in fish, are attributed to the past operation of the once-through cooling reactors at Hanford. Following shutdown of the last of these reactors in January 1971, P 32 showed a rapid decline. Zinc 65 concentrations declined more slowly. Zinc 65 concentrations in oysters displayed an approximately 100-fold decrease in 1971-75. Median concentrations of K 40 during the sampling period were: milk - 1000 pCi/L, beef - 2 pCi/g, chicken - 1.8 pCi/g, eggs - 0.9 pCi/g, green leafy vegetables - 3 pCi/g, whitefish, 3.2 pCi/g, deer - 2.5 pCi/g, and oysters - 2 pCi/g. Estimated 50-yr whole body dose commitment from consumption of 365 l of milk containing 100 pCi/l Zn 65 is 0.1 mrem; consumption of 19 kg of whitefish containing 2.2 pCi/g Zn 65 and 3 pCi/g P 32 would incur a 50-yr dose of 0.3 mrem and 0.4 mrem whole body, respectively. Eating 9 kg of oyster meat containing the average Zn 65 concentration observed (8.6 pCi/g) yields a 50-yr dose of 0.3 mrem whole body and 0.2 mrem bone. These values may be compared with the approximately 100 mrem/yr background (50-yr dose = 5000 mrem). (LFH)

For measurements of game birds, see BNWL-2089.

Total Ion Concentration

K 40; P 32; Sr 90; Cs 137; I 131; Zn 65

ANIMALS; PLANTS; CROPS; FOODS; UPTAKE; ENVIRONMENTAL EXPOSURE PATHWAY; MAN; DISPOSAL SITE; RADIONUCLIDES; BIRDS; FISH; MOLLUSKS; INVERTEBRATES; MAMMALS; POTASSIUM 40; STRONTIUM 90; IODINE 131; CESIUM 137; PHOSPHORUS 32; ZINC 65; FALLOUT; EXPLOSIONS, NUCLEAR; DOSE COMMITMENTS; RADIATION DOSES; BACKGROUND RADIATION; RADIONUCLIDE MIGRATION; INGESTION; EFFLUENTS; EMISSIONS; CONCENTRATIONS; FIELD STUDIES; BIOLOGICAL STUDIES; ECOLOGICAL STUDIES

<72>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

A Summary of the Phase II - Title I Engineering Assessment of Inactive Uranium Mill Tailings, Riverton Site, Riverton, Wyoming. (8)

GJT-195; 22 pp. (1977, December)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Riverton, Wyoming site. The Phase II - Title I services include: the performance of core drillings; soil, water, and other sample analyses; radiometric measurements to determine areas with radium-contaminated materials; the evaluation of resulting radiation exposures of individuals and nearby populations; the investigation of site geology, hydrology, and meteorology; and the evaluation and costing of alternative corrective actions. Rn 222 gas released from the 900,000 tons of tailings at the Riverton site constitutes the main environmental impact, ranging from 6.2 pCi/l on the pile to 0.8 pCi/l four mi north of the pile, measured over 24 hrs. Gamma radiation exposure is essentially zero beyond 0.1 mi of the site. No quantitative evaluation was made of windblown Th 230 and Ra 226, the principal alpha-emitters. The two alternative actions presented are fencing and maintenance of the site and off-site remedial action (Option I); and, in addition to the items in Option I, decontamination of the millsite and ore storage areas and additional stabilization cover to a minimum of 2 ft (Option II). The cost estimates for the options are $860,000 and $1,180,000, respectively. Estimated costs for moving the tailings and all contaminated materials to unspecified sites 5 and 10 mi from the present location are $6,000,000 and $6,800,000, respectively. Reprocessing the tailings for uranium is not economically attractive at present. (Auth) (LFH)

Maps, tables, and a stratigraphic column are included as an addendum.

Total Ion Concentration

Rn 222; Ra

ENVIRONMENTAL EXPOSURE PATHWAY; TAILINGS; URANIUM; MILLS; RADON; RADIUM; THORIUM; COST BENEFIT ANALYSIS; RADIATION HAZARDS; SITE EVALUATION; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; SURFACE CONTAMINATION; EROSION; INSPECTION; WASTES, INDUSTRIAL; FIELD STUDIES

<73>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

A Summary of the Phase II - Title I Engineering Assessment of Inactive Uranium Mill Tailings Green River Site, Green River, Utah. (8)

<7D>

DISPOSAL SITE

<7D> CONT.
GJT-105; PB and DE 130-10; 21 pp. (1977, December)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Green River site, Utah. The Phase II - Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas released from the 123 thousand tons of tailings at the Green River site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. Short-term Rn measurements using continuous Rn monitors showed no correlation between Rn concentration and distance from the tailings pile. Values ranged from 0.9 pCi/l at 0.08 mi from the pile to 2.3 pCi/l at 3.8 mi distance; 1.5 pCi/l was the average background concentration. Average gamma background, measured with a Geiger-Mueller detector, was 8 uR/hr; values on the tailings pile were up to 96 uR/hr, while radiation at the former ore stockpile area was up to 220 uR/hr. Background was reached 0.1-0.2 mi from the pile. Ra 226 in surface soil samples ranged from background (1.4 pCi/g) on the west to 3.5 and 2.5 times background 1/8 mi to the north and east of the pile, respectively. To the south, Ra was less than twice background at 0.8 mi distance. A shallow groundwater sample from Browns Wash downstream from the tailings contained less than 10% of the EPA Interim Drinking Water Standard for Ra 226. Other potentially toxic materials in the tailings include Ba and Pb (70-130 ppm), Se (up to 237 ppm), and As (2 ppm); two water samples from an auger hole between the tailings and Browns Wash exceeded the EPA Drinking Water Standards for Se, Pb, Cr, and As. The three alternative actions presented are dike stabilization, fencing, on- and off-site decontamination and maintenance (Option I); improvements in the stabilization cover and dike; plus cleanup of the site and Browns Wash, and realignment of Browns Wash (Option II); and addition of stabilization cover to a total of 2 ft, realignment of Browns Wash and placement of additional riprap, on-site cleanup and drainage improvements (Option III). All options include remedial action at off-site structures. Cost estimates for the three options range from $700,000 to $926,000. Reprocessing the tailings for uranium is not economically attractive at present. (Auth) (LKH)

Maps and a generalized stratigraphic column are included as an addendum.

Total Ion Concentration

Ra 226; Th 230; Rn 222

TAILINGS; URANIUM; MILLS; RADON; RADIUM; ENVIRONMENTAL EXPOSURE PATHWAY; COST BENEFIT ANALYSIS; RADIATION HAZARDS; SITE EVALUATION; WASTE MANAGEMENT; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; EXPOSURE RATE; FIELD STUDIES

<7D>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

Phase 2 - Title I Engineering Assessment of Inactive Uranium Mill Tailings New and Old Rifle Sites, Rifle, Colorado. (3)

GJT-10; PB and DE 130-10; 180 pp.; GJT-105; 5 pp. (1977, October)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existance of radioactive uranium mill tailings at Rifle, Colorado. The Phase 2 - Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon 222 gas release from the 3.1 million tons of tailings at the two Rifle sites, constitutes the most significant environmental impact. Windblown tailings, external gamma radiation and localized contamination of surface waters are other environmental effects. Short-term Rn measurements performed with continuous Rn monitors at 12 locations in the vicinity of the tailings piles showed the highest outdoor concentration (180 pCi/L) on the Old Rifle pile. Background atmospheric Rn measured at 4 locations 0.5-2.0 mi from the piles averaged 1.2 pCi/L. Radon above average background was detected to 0.8 mi from the site. Natural gamma background in the Rifle area averaged 12 uR/hr (8-15 uR/hr); above the tailings piles, values ranged up to 780 uR/hr. In the mill and ore storage areas at New Rifle, gamma values were 20-640 uR/hr, while at the Old Rifle mill and ore storage areas, values were up to 230 uR/hr. Surface soil samples indicate some windblown contamination to the east of the piles. Twenty-one water samples from the Colorado River, standing water, a spring, and a well near the piles had Ra 226 contents of 0.03-13.0 pCi/L. There is evidence of contamination of the surface water adjacent to the piles, and hydrologic conditions at the site indicate a potential for groundwater contamination. Leaching of Ra from the tailings into the subsoil generally extends to about a ft in depth before reaching twice the average background soil Ra concentration (average soil background is 1.5 pCi/g). There are also isolated locations in the ore storage areas where contamination reaches to depths of at least 5 ft. The 15 alternative remedial action options presented range from millsite decontamination and off-site remedial action (Options I and IV), to adding various depths of stabilization cover material (Options II, V, VI and VII), to removal of the tailings to long-term storage sites and decontamination of the present sites (Options III and VIII through IV). Cost estimates for the first 14 options range from $220,600 to $20,300,000. Option IV, estimated at $32,200,000, includes the cost for moving both Rifle Tailings piles and the Grand Junction tailings pile to DeBeque for long-term storage and site decontamination after removal of the piles. Reprocessing of the tailings for uranium appears to be economically attractive at present. (Auth) (LKH)

GJT-105 is a summary of GJT-10.

DISPOSAL SITE

<78> COST.
Total Ion Concentration

Ra 222; Ra 226

TAILINGS; URANIUM; MILLS; RADON 222; RADIUM 226; ENVIRONMENTAL EXPOSURE PATHWAY; COST BENEFIT ANALYSIS; RADIATION HAZARDS; SITE EVALUATION; WASTE MANAGEMENT; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; EXPOSURE RATE; WASTES, SOLID; GASES; FIELD STUDIES

<75>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

Phase 2 - Title I Engineering Assessment of Inactive Uranium Mill Tailings Maybell Site, Maybell, Colorado. (3)

GJT-11; FB and DU 130-11; GJT-115; 116 pp.(1977, October)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Maybell, Colorado. The Phase 2 - Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings and radiometric measurements to determine radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 2.6 million tons of tailings at the Maybell site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. Short-term radon measurements performed with continuous Rn monitors at 8 locations in the vicinity of the Maybell tailings pile showed a maximum concentration of 15 pCi/L Rn 222 on the pile. Background measurements of atmospheric Rn at 2 locations, 2.5-3.5 mi from the site averaged 3.0 pCi/L. Radon above average background level was detected up to 0.5 mi from the site. The lowest gross gamma radiation value measured in the area (11 uR/hr) was found 6000 ft NW of the tailings, while above the tailings, readings ranged as high as 360 uR/hr. Gamma rates were more than twice background in the area surrounding the tailings, due largely to windblown contamination and stockpiles of low-grade ore nearby. Surface soil samples indicate windblown contamination to the east of the pile. A sample 375 yd east of the pile contained ten times the average Ra 226 background concentration of 1.5 pCi/g. Water samples from Ley Creek, Johnson Wash, the Yampa River, and a wash just off the tailings ranged in Ra 226 content from 0.02 to 12.8 pCi/L, the high value being from the wash adjacent to the tailings. A water sample from a monitoring well west of the tailings contained 10.8 pCi/L Ra 226, but this was contamination from the Brown Park Formation, host for the local uranium deposits. The tailings have not increased the Ra content of the water at Maybell. Leaching of Ra into the subsoil under the tailings ranges from 2 to 5 ft before reaching background. The three alternative remedial actions presented range from fencing and maintenance (Option I) to placing the tailings in an open-pit mine and adding 2 ft of stabilization cover material (Option III). Cost estimates for the three options range from $250,000 to $8,520,000. Reprocessing the tailings for uranium does not appear to be economically attractive at present. (Auth) (LES)

GJT-115 is a summary of GJT-11.

Ra 222; Ra 226

TAILINGS; URANIUM; MILLS; RADON 222; RADIUM 226; ENVIRONMENTAL EXPOSURE PATHWAY; COST BENEFIT ANALYSIS; RADIATION HAZARDS; SITE EVALUATION; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; DECOMMISSIONING; WASTE VOLUME; SURFACE WATERS; BACKGROUND RADIATION; RADIATION, GAMMA; PARTICLES, AIRBORNE; SAMPLES; SOILS; WELLS; LEACHING; CORES; FIELD STUDIES; LABORATORY STUDIES; MAPS; CORES; RADIATION DOSE; EXPOSURE, POPULATION; DISPOSAL SITE; HYDROLOGY; DECONTAMINATION

<76>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

Phase 2 - Title I Engineering Assessment of Inactive Uranium Mill Tailings Gunnison Site, Gunnison, Colorado. (3)

GJT-12; FB and DU 130-12; GJT-125; 138 pp.(1977, November)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Gunnison, Colorado. The Phase 2 - Title I services include the preparation of topographic measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 0.5 million tons of tailings at the Gunnison site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. Short-term radon measurements performed with continuous Rn monitors at 11 locations in the vicinity of the tailings revealed a maximum concentration of 1.6 pCi/L Rn 222 on the pile, but the value may be low due to moisture in the cover material. Background measurements at 5 locations 0.7-5.1 mi from the site averaged 1.0 pCi/L; above background Rn levels were detected up to 0.6 mi from the site. Natural gamma background in the area is 10-15 uR/h (averaging 13 uR/hr), measured 3 ft above the surface. Gamma readings reached 280 uR/hr above the tailings pile, while values from twice background to 230 uR/hr were observed in the mill and ore storage areas. Surface soil samples indicate very little windblown contamination. Radium 226 contents of 16 water samples from the Gunnison River, Blue Mesa Reservoir, Tomichi Creek, and from wells surrounding the pile were 0.02-0.16 pCi/L. There was no definitive evidence of surface or ground water contamination in the vicinity of the tailings; however, hydrologic conditions at the site indicate a potential for contamination. Leaching of Ra from the tailings into the subsoil ranges 1-4 ft beneath the tailings and averages 3 ft before reaching the average background soil Ra concentration (1.5 pCi/g). The mine

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DISPOSAL SITE

<76> COST.
alternative remedial actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through IX). Cost estimates for the nine options range from $880,000 to $5,890,000. Reprocessing the tailings for uranium does not appear to be economically attractive at present. (Auth) (LKH)

GJT-125 is a summary of GJT-12.

Total Ion Concentration

Ra 222; Ra 226

DISPOSAL SITE; TAILINGS; URANIUM; ORES; MILLS; RADON 222; RADIUM 226; SITE EVALUATION; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; WASTE VOLUME; DECOMMISSIONING; DECONTAMINATION; COST BENEFIT ANALYSIS; ENVIRONMENTAL EXPOSURE PATHWAY; EXPOSURE, POPULATION; RADIATION DOSE; RADIATION HAZARDS; SURFACE WATERS; BACKGROUND RADIATION; RADIATION, GAMMA; PARTICLES, AIRBORNE; SAMPLES; SOILS; WELLS; HYDROLOGY; LEACHING; MAPS; CORES; FIELD STUDIES; LABORATORY STUDIES

<77>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

Phase 2 - Title 1 Engineering Assessment of Inactive Uranium Mill Tailings Lakeview Site, Lakeview, Oregon. (3)

GJT-18; FB and DU 130-18; 97 pp. (1977, December)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Lakeview, Oregon site. The Phase 2 - Title 1 services include: performance of core drillings; analyses of soil, water, and other samples; radiometric measurements to determine areas with radium-contaminated materials; evaluation of resulting radiation exposures of individuals and nearby populations; investigation of site geology, hydrology, and meteorology; and evaluation and costing of alternative corrective actions. Radon gas release from the 130,000 tons of tailings at the Lakeview site constitutes the main environmental impact, which is minimal. Short-term radon measurements performed with continuous Rn monitors at 8 locations in the vicinity of the tailings ranged from 0.6 to 0.8 pCi/L (average 0.7 pCi/L). Radon exhalation flux from the tailings measured by the charcoal canister technique was 610-710 pCi/sq m on the pile. Above background Rn levels were detected up to 0.2 mi from the tailings. Natural gamma background was 5-10 uR/hr (average 8 uR/hr). Values as high as 53 uR/hr were measured above the tailings pile, and a maximum of 380 uR/hr was detected at the former ore stockpile area [subsequently remedied as part of the Atlantic Richfield Company (ARCO) reclamat. program]. Gamma background was reached within 0.05 mi from the tailings. There is no evidence of windblown contamination. Analysis of water samples downstream from the tailings showed Ra 226 concentrations well below EPA Interim Drinking Water Standards. No Ra 226 was detected in auger holes 2-2.5 ft deep adjacent to the pile. Analyses of soil samples obtained previously from a trench dug through the pile indicated Ra 226 was being trapped in the clay liner under the tailings. The two alternative remedial actions presented are maintenance of the site now that the ARCO reclamation program has been completed (Option I); and addition of stabilization cover to a minimum depth of 2 ft, improved fencing, and removal of a few isolated spots of contamination (Option II). The cost estimates for these options are $80,000 and $290,000, respectively. (Auth) (LKH)

Ra 222; Ra 226

DISPOSAL SITE; TAILINGS; URANIUM; MILLS; RADON 222; RADIUM 226; ENVIRONMENTAL EXPOSURE PATHWAY; EXPOSURE, POPULATION; RADIATION DOSE; RADIATION HAZARDS; SITE EVALUATION; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; WASTE VOLUME; DECOMMISSIONING; COST BENEFIT ANALYSIS; SURFACE WATERS; BACKGROUND RADIATION; RADIATION, GAMMA; PARTICLES, AIRBORNE; SAMPLES; SOILS; WELLS; LEACHING; ORES; FIELD STUDIES; LABORATORY STUDIES; MAPS; CORES; HYDROLOGY; DECONTAMINATION

<78>
Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

Phase 2 - Title 1 Engineering Assessment of Inactive Uranium Mill Tailings Ray Point Site Ray Point, Texas. (3)

GJT-20; FB and DU 130-20; 95 pp. (1977, December)

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Ray Point, Texas. The Phase 2 - Title 1 services included the preparation of topographic maps, the performance of soil sampling and radiometric measurements radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. About 890,000 tons of ore were processed at this mill with all of the uranium sold on the commercial market. None was sold to the AEC; therefore, this report focuses on a physical description of the site and the identification of radiation pathways. No remedial action options were formulated for the site, because none of the uranium was sold to the AEC and because Exxon Corporation had agreed to perform all actions required by the State of Texas. Background Rn concentrations measured using continuous Rn monitors were 0.8-1.0 pCi/L for the Ray Point area (a. ge 0.9 pCi/L). Above-background Rn values were detected up to 1/4 mi from the site. The highest value was 1.3 pCi/L at the mill building NE of the tailings. Field measurements of Rn exhalation flux from the tailings using the charcoal canister technique averaged 430 pCi/sq m sec on the tailings pile. Background gamma levels measured 3 ft above the ground at several locations within 0.6 mi of the site were 9-11 uR/hr (average 8 uR/hr); about 8 uR/hr of this is cosmic radiation. External gamma radiation rates on the tailings pile ranged between 3 and 65 times background -- up to 520 uR/hr toward the center of the pile. In the former mill and ore storage areas gamma rates were 3-22 times background. Gamma rates reached background within 0.2 mi from

DISPOSAL SITE

<78> COST.
the pile. A mobile gamma survey located a "hot spot" (up to 500 uR/hr) along a road near Three Rivers, Texas, probably caused by ore spillage. Seven surface and ground water samples were taken from the vicinity of the tailings and analyzed for Ra 226. The highest values obtained were 188 pCi/L from a pond on the pile and 52.7 pCi/L from a runoff pond in the mill area. Stream samples contained 0.02-1.5 pCi/L, the highest value corresponding to a stream sediment measurement of 198 pCi/g taken near a highway bridge, probably indicating contamination by spillage. All water sampled off-site was below EPA Interim Drinking Water Regulations for Ra contamination; however, there are areas of offsite contamination that could contaminate water. These should be delineated and decontaminated, and contaminated water onsite should not be allowed to contaminate offsite areas. (Auth) (LKH)

Rn 222; Ra 226

SAMPLES; SOILS, WELLS; HYDROLOGY; LEACHING; MAPS; CORES; FIELD STUDIES; LABORATORY STUDIES; DISPOSAL SITE; TAILINGS; URANIUM; ORES; HILLS; RADON 222; RADIUM 226; SITE EVALUATION; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; WASTE VOLUME; DECOMMISSIONING; DECONTAMINATION; COST BENEFIT ANALYSIS; ENVIRONMENTAL EXPOSURE PATHWAY; EXPOSURE, POPULATION; RADIATION DOSE; RADIATION HAZARDS; SURFACE WATERS; BACKGROUND RADIATION; RADIATION, GAMMA; PARTICLES, AIRBORNE

<79>
Fraley, L., Jr., G.C. Bowman, and C.D. Markham, Colorado State University, Fort Collins, CO; Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Iodine 129 in Thyroids of Herbivores on the Idaho National Engineering Laboratory Site. (3)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (p. 40) 72 pp. (IDO-12088).(1979, April)

Antelope (ANTILOCAPRA AMERICANA) and three species of rabbits (LEPUS CALIFORNICUS, SILVILAGUS NUTTALLII, S. IDAHOENSIS) were collected on the INEL site and their thyroids removed for I 129 analysis. Twelve antelope thyroids from animals collected near Test Area North (TAN) averaged 3.5 X 10(E-5) plus or minus 3.9 X 10(E-5) atoms of I 129 to atoms of I 127; thyroids from antelope collected near the Central Facilities Area averaged 9.6 X 10(E-5) plus or minus 8.2 X 10 (E-5) for the atom ratio. The I 129/I 127 ratio in rabbit thyroids ranged from below detection for some background samples to an average of 2.7 X 10(E-7) for four background samples to a maximum of 8.7 X 10(E-8). I 129 concentration ranged from a minimum of 0.11 pg I 129/g thyroid tissue (wet) for one background sample to a maximum of 0.23 ng I 129/g thyroid tissue. The resulting doses to the thyroid ranged from 3 mrad/yr to 64 mrad/yr. Sixty percent had doses less than 1 mrad/yr. Maximum doses were associated with rabbits collected near the Idaho Chemical Processing Plant (ICPP), the source of gaseous I 129 effluent (0.1 Ci/yr average). Further studies will estimate I 129 concentrations in vegetation and behavior in a sagebrush-grass dominated ecosystem. (LKH)

Total Ion Concentration

I 129; I 127

MAMMALS; IODINE 129; ISOTOPE RATIOS; RADIATION DOSE; EFFLUENTS, AIRBORNE; UPTAKE; CONCENTRATIONS; DOSE RATE; FIELD STUDIES; BIOLOGICAL STUDIES

<80>
Frigerio, N.A., T.J. Larson, and R.S. Stowe, Argonne National Laboratory, Division of Environmental Impact Studies, Argonne, IL.

Thorium Residuals in West Chicago, Illinois. (3)

NUREG/CR-0413; ANL/ES-67; 28 pp.(1978, September)

Seventy-five areas of Thorium residuals accumulation from the former Lindsey and Company plant in West Chicago, Illinois were located and analyzed. This report is mainly concerned with material which found its way into Kress Creek and the Du Page River, the present West Chicago sewage treatment plant, and various public and private areas in the vicinity. The survey was conducted on foot and by vehicle using batteries of sodium iodide crystals and high-resolution scintillators; it was assisted by data from the ANMS flyover completed in October 1977. Core samples were analyzed at Argonne National Laboratory using GeLi detectors. Calculated maximum surface exposure rates for Th concentrations around the city ranged from 9 uR/hr to 3500 uR/hr, maximum dose rates from 4 to 900 mrem/hr, and maximum annual doses from 7.0 x 10(E-2) to 2.0 x 10(E+1) rem. Dose rates for Kress Creek and the Du Page River near the creek mouth ranged from background to 150 mrem/hr at 1 m above ground. Most of this material, acting as placers, has moved less than 1 mi in 47 years. Radioactivity in Reed-Keppler Park was essentially restricted to the fenced security area, where tailings used as landfill were secured in 1976. Cores from this area contained Th 232 concentrations from 3 to 40,000 pCi/g in the soil above 760 ft MSL; below 756 ft MSL only background radioactivity was present. Cores from radioactive patches outside of the fence contained 5-50 pCi/g Th, but reached background 5-15 cm below the surface. Water from the park drainage system contained 0.5-15 pCi/l Ra 226 or 228 and 0.2-1.5 pCi/l Th 232 or 228; sediments had 5-50 pCi/g Th 232 and 2-10 pCi/g Ra 226. Airborne anomalies were restricted to Rn 220 and 222 immediately downwind from the security area (30 nCi/cu m Rn 222 and 4 nCi/cu m Rn 220 maxima); annual average ratio of these isotopes was 1.5 background. The factory site and tailings pile were assigned a maximum annual population dose of 20 man rem/yr; total population dose from all sources is less than 30 man rem/yr, compared with about 2000 man rem/yr natural background. It is concluded that the Th residuals pose no hazard to public health, though they do constitute a public nuisance of some magnitude. (LKH)

Total Ion Concentration

Th 232; Th 228; Ra 226; Ra 228; Rn 222; Rn 220

THORIUM; EXPOSURE RATE; TAILINGS; POLLUTION, WATER; POLLUTION, SOIL; GAMMA; DOSE COMMITMENTS; RIVERS; STREAMS; WASTES, RADIOACTIVE; SEDIMENTS; CORES; FIELD STUDIES

<81>

DISPOSAL SITE

<81>
Gailledreau, C., and C. Berlin, Nuclear Study Center of Cadarache, France.

Experimental Storage of Radioactive Waste at Shallow Depth. (E)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 251-259), 666 pp. (STI/PUB/156).(1967)

Solid radioactive waste may be stored safely in the soil at shallow depths provided it lies above the water table and is protected from any significant infiltration by rainwater. A facili y has been constructed whereby the buried waste is covered by a polyethylene umbrella with a surrounding drain. The walls and bottom of the waste pit itself are highly permeable and are made of large pebbles to catch any ground water diffusing laterally into the facility. Water from the drain surrounding the umbrella and from the bottom drain flows by gravity towards a nearby ravine, passing into a monitoring sump. To reduce water condensation beneath the umbrella, the latter is covered by a mound of earth 30-50 cm thick with turf on top, which acts as a thermal screen. The amount of water in the area in which the waste is stored - 20 mCi of fission products - and in the soil outside the facility is measured with a neutron moisture gauge, and the results of these measurements are given in the paper. It has been found that the volume filled by the waste constantly remains dry. The results of monitoring the drain sump are also quoted. Finally, an estimate of the cost price of such storage per unit volume is given. (Auth)

GROUND WATER; WATER TABLE; DRAINAGE; WASTES, RADIOACTIVE; WASTES, SOLID; SOILS; MOISTURE; ECONOMICS; DIFFUSION; MONITORING; FISSION PRODUCTS; PITS; FIELD STUDIES

<82>
Garrett, P.B., Technology for Energy Corporation, Knoxville, TN.

An Evaluation of Low-Level Radioactive Waste Burial Ground Capacities at the Major Department of Energy Reservations. (T)

ORNL/NFW-79/17; 49 pp.(1979, January 26)

This investigation was conducted for the National Low-Level Radioactive Waste Program, Oak Ridge National Laboratory (ORNL), to provide information for a contingency plan on commercial radwaste management being prepared by EG and G Idaho, Inc. at the Idaho National Engineering Laboratory (INEL). The purpose of this contingency plan is to evaluate the options that may be available to DOE should the Federal government be required to assume an active management role in the disposition of commercial low-level radwastes. The primary objectives of this work were to determine the remaining acreages and capacities of the low-level radwaste shallow-land burial grounds at various major DOE reservations and to forecast DOE's research and defense program needs for these unused portions of existing burial grounds. The possibility of expanding existing capacities as well as establishing new burial ground utilization factors at each of the reservations was considered. The six sites investigated were INEL, Hanford, Nevada Test Site (NTS), Los Alamos Scientific Laboratory (LASL), Savannah River Plant (SRP), and ORNL. The major findings of the study are summarized as follows: (a) remaining usable authorized burial space (in acres), INEL = 10, Hanford = over 1000, NTS = 0, LASL = 25, SRP = 81, ORNL = 0; (b) estimated years until authorized acreage is filled to capacity based on forecasted volumes of on-site radwaste generation from DOE activities, INEL = 12 + or - 6, Hanford = over 100, NTS = 0, LASL = 40, SRP = 30, ORNL = less than 10; (c) potential for expansion of existing or establishment of new burial capacity, INEL = possibly extensive, Hanford = extensive, NTS = extensive, LASL = virtually nil, SRP = possibly extensive, ORNL = virtually nil; (d) possible availability for disposal of commercial radwaste, by 1980 (by 1985), INEL = no (yes), Hanford = yes (yes), NTS = no (yes), LASL = no (no), SRP = yes (yes), ORNL = no (no). (Auth) (LKH)

DISPOSAL SITE; SITE EVALUATION; PREDICTIONS; WASTES, LOW-LEVEL; WASTES, INDUSTRIAL; WASTE MANAGEMENT; WASTE DISPOSAL; FIELD STUDIES; REVIEWS

<83>
Giardina, P.A., N.F. DeBonis, J. Eng, and G.L. Meyer, U.S. Environmental Protection Agency, New York, NY.

Summary Report on the Low-Level Radioactive Waste Burial Site, West Valley, New York (1963-1975). (T)

USGS Open File Report.(1977, February)

This report discussed the status of the state-licensed low-level radioactive waste burial site at the Nuclear Fuel Services Center in West Valley, New York. The stated purposes of this report were to present the results of shallow drilling in the immediate vicinity of the trenches to investigate the possibility of migration, to provide a thorough compilation of data on the West Valley site in one document to assist in waste management criteria, and to relate the operational history, problem development, and remedial work information which may prove useful to site selection decision-makers in the future. The report contains a summary of a literature survey describing the previous work at the site performed by Nuclear Fuel Services, the New York State Department of Environmental Conservation, New York State ERDA, and the New York State Geological Survey. The results of a NYSERDA funded subsurface investigation which included the drilling of eighteen borings in the vicinity of the burial trenches is described in detail. Shelby tube samples from these holes were analyzed for radionuclides. Elevated concentrations of tritium were observed in localized horizons. A discussion of the burial site inventory is also included. The site conditions are compared with EPA and USGS recommendations for site selection criteria for low-level radioactive and hazardous waste burial sites. Recommendations for site improvements and future research are presented. The enclosed appendices include descriptions of site geology, hydrology, the conditions and amendments of the burial ground license, low-level waste parameters, and secure hazardous waste landfill disposal criteria. (JC)

DISPOSAL SITE

<83> CONT.
The comparisons to hazardous waste disposal site selection criteria are informative. Lithologic data from cores near trenches are somewhat generalized. (DN/JC)

Depth to Water Table; Hydraulic Conductivity; Porosity; Permeability

H 3; Sr 90; Co 60; Cs 137; Cs 134; Sb 125; Ru 106

GEOLOGY; HYDROLOGY; BURIAL; TRENCHES; WASTE VOLUME; TRITIUM; RADIONUCLIDE MIGRATION; MONITORING; TILL; SANDS; ENVIRONMENTAL EXPOSURE PATHWAY; RADIATION DOSE; REVIEWS; SITE SELECTION; WASTES, LOW-LEVEL; RECOMMENDATIONS

<84>
Godse, V.B., A.L. Mohan, H. Singh, R.V. Ambraj, and K.T. Thomas, Bhabha Atomic Research Center, Trombay, Bombay, India.

Characterization of Trombay Soils for Disposal of Radioactive Wastes. (2)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 301-314), 666 pp. (STI/PUB/156).(1967, June)

Solidified radioactive wastes are buried in shallow trenches within the Bhabha Atomic Research facility. The results of hydrogeologic studies performed at the site to aid in engineering considerations to limit radionuclide egress are presented. Field studies were initiated which included the drilling of boreholes to determine the nature of the subsurface geology. Laboratory and field studies were performed to establish the physical and chemical properties of the subsurface materials such as distribution coefficients, cation exchange capacity, and organic content. Tracer studies were performed to determine rate and direction of groundwater movement. Rainfall during monsoon season can bring 10 inches or more per day and 40 inches or more per month. These meteorologic conditions cause the water table to rise within two feet of the ground surface. Consequently, great care has to be given to the engineering of containment for the waste and monitoring of the environment. (JC)

Useful data on the Trombay disposal site are presented. (DN/JC)

Ion Exchange Capacity; pH; Grain Size Distribution; Total Organic Carbon Content; Porosity; Hydraulic Conductivity; Distribution Coefficient

Cs 137; Sr 90

SITE EVALUATION; GEOLOGY; HYDROLOGY; WASTES, RADIOACTIVE; BURIAL; DISTRIBUTION COEFFICIENT; CATION EXCHANGE CAPACITY; ALLUVIUM; BASALTS; LEACHATES; BOREHOLES; WATER TABLE; GROUND WATER; PRECIPITATION, METEOROLOGICAL; FIELD STUDIES

<85>
Graf, P., and W. Rottenberg, Motor-Columbus Ltd., Baden, Switzerland; Federal Office of Public Health, Bern, Switzerland.

Plans for Long-Term Storage of Low- and Medium-Level Radioactive Wastes in Switzerland. (3)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria (pp. 329-341), 666 pp.(1967, June)

The generally unfavorable hydrogeologic conditions in Switzerland and the ever increasing consumptive demand for ground and surface water for drinking purposes preclude the ground disposal of liquid or packaged solid radioactive waste. Presently, low-level solid radioactive waste originating from the nuclear research centers and power plants is compacted into standard steel drums and stored in temporary weather proof storage areas at the plant sites. Generators of small quantities of low-level waste such as hospitals, universities, and radioisotope laboratories ship their waste to temporary storage facilities made available by the Federal Office of Public Health. Plans to build permanent centralized waste storage buildings for both the low- and intermediate-level wastes are presented. Plant layouts for these facilities and proposed waste packaging methods are discussed. Volume reduction by incineration for some of the waste is desired when incineration technologies improve in the near future. (Auth) (JC)

Report includes discussion of waste management alternatives when shallow land burial is impractical or impossible. (DN/JC)

WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, SOLID; WASTE STORAGE; CONTAINMENT; BURIAL; SITE EVALUATION; DRUMS; WASTE MANAGEMENT; INCINERATION; VOLUME REDUCTION; DESIGN; CONTAINERS; REVIEWS

<86>
Groves, C.R., and J.L. Keller, Idaho State University, Pocatello, ID.

Species Composition and Local Movement of Small Mammals on the Radioactive Waste Management Complex, Idaho National Engineering Laboratory Site (Home Range and Local Movement of Small Mammals on the Radioactive Waste Management Complex Idaho National Engineering Laboratory Site). (4)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 30-31) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 93-107) 371 pp. (IDO-12087).(1978, December; 1979, April)

In May 1978, a major investigation of rodent species composition, local movement, and density was initiated on the Subsurface Disposal Area (SDA) of the INEL Radioactive Waste Management Complex. Four 0.6 ha grids, each containing 100 Longworth live traps in a 5x20 checkerboard arrangement were employed inside the SDA; additionally, 297 live traps were placed at 9 m intervals along the perimeter of the SDA. The trapped animals are tagged individually and released at the point of capture. Weight, sexual condition, location, and species are noted for each

<86>

DISPOSAL SITE

<86> CONT.
rodent. A two week block of data has been used to report preliminary movement information for the SDA. Average linear movement was calculated as the average distance between successive captures for rodents occupying the grids and for those residing on the perimeter. Rodent density was estimated on each internal grid with a modification of the assessment line technique. The deer mouse (PEROMYSCUS MANICULATUS) was found to be the most abundant species on the SDA, followed by Ord's kangaroo rat (DIPODOMYS ORDII), the montane vole (MICROTUS MONTANUS) and Townsend's ground squirrel (SPERMOPHILUS TOWNSENDII). Density estimates for grids A and B were approximately equal with 15 rodents/ha. Grid C density was slightly lower at 9 rodents/ha, and grid D density was higher at 55 rodents/ha. Preliminary findings indicate that male PEROMYSCUS have larger ranges of movements than females. Although no significant difference has been detected between adult and juvenile PEROMYSCUS on the SDA, long-term trends have not been analyzed. In future it is hoped that grids will be established external to the SDA, in order to compare data for this area to that in the SDA. (Auth) (LKH)

MAMMALS; BURROWING ANIMALS; FIELD STUDIES; DISPOSAL SITE; ECOLOGY; ECOLOGICAL STUDIES

<87>
Halford, D.K., and O.D. Markham, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Radiation Dosimetry of Small Mammals Inhabiting a Liquid Radioactive Waste Disposal Area. (2)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arther (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 8-9) 72 pp. (IDO-12088). (1979, April)

A dosimetry study was conducted on three species of small mammals inhabiting the dry bed of a liquid radioactive waste disposal pond at the Test Reactor Area (TRA) of INEL. White-footed deer mice (PEROMYSCUS MANICULATUS), least chipmunks (EUTAMIAS MINIMUS), and Ord's kangaroo rats (DIPODOMYS ORDII) were live trapped at 70 trapping stations between July and November 1976. Individuals were sexed, aged, weighed, and measured, then tagged, surgically implanted with a thermoluminescent dosimeter chip packet, and released. Deer mice were most frequently captured on the dry pond bed (site exposure rate 200-2000 mR/d), while chipmunks and kangaroo rats were usually captured on pond banks (exposure rate 10-30 mR/d). All species from the pond received significantly greater (P less than 0.001) doses than control species. Deer mice received a mean dose equivalent rate of 140 mrem/d, which was significantly greater (P less than 0.001) than that received by chipmunks (17 mrem/d) and kangaroo rats (6 mrem/d). The mean dose received by deer mice was 4% of the maximum air exposure recorded near the ground surface of the leaching pond, but the maximum dose rate received by an individual deer mouse was almost 50% of the maximum exposure rates in the study plot. Doses received by individuals of each species were highly variable and appeared to be caused by variable site exposure rates and the mobility of the animals. Intraspecific differences in activity, behavior, and home range may also have influenced dose variability in individual rodents. (LKH)

MAMMALS; PONDS; HOLDING PONDS; BURROWING ANIMALS; RADIATION DOSE; DOSE RATE; EXPOSURE RATE; FIELD STUDIES; ECOLOGY; ECOLOGICAL STUDIES

<90>
Halford, D.K., O.D. Markham, and J.B. Millard, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID; Colorado State University, Fort Collins, CO.

Activation and Fission Radionuclide Concentrations and Retention by Ducks Using Radioactive Leaching Ponds (Radionuclide Concentrations in Wild Waterfowl Using the Test Reactor Area Radioactive Leaching Pond). (2)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arther (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, Grand Teton National Park, WY, September 10-12, 1978, (pp. 36-37) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 47-55) 371 pp. (IDO-12087). (1978, December; 1979, April)

A study of waterfowl at the Test Reactor Area (TRA) radioactive leaching pond was conducted from 1974 to 1977 to determine: (1) species and numbers of waterfowl using the pond; (2) concentrations of gamma and transuranic radionuclides in their tissues and body burdens that they can obtain and carry from the TRA environs; (3) effective and biological half-lives of activation and fission products in waterfowl; (4) radiation doses from gamma emitters concentrated by waterfowl on the pond; and (5) potential internal dose commitment to man from consuming contaminated waterfowl. Twenty-six ducks and two coots were collected from the pond during the study period. Fifteen ducks from background areas were also collected. Duck tissues contained up to 30 radionuclides. Cr 51 had the highest concentrations of all radionuclides identified (130,000 pCi/g in the gut and 37,500 pCi/g in the feathers). Nd 147 had the highest concentration in feathers (104,000 pCi/g). Cs 137 was the predominant radionuclide in muscle tissue, with a maximum concentration of 4070 pCi/g. Radionuclide concentrations were lower in edible than in nonedible tissues. Ninety-eight percent of the potential whole body dose to man from eating contaminated ducks was from Cs 134 and Cs 137; I 131 would contribute all of the thyroid dose to man. Dose commitments would be a small fraction of the recommended guidelines (22 mrem average whole body dose and 19 mrem average thyroid dose), even u... consumption of the most contaminated specimens collected. Work is still in progress on the radiological analysis of banded wild-wild mallard ducks fitted with thermoluminescent dosimeters for 75 and 185 days on the pond. Concentrations of radionuclides detected at capture and after 52 days of physical and biological decay are being compared. (LKH)

See also IDO-12087; Ecological Studies on the National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 56-63) 371 pp.

DISPOSAL SITE

<88> CONT.
Cr 51; Cs 137; Cs 134; I 131; Mn 187

BIRDS; PONDS; HOLDING PONDS; UPTAKE; CONCENTRATIONS; CONCENTRATION FACTORS; ACTIVATION PRODUCTS; FISSION PRODUCTS; TRANSURANICS; RADIATION DOSE; CHRONIC; RADIATION, GAMMA; DOSE COMMITMENTS; ENVIRONMENTAL EXPOSURE PATHWAY; EXPOSURE, INTERNAL; FOOD CHAINS; RADIONUCLIDES; CESIUM; IODINE; MAN; ECOLOGY; BIOLOGICAL STUDIES; FIELD STUDIES

<89>
Halford, D.K., J.B. Hillard, and R.G. Schreckhise, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Retention of Activation and Fission Radionuclides by Mallards from the Test Reactor Area Radioactive Leaching Ponds. (3)

IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site, 1978 Progress Report, O.D. Markham (Ed.), (pp. 56-63) 371 pp. (IDO-12087).(1978, December)

Twenty semi-wild mallard ducks (ANAS PLATYRHYNCHOS) were banded, fitted with dorsal and ventral thermoluminescent dosimeter packets and released on the Test Reactor Area radioactive leaching ponds. The leaching ponds form a continuous body of water in which 48,000 Ci (1.8 PBq) of beta-gamma activity has been released. Most of the activity comes from primary activation and fission products released from 1952 to 1977. Ducks were live-captured after 75 days and 105 days on the pond, placed in metabolic cages and whole body counted periodically for 52 days. Ducks from each group were sacrificed immediately after capture, dissected, and muscle, feather, gut, and liver samples submitted for analysis. The remaining ducks were also sacrificed and dissected after the 52 day counting period. Concentrations of the 17 gamma emitting radionuclides detected at capture and after 52 days of physical and biological decay were compared. Seven of the radionuclides were detected in muscle tissue, 13 in gut, 13 in feathers, and 10 in liver samples. Nine of the radionuclides (Se 75, Hg 203, Cr 51, Zn 65, Co 60, La 140, Ba 140, Cs 134, and Cs 137) detected in the individual tissues were detected regularly during early whole-body counts but were not found in tissues due to physical decay before analysis. Highest mean radionuclide concentrations were found in feathers, followed by gut, liver, and muscle. Chromium 51 had the highest average concentrations of all radionuclides followed by Co 60 and Cs 137. Effective and biological half-lives have been calculated for Cr 51 (20 plus or minus 1 days and 70 plus or minus 2 days, respectively), Zn 65 (53 plus or minus 3 days and 68 plus or minus 2 days, respectively), Se 75 (22 plus or minus 1 days and 27 plus or minus 2 days, respectively), Cs 134 (11.1 plus or minus 0.8 days for both), and Cs 137 (11.7 plus or minus 0.7 days for both), and the results compared with previous studies. Samples are currently being analyzed for Pu 238, Pu 239, 240, Am 241, Cm 242, Cm 244, and Sr 90. Further data analyses will be completed after data collection has terminated. The counting apparatus used in this study can be modified to accomodate any small birds or mammals for similar studies. (Auth) (LKH)

See also IDO-12088, Proceedings of a Symposium on the Idaho National Engineering Laboratory Ecology Programs.

Cs 137; Cs 134; Se 75; Hg 203; Co 58; Co 60; Zn 65; Ba 140; La 140; Cr 51; Mn 54; Zr 95; Nb 95; Ce 141; Ce 144; Co 57; Ag 110m

HOLDING PONDS; HALF-LIFE, BIOLOGICAL; HALF-LIFE, EFFECTIVE; UPTAKE; WATERFOWL; RADIONUCLIDES; CONCENTRATIONS; METHODS; CHROMIUM 51; COBALT 60; CESIUM 137; LABORATORY STUDIES; EFFLUENTS, LIQUID; WASTES, LIQUID; WASTES, RADIOACTIVE; LEACHING; DUCKS

<90>
Hanson, W.C., and P.T. Hiers, Jr., Los Alamos Scientific Laboratory, Environmental Studies Group, Los Alamos, NM.

Continued Studies of Long-Term Ecological Effects of Exposure to Uranium. (4)

LA-6742; APATL-TR-77-35; 19 pp.(1977, June)

Research on the ecological effects of exposure to uranium at Eglin Air Force Base (EAFB) and Los Alamos Scientific Laboratory (LASL) are summarized. The uranium was derived from chemical explosives tests at LASL and test firing of depleted uranium penetrators at EAFB. Soil and fauna samples were taken at both areas. At EAFB the soil usually contained higher concentrations from 0 to 5 cm than soil 5 to 10 cm. Approximately 70,000 kg of natural and depleted uranium was expended at LASL during 33 years. The highest concentrations are at the surface (0 to 2.5 cm) 0 to 10 m from the detonation point. The average concentration is 4500 ppm. Surface concentrations at 50 to 200 m are usually less than 15% of 4500 ppm. A three-space plot shows the highest values clustering to the west, south, and northeast of the detonation point. From soil samples taken at 30 cm depths at 10, 20, 30, 40, and 50 m from the detonation point show significant penetration into the soil. The concentration at 50 m in this soil sample was 50 times greater than background. Surface alluvium 250 m beyond the detonation point contained 300 ppm uranium, and at 2800 m samples contained twice the background levels. More soluble uranium in storm runoff was indicated than originally anticipated. Soil and litter macrofauna population and species diversities were apparently reduced at the high-uranium study area. Significantly lower at the site was the Collembola population. (NDV)

ALLUVIUM; BIOTA; CONTAMINATION; DISPOSAL SITE; URANIUM; ENVIRONMENT; ECOSYSTEMS, TERRESTRIAL; EXPLOSIONS; FIELD STUDIES; RADIONUCLIDE MIGRATION; SOILS; RUNOFF; WEAPONS

<91>
Hardin, C.M., Kentucky Department of Human Resources, Frankfort, KY.

Operational Experience of the Kentucky Radioactive Waste Disposal Site. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York,

<91>

DISPOSAL SITE

<91> CONT.
NY, Ch. 8, (pp. 831-836), 12 pp.
(CONF-770512)-(1979)

In October 1962, the Kentucky Department of Health issued a radioactive material license to Nuclear Engineering Company, Inc., authorizing disposal of solid radioactive waste at Maxey Flats, KY. The first disposal of waste occurred in May 1963. A total of 2,225,016 Ci of by-product material, 532,675 lbs of source material, and 613,855 gm of special nuclear material had been buried as of April 1, 1977. This material was contained in 4,767,556 cu ft of waste. Until recently, except for the burial of solidified liquids and discrete high-specific-activity sources, the general types of wastes (55-gal drums, wooden boxes, paper, clothing, resins, filters, etc.) have been dumped or rolled at random into trenches. Each trench is designed with sump pumps to provide for water removal and for monitoring of water level and quality. The license requires that the trenches be maintained in a "dry status", therefore, trench covers or caps are necessary to minimize rainwater infiltration. Layers of clay shale are laid over the trench, and each layer tightly compacted. These layers are overlain by a cover of topsoil and shallow-rooting vegetation planted to reduce erosion. Even with these efforts, some water infiltrates, requiring continuous removal. As a result of improper management prior to 1972, water accumulated in certain trenches, necessitating removal and evaporation. Solidification was considered, but discarded due to the high cost and the absence of criteria for shallow burial of the resulting solids. Initially, the license permitted receipt of low-level liquid wastes for solidification and disposal in special plastic-lined trenches, but in 1972, the license was amended to restrict the receipt of liquid wastes. In 1978, the license was amended to restrict burial of transuranics to a concentration of 10 nanocuries/gm or less. Although the burial of radioactive wastes in shallow land sites has come under a great deal of criticism, the experience at the Maxey Flats site indicates that this method of burial can be performed in an acceptable manner. This may require the categorization of "other than high-level waste", and that these different categories be handled differently. Other considerations include standards for solidification of liquids, and water management programs. Most importantly, the owners of sites must be provided with adequate financial coverage for long-term care after the site is closed and decommissioned. (Auth) (LSH)

Waste Volume

DISPOSAL SITE; WASTES, SOLID; SHALES; CLAYS; SOILS; SEAL MATERIALS; TRENCHES; WATER; PRECIPITATION, METEOROLOGICAL; INFILTRATION; STABILIZATION, VEGETATIVE; PUMPS; EVAPORATION; WASTE TREATMENT; METHODS; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, TRANSURANIC; BURIAL, SHALLOW; WASTE MANAGEMENT; WASTE DISPOSAL; RECOMMENDATIONS; MONITORING; REVIEWS

<92>
Hanson, K.H., Battelle-Pacific Northwest Laboratories, Richland, WA.

Decommissioning of Retired Contaminated Facilities at Hanford. (3)

BNWL-2245; Nuclear Waste Management Quarterly Progress Report, October Through December 1976, R.E. Platt (Comp.), (pp. 13.1 - 13.4), 60 pp.-(1977, April)

An important parameter in evaluating the potential offsite hazard from the presence of fission products and transuranics in subsurface soils of the 200 area plateaus is the extent to which they might migrate from their present location if inundated by groundwater. A modeling study is currently being conducted to estimate potential migration of radionuclides sorbed on soil beneath 200 area cribs under conditions which would cause a rise in the water table. A stage equilibrium method was used originally whereby unit cells of a soil column attained equilibrium with a radioactive solution passing through the column. This model was later modified by use of a delay factor (velocity of the radionuclide divided by the velocity of the water) so that a separate equilibrium distribution calculation was not required for each cell. Strontium results obtained using the delay factor are in good agreement with the stage equilibrium method, both showing migration no further than about 100 meters for the 10 pCi/g Sr 90 isopleth in 100 years. Cesium-137 showed essentially no migration before it decays to less than 10 pCi/g. Plutonium was found to migrate about 500 m in southeasterly directions from the crib over a period of 72,000 years. A radiological design guide for decontamination and decommissioning operations at Hanford is nearly complete and provides release criteria, results of hazards analysis studies, and guidance for detailed planning activities. Limited work was continued during the last quarter on the project to test the use of a "biobarrier" to protect subsurface radioactive waste repositories from penetration by plant roots and animals. Initial calibrating tests were made on a new field instrument (a planar, intrinsic germanium diode spectrometer) for measuring residual transuranic activity in structural materials and soils at very low levels. (Auth) (RT)

Information pertinent to decommissioning of a shallow waste site is presented. (DS/RT).

Sr 90; Cs 137; Pu

RADIONUCLIDE MIGRATION; CONTAINMENT; MODELS; DECOMMISSIONING; DECONTAMINATION; MONITORING; RADIATION DETECTORS; FISSION PRODUCTS; SOILS; ENVIRONMENT; WASTES, RADIOACTIVE; HAZARD ANALYSIS; THEORETICAL STUDIES

<93>
Havens, R., and K.C. Dean, U.S. Bureau of Mines, Salt Lake City Metallurgy Research Center, Salt Lake City, UT.

Chemical Stabilization of the Uranium Tailings at Tuba City, Arizona. (8)

Bureau of Mines Report of Investigations 7288; 12 pp.(1969, August)

A report by the U.S. Public Health Service in 1967 on the radiological safety of the El Paso Natural Gas Co. uranium tailings pile at Tuba City, AZ recommended that the tailings be stabilized against wind erosion. El Paso Natural Gas Co. requested the assistance of the U.S. Bureau of Mines Salt Lake City Metallurgy Research Center, and as

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<93> CONT.
investigation of suitable stabilization methods was initiated. Stabilization by vegetation was considered impractical because of the harsh climate; cost of country rock and soil coverage was prohibitive ($1113*/acre). Chemical stabilization was selected as the most suitable. A resinous adhesive, a cationic neoprene emulsion, elastomeric polymers, a sulfonated petroleum derivative, a cutback asphalt product, and various calcium, sodium, ammonium, and mixed lignosulfonates were tested for wind and water erosion-resistance. The two preferred chemicals were DCA-70, an elastomeric polymer, and Borlig A, a calcium lignosulfonate. The former was applied to the dike areas and the latter to the beach areas of the tailings ponds. The water soluble chemicals were applied using an automated sprinkling system. Costs were $335/acre to stabilize the entire 34.5 acres of tailings. These chemicals proved ineffective in tests of radon emission retardation. (LKH)

TAILINGS; URANIUM; MILLS; STABILIZATION, PHYSICAL; EROSION; WINDS; WASTES, INDUSTRIAL; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTE MANAGEMENT; COST BENEFIT ANALYSIS; SEAL MATERIALS; EMISSIONS; RADON; PARTICLES, AIRBORNE; FIELD STUDIES

<90>
Hedahl, T.G., and D.H. Janke, EG and G Idaho, Inc., Idaho Falls, ID.

Environmental Surveillance Report for the Idaho National Engineering Laboratory Radioactive Waste Management Complex Annual Report, 1977. (2)

TREE-1251; 42 pp. (1978, April)

This report presents the results of monitoring and surveillance activities conducted at the INEL Radioactive Waste Management Complex (RWMC) during 1977. The surface radiation survey of the Subsurface Disposal Area (SDA) showed that for the most part, gamma levels above 1 mR/hr were restricted to areas around Pit 15 and Trench 50, which are currently in use. Thermoluminescent dosimeter surveys of the RWMC perimeter revealed exposures of 68-1851 mR over the six-month exposure periods; average background exposure was 130 mR/yr. Seventy-five soil samples collected in the RWMC during 1977 contained Cs 137, Co 60, Am 241, Th 228, K 40, and Ra 226, mostly near detection limits; Pu 239 and 240 ranged from less than one d/m/g to 286 d/m/g. Air sampling detected a minor Cs 137 release from Pit 15 disposal operations in May and contamination from a Chinese nuclear test in September; in both cases, concentrations were below Federal standards. Maximum concentrations of radionuclides in water samples from RWMC and the Big Lost River during the year were 2.5 X 10(E-8) uCi/ml Am 241, 1.8 X 10(E-9) uCi/ml Co 60, 1 X 10(E-7) uCi/ml Cs 137, and 4.7 X 10(E-9) Ra 226. Samples from the Snake River Plain aquifer showed detectable H 3 in four wells, verifying the predicted expansion of the plume. Other work discussed includes the subsurface moisture probe, subsurface water sampling, biotic studies, soil moisture and temperature studies, soil moisture exclusion studies, and Transuranic Storage Area monitoring studies. (LKH)

Total Ion Concentration

Cs 137; Co 60; Am 241; Th 228; K 40; Ra 226; Pu 239; Pu 240; H 3

MONITORING; COBALT; CESIUM; TRITIUM; PLUTONIUM; GROUND WATER; RIVERS; SAMPLING; WASTES, RADIOACTIVE; FALLOUT; DISPOSAL SITE; EXPOSURE RATE; FIELD STUDIES

<95>
Holcomb, H.P., Savannah River Laboratory, Aiken, SC.

Radionuclide Content of An Exhumed Canyon Tank and Neighboring Soil. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 10, (pp. 1109-1160), 1218 pp. (CONF-770512). (1979)

To assess the long-term hazard potential associated with the burial of partially decontaminated process equipment, burial emplacements of equipment from an irradiated-fuel separations building (canyon) are being exhumed and examined. One piece of equipment, a Purex feed adjustment tank that was retired in 1957 from service in a hot canyon at the Savannah River Plant, has been exhumed after 18 years of burial. Radionuclide surveys of the tank and core samples of neighboring soil showed that 1 mCi of Cs 137 and 0.8 mCi (7 mg) of Pu 239 remain on the surfaces of the vessel; more than half the Pu was concentrated on the upper surface of the tank. The amount of radionuclides in neighboring soil is substantially less. The tank and neighboring soil contained less than 10 nCi of Pu 239/gm. The feed adjustment tank had been in operation from October, 1975, to March, 1957. Although the tank was decontaminated before burial, records showed a radiation level of 22.5 R/hr at 1 ft distance at the time of burial. After exhumation, beta-gamma measurements made on the tank with a Cutie Pie averaged 3 mrads/hr at 1 ft. When recovered, the tank was found with the agitator opening uncovered and the tank filled with sand and water. The sand contained 175 mCi of Cs 137 (18% of the quantity found on the tank surfaces) and only 5 mCi of Pu 239 (0.08 mg). The 356 gal of water that were removed from the tank contained 0.2 mCi of Cs 137 and less than 0.01 mg of Pu 239. Six 2-in diameter sample coupons were cut from the 3/8-in thick stainless steel tank wall and bottom; these were assayed for alpha and gamma emitters, and are undergoing long-term static leach testing in 2 L samples of groundwater from the burial ground. After 120 days, only 3 of the coupons showed positive leaching results (less than or equal to 0.01 pCi/ml Pu 239). Maximum total quantity leached was 20 pCi, about 1.5% of the initial Pu 239 surface activity. Analyses of Sr 90, Cs 137, and Pu 239 contents of the 3-in thick layer of soil contiguous to the tank, based on averages of 32 soil samples, showed most of the activity in this soil layer came from 2.3 mCi of Sr 90; the layer also contained 380 mCi of Cs 137 and 1 mg of Pu 239. Samples from beneath the tank showed values of 0.20-1.59 pCi/gm Pu 239, 3.76-17.3 pCi/gm Cs 137, and 68-380 pCi/gm Sr 90, with the highest values at the outer radius of the tank, suggesting a

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downward radionuclide migration from the vertical walls of the tank. This is also evidenced by positive values (over 5 fCi of Pu 239/gm, 200-800 fCi of Cs 137/gm) found deeper than 7 ft beneath the tank bottom. Samples to measure horizontal radionuclide migration showed only limited outward migration of Cs 137 and Pu 239; the average Sr 90 activity at a distance of one foot from the tank and 1 to 3 ft below it is 7 times that of the contiguous soil sector. This confirms the more extensive migration of Sr 90, and indicates that most of the leachable Sr 90 has moved away from the tank. Future studies planned include exhumation of other equipment and in situ lysimeter and laboratory-column studies of radionuclide migration in soil. (Auth)(LKH)

Cs 137; Pu 239; Sr 90

EXHUMATION; TANKS; SOILS; CESIUM 137; PLUTONIUM 239; WATER; SAMPLES; LEACHING; STRONTIUM 90; RADIONUCLIDE MIGRATION; SOIL TRANSPORT; DISPOSAL SITE; FIELD STUDIES; LABORATORY STUDIES; RADIOACTIVITY; WASTES, RADIOACTIVE

<96>
Holcomb, W.P.

A Summary of Shallow Land Burial of Radioactive Wastes at Commercial Sites Between 1962 and 1976, with Projections. (T)

Nuclear Safety 19(1):50-59.(1978)

The results of an inventory survey by the U.S. Environmental Protection Agency of six commercial low-level burial sites are presented. The six sites include Maxey Flats, Kentucky; Beatty, Nevada; Barnwell, South Carolina; Sheffield, Illinois; Richland, Washington; and West Valley, New York. The current status of the six buried sites is discussed with respect to both regulatory restrictions and existing capacity. Waste volumes, curies of by-product material, mass of special nuclear materials, and mass of source materials data are presented in tabular form for all six sites. Projections of future waste volumes through the year 2000 are presented. (JC)

Good single source for inventory data on all six commercial sites. (DM/JC)

BURIAL; WASTES, TRANSURANIC; DISPOSAL SITE; TRENCHES; STANDARDS, FEDERAL; STANDARDS, STATE; WASTES, RADIOACTIVE; WASTE VOLUME; PREDICTIONS; SEEPAGE; REVIEWS

<97>
Horton, J.H., U.S. Atomic Energy Commission.

Disposal Practices and Experience at the Savannah River Plant. (T)

Ground Disposal of Radioactive Wastes, H.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959. University of California, Berkeley, CA, (pp. 30-36), 168 pp.(1961, July)

Disposal practices and experience are briefly outlined. The Savannah River Plant is in an area where the soils are generally sands and sandy clays which exhibit low ion exchange capacities. The water table is never more than 100 ft below the surface and is usually 20 to 60 ft below. Rainfall in the area is about 45 inches/year. Due to the poor exchange condition use of open seepage basins has been limited. Low-level, high-volume radwastes have been placed in the seeps. The discharges totalled 3.6 Ci of alpha emitters and 3200 Ci of non-volatile beta emitters. Monitoring results indicate that liquid radwaste disposal must continue to be limited and that Sr is poorly retained. Burial of solid waste, however, has been highly successful. Tritium has been used to trace the path of waste from the seepage basins to a nearby stream. (NDV)

Depth to Water Table; Mean Precipitation

CONTAMINATION; DISPOSAL SITE; GROUND WATER; MONITORING; PIEZOMETRIC SURFACE; SEEPAGE PITS; SITE SURVEILLANCE; WASTE MANAGEMENT; WASTE DISPOSAL; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, SOLID; SEEPAGE; FIELD STUDIES

<98>
Horton, J.H., Savannah River Laboratory, Aiken, SC.

Exhumation of Radioactive Solid Wastes Buried for Fourteen Years. (T)

DP-1456; 11 pp.(1977, March)

Observations during the exhumation of low-level waste buried 14 years ago at the Savannah River Plant are reported. The burial site is located in unconsolidated sands, clayey sands, sandy clays, and clays, which extend to about 1000 ft in depth. Although the average rainfall is about 47 in/yr the average depth to the water table is 45 ft. The vertical percolation rate in the unsaturated zone is about 7 ft/yr. Perched water does occur in the bottom of some of the trenches because the backfill has a higher permeability than the undisturbed soil. Low-level beta-gamma wastes were buried in trenches approximately 20 ft deep and 20 ft wide. The waste was covered with a minimum of 4 ft after burial. Wooden box, lumber, steel bars, steel pipe, steel rods, electrical cords, rope, tarpaulins, polyethylene bags, plastic and cotton-cloth shoe covers, rubber overshoes, rubber gloves, carboard boxes, papers, and steel planchets comprised the waste exhumed. Most of the waste was well preserved. The soil around the waste was dark as if stained by decaying organic material. The decomposition of materials buried in unsaturated soil at SRP is very slow. Complete disintegration of wood, cotton cloth, and paper will take decades. The metals will survive indefinitely, as will plastics if the radiation does not destroy the plastic. The slow decomposition of waste should inhibit the dispersion of the radionuclides. (NDV)

Stratigraphic Unit Thickness; Mean Precipitation; Depth to Water Table; Percolation Rate

BACKFILLING; BURIAL; BOXES; CONTAINMENT; CONTAINER INTEGRITY; DISPOSAL SITE; EXHUMATION; PERCHED WATER; PERCOLATION; PRECIPITATION, METEOROLOGICAL; SOILS; WASTE MANAGEMENT; UNSATURATED ZONE; WASTES, LOW-LEVEL; WASTES, SOLID; WATER TABLE; SANDS; CLAYS; DEGRADATION; FIELD STUDIES

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<99>
Lorton, J.H., Savannah River Laboratory, Aiken, SC.

Exhumation Test with Aged Radioactive Solid Wastes. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 10, (pp. 1139-1148), 1214 pp. (CONF-770512). (1979)

This paper presents observations made during the excavation of low-level beta-gamma waste buried for 14 years (1958-1972) in the humid environment of the Savannah River Plant. The waste was buried in a sandy clay soil trench more than 20 ft above the water table and covered with about 7 ft of overburden. Excavation was performed with a mechanical shovel that removed layers 1-2 in. thick and 5 ft wide and left a smooth surface. When waste was uncovered, the excavation continued with a hydraulic clam shell which removed 6-12 in. of soil per scoop from a 2x8 ft area. With this equipment, an area 10 ft wide (one half the width of the trench) and 25 ft long was excavated to the bottom of the trench (17 ft below the surface). The excavated waste included a wooden box, lumber, steel bars, steel pipe, steel rods, electrical cords, rope, tarpaulins, polyethylene bags, both plastic and cotton cloth shoe covers, rubber overshoes, rubber gloves, cardboard boxes, papers, and steel planchets. Most of the waste was exceptionally well preserved. Unencapsulated cardboard boxes showed the only visible evidence of decay, but were still recognizable. Cardboard and paper protected inside plastic bags was in excellent condition. All of the waste was wet, including that in unsealed plastic bags. The slow decomposition of the waste may be due to oxygen or nitrogen deficiency in the soil. Savannah River Plant soils are naturally deficient in nitrogen. Before the test it was thought that the waste and soil would be fairly well separated because data from drill holes and soil cores collected from trenches before the excavation showed layers of waste and layers of soil. The excavation revealed that these layers are so distorted that clean soil in the waste zone in the trench would be very difficult to separate in the field with mechanical equipment. (Auth) (LKH)

EXHUMATION; WASTES, SOLID; PLASTICS; TRENCHES; DISPOSAL SITE; DEGRADATION; EVALUATION; METHODS; FIELD STUDIES

<100>
Horton, J.H., and L.L. Wilhite, Savannah River Laboratory, Aiken, SC.

Estimated Erosion Rate at the Savannah River Plant (SRP) Burial Ground. (3)

DP-1493; 10 pp. (1978, April)

The rate of soil erosion at the Savannah River Plant has been calculated by means of the universal soil loss equation. Factors in the equation are rainfall, soil erodibility, topographic, cover and management, and supporting practices. The equation was applied to four different vegetation types likely to occur in the area - grass meadow, natural successional oak-hickory woodland, and cultivated farmland (cotton and corn). Predicted erosion rates ranged from 0.0007 cm/yr for stable woodland to 0.38 cm/yr for farmland planted in corn. To expose waste buried four feet deep, these values require erosion duration equivalent to 170,000 and 320 years, respectively, under present conditions. This method is felt to be more suitable for long-term prediction than measured rates. (LKH)

Erosion Rate

EROSION; SOILS; LAND USE; PRECIPITATION, METEOROLOGICAL; RUNOFF; TOPOGRAPHY; BURIAL; PREDICTIONS; EQUATIONS; THEORETICAL STUDIES

<101>
Iranzo, E., and V.E. Hingarro, Nuclear Energy Group, Madrid, Spain.

Disposal of Low- and Intermediate-Level Solid Radioactive Wastes. (3)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 61-78), 666 pp. (STI/PUB/156). (1967, June)

In view of the future importance of radioactive waste disposal and burial in the ground, studies have been undertaken to find suitable sites for this purpose in Spain. The paper describes the geographical, geological, hydrological, petrographical, and seismological considerations which led to the choice of some old mines in the south of Spain as storage sites for low- and intermediate-level solid wastes. The availability of these sites will ensure that enough space is available to meet the requirements of the Spanish nuclear energy program for a very considerable time. (Auth)

WASTE DISPOSAL; GROUND WATER; SEISMOLOGY; SITE SELECTION; GEOLOGY; HYDROLOGY; GEOGRAPHY; STORAGE, GEOLOGIC; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; FIELD STUDIES

<102>
Isaacson, R.E., and D.J. Brown, Rockwell International, Atomics International Division, Richland, WA.

Environmental Assessment Related to Hanford Radioactive Waste Burial. (3)

RHO-SA-36; CONF-780316; Waste Management and Fuel Cycles '78, R.G. Post (Ed.), Proceedings of a Symposium, Tucson, AZ, March 5-8, 1978, (39 pp.) (RHO-SA-36, CONF-780316). (1978, February)

About 190,000 cu m of solid wastes contaminated with two million curies of radioactive fission products and transuranium isotopes have been buried at Hanford since the project started in 1943. Burial practices and site characteristics that are important to isolating radioactive wastes from the biosphere are summarized in this article. Also discussed are ecological aspects and food web relationships at Hanford. The routine monitoring program for detecting migration of radioactive materials at burial grounds is limited to aboveground surveillance. Criteria call for radiation

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Levels to be less than one millirad per hour, and no detectable surface contamination. All burial grounds are surveyed at least semiannually and corrective action is taken when criteria are exceeded. Burial ground problems include: 1) backfill cave-ins due to deterioration of wooden boxes used for defunct industrial equipment; 2) wind erosion and reduction of ground cover; 3) burrowing animals; and 4) deep-rooted plants which bring radioactivity to the surface. Assessments to date indicate that burial practices have effectively prevented environmental contamination, and that the potential dissolution and transport of radionuclides from buried wastes by rainfall or snowmelt at Hanford becomes vanishingly small. (HAF)

Ion Exchange Capacity; Transmissivity; Hydraulic Velocity

BURIAL; WASTES, SOLID; WASTES, TRANSURANIC; PLUTONIUM; URANIUM; THORIUM; FISSION PRODUCTS; SITE SURVEILLANCE; RADIONUCLIDE MIGRATION; PRECIPITATION, METEOROLOGICAL; METEOROLOGY; GEOLOGY; ECOLOGY; FOOD CHAINS; MONITORING; HYDRAULICS; AQUIFERS; FLOODING; EARTHQUAKES; PLANTS; ROOTS; FIRES; WINDS; EROSION; STABILIZATION, VEGETATIVE; STABILIZATION, PHYSICAL; BURROWING ANIMALS; GROUND WATER; SOILS; MOISTURE; GRASSES; STRONTIUM; CESIUM; RUTHENIUM; RARE EARTH COMPOUNDS; SORPTION; DISPOSAL SITE; FIELD STUDIES

<103>
Jacobs, D.G., and W. De Laguna, Oak Ridge National Laboratory, Oak Ridge, TN.

Comments on Waste Disposal to the Earth at the Oak Ridge National Laboratory. (3)

Ground Disposal of Radioactive Wastes, H.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959. University of California, Berkeley, CA, (p. 69), 168 pp. (1961, July)

Disposal of intermediate-level wastes in pits has raised questions as to the desirability of ground disposal and the criteria for waste suitability. Three pits have seeps which contain mostly ruthenium at ORNL. The cesium which comprises 85% of the radwaste, has an affinity for the illite of the Conasauga Shale. However, there is a question as to the effect of the high sodium content in the radwastes on the shear resistance of the clays. The disposal pits are open and some of the radioactivity becomes airborne. In spite of the above defects no unacceptable hazard has been created. For the future exchange-adsorption treatment will continue to be necessary. Treatment of high-level wastes may increase the amount of intermediate-level waste so studies are under way to use low-cost natural exchangers. One suggestion is to use asphalt-lined trenches containing natural local exchanger. The pits will have to be covered to prevent vegetation from growing in them. (NEW)

ADSORPTION; CLAYS; CONTAINMENT; DISPOSAL SITE; IMMOBILIZATION; ION EXCHANGE; RADIONUCLIDE MIGRATION; SHALES; WASTE DISPOSAL; WASTE TREATMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; PITS; CESIUM; ILLITE; SEEPAGE; REVIEWS

<104>
Johnson, L.J., and H.E. Lewis, Los Alamos Scientific Laboratory, Los Alamos, NM.

Nuclear Waste Management Technology Development Program, January-December 1977. (2)

LA-7501-PR; 29 pp. (1978, October)

A preliminary evaluation (CY 1976) of the Area G TRU waste burial site at Los Alamos Scientific Laboratory (LASL) indicated that vegetation uptake was primary contributor to long-term radionuclide release. A computer simulation model, BIOTRAN, used to evaluate that release, was updated and documented in CY 1977. Some field data were collected. An assessment of DOE burial and storage operations at active solid waste disposal sites reflected favorably on LASL programs and indicated the need for extensive monitoring if radionuclide migration is to be quantified. A major geological mapping program was begun for disposal sites at LASL; work was begun to define surface contamination via field surveys with a portable gamma detector, soil and vegetation sampling, analysis for various radionuclides, and geophysical efforts to define pit boundaries. The eastern portion of Area B was found to have widespread surface contamination (the western portion is paved and used for vehicle storage); maximum values in this portion were 6200 pCi/g gross alpha, 560 pCi/g gross beta, 35 pCi/g H 3, and 130 pCi/g Cs 137. Disposal Area C, also with widespread surface contamination, had concentrations of 220-18,000 pCi/g gross alpha, 32-69,000 pCi/g gross beta, and 8-41,000 pCi/g Cs 137. Preliminary results of soil moisture flux studies show that flux below 5 m is about 1 cm/yr. Core sampling beneath Waste Pit 3, Area G demonstrated that there is little or no migration of radionuclides by groundwater movement at LASL. Instrumentation techniques were developed for measurement of low concentrations of various radionuclides in soils and plants. A survey of burial practices reaffirmed the main cause of unsatisfactory containment to be water accumulation in trenches at humid sites. Prototypes of field phoswich detector were developed. A survey of Pu and Am measurement techniques at the pCi/g level showed detector/multichannel analyzer systems to offer the best available detection. (LKW)

Total Ion Concentration

H 3; Cs 137

PLANTS; UPTAKE; RADIONUCLIDE MIGRATION; SURFACE CONTAMINATION; GROUND WATER; MONITORING; BURIAL; GEOLOGY; HYDROLOGY; SAMPLING; CORES; INSTRUMENTS; GEOPHYSICAL SURVEYS; WASTE MANAGEMENT; SOILS; FIELD STUDIES

<105>
Jones, T.L., Rockwell International, Rockwell Hanford Operations, Richland, WA.

Sediment Moisture Relations: Lysimeter Project 1976-1977 Water Year. (2)

RHO-ST-15; 83 pp. (1978, June)

The study's objective was to characterize moisture movement above the water table as

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part of the long-term management of low-level wastes at Hanford. Two large lysimeters were installed in 1977 measuring 3 m in diameter and 17 m deep. Both were equipped with instruments (1.5-inch neutron moisture probes) for evaluating possible vertical movement of sediment moisture. One lysimeter was left open while the other was sealed off at about 17 m depth. During the 1976-1977 water year, the sediment water content was measured 11 times. The moisture content of the upper 12 m of the lysimeters was nonuniform and changed from month to month throughout the year. These changes in moisture content were in response to monthly fluctuations in surface precipitation and solar radiation. Fluctuations of greater than 2 to 3% were recorded in the top 9 to 2 m, while changes on the order of 1% or less were recorded below this depth. The nonuniformity and transitory nature of the moisture distribution above 12 m made quantitative analysis of moisture flux difficult. Small increase in moisture content were also difficult to detect due to precision limitations and spatial resolution of the neutron moisture probe. No significant changes in moisture content were recorded below the 12 m depth throughout the year. The over-all liquid downward moisture flow was estimated to be on the order of millimeters/year. (DAF)

Appendices contain a discussion of moisture flow theory, neutron probe calibration and precision data, the sediment characteristic curve, and sediment moisture data tables.

Moisture Content

SEDIMENTS; MOISTURE; LYSIMETERS; WASTES, LOW-LEVEL; SITE EVALUATION; FIELD STUDIES; PRECIPITATION, METEOROLOGICAL; SEASONS; TEMPERATURE; INSTRUMENTS; HYDRAULICS; EQUATIONS; FIELD STUDIES

<106>
Kaufmann, R.F., G.G. Eadie, and C.R. Russell, U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, NV.

Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico. (3)

Ground Water 14(5):296-308. (1976)

A water quality survey was conducted by the U.S. EPA in 1975 in the Grants Mineral Belt, NM, at the request of the New Mexico Environmental Improvement Agency. Ground water, alluvial and bedrock, is the main source of water in the area. Principal aquifers are the unconsolidated valley fill along the Rio San Jose and Rio Puerco valleys, and the San Andres Limestone and Westwater Canyon Member of the Morrison Formation. Sites investigated were the Bluewater-Milan-Grants area (Anaconda Company mill), the United Nuclear-Homestake Partners mill, Ambrosia Lake (Kerr-McGee mill and United Nuclear tailings pile), Churchrock (United Nuclear and Kerr-McGee mines), and Jackpile-Paguate (Anaconda Company mine). Of 74 ground water samples collected, only one showed a Ra 226 concentration above 5 pCi/l (EPA drinking water standard). This was in an area down-gradient from the Kerr-McGee tailings ponds at Ambrosia Lake. The former U.S. Public Health Service guide of 3 pCi/l was exceeded at 5 other sites. Locations are all monitoring wells in restricted areas or irrigation or stock wells. Radium concentrations in municipal water supplies ranged from 0.12-0.68 pCi/l. For this study gross-alpha determinations did not appear to have any correlation with Ra 226 content. The reason for the observed poor correlation between the sum of isotopic U concentrations and total U is not known. Since U, Th, and Po 210 levels fluctuate around background levels, routine monitoring of potable water supplies might best be restricted to monitoring for Ra 226. Approximately 2000-3000 Ci of radioactivity have been released to the subsurface by waste disposal operations at the Anaconda Company and Kerr-McGee mines, in addition to the much greater activity of the solid fraction although at present this activity is apparently confined to restricted areas, the half-lives of the elements involved (Th 230, Ra 226 and U) and limited geohydrologic knowledge make detailed ground water monitoring data of critical importance. (ERA)

Waste Volume

U; Th 230; Po 210; Ra 226

GROUND WATER; MINING; MINING; MILLING; TAILINGS; ORES; ORE PROCESSING; AQUIFERS; STANDARDS, FEDERAL; RADIUM; WELLS; MONITORING; WASTE DISPOSAL; RADIOACTIVITY; FIELD STUDIES

<107>
Pelleher, R.J., N.Y. York State Department of Environmental Conservation, Albany, NY.

Water Problems at the West Valley Burial Site. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New Yor , NY, Ch. 8, (pp. 843-851), 1214 pp. (CONF-770512). (1979)

When a permit to bury wastes at West Valley, New York was first issued to Nuclear Fuel Services (NFS) in 1963, the problems of ponding of precipitation in trenches and of erosion on the steep slopes to the north and east of the burial ground were recognized. Water rose persistently in 3 completed trenches in the north burial area, so the permit was revised in 1968 to be more explicit on how the trenches should be constructed to minimize the entrance of water into completed trenches. Probably the single most important factor that led to water infiltration and soil settling was the minimum soil cover of 1.2 m required in the original permit. Water has not risen in the 7 trenches in the south burial area, which were completed in accordance with the revised permit. Water continued to rise in the 4 trenches in the north burial area and in early 1975 water from 2 of these trenches began to seep out through the cover. Monitoring of surface streams has indicated no large-scale migration of radioisotopes (mainly H 3) away from the burial site. However, extraneous sources of H 3 made it impossible to detect small amounts of seepage. Soil samples taken in 1973 near the trenches confirmed that there was no large-scale underground migration. The borings did indicate the existence of perched groundwater near the problem trenches in the

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DISPOSAL SITE

<107> CONT.
north burial area that could result in horizontal migration of water in or out of trenches. The USGS is now making a detailed hydrogeological study of the burial area. Approximately 6 X 10(2+6) L of leachate was pumped from 3 of the 4 burial area trenches in 1975-76, treated at the NRTS low-level waste treatment plant, and released to Cattaraugus Creek. The most significant release was 5400 Ci of H 3. The calculated population dose commitment from this release was 8.7 person-rem; maximum individual dose from H 3 was 0.01 mrem assuming a water intake of 2.2 L/day. Doses of these magnitudes could not be considered a health hazard. Nevertheless, the routine pumping of water from completed trenches is not considered to be a satisfactory method for operating a low-level radioactive waste burial site. The experience at the south burial area indicates that it is possible to operate and maintain the site so that there is no significant underground migration, nor any seepage out of the trench caps. However, the cost of perpetual care of the site cannot be ascertained with certainty because it is not known how rapidly trenches in the south area will settle once natural compaction starts to occur. Pre-compaction of wastes and the use of rectangular containers will minimize long-term settlement and reduce the land area used. In the north burial area additional trench cover is needed. There is also a need to reduce erosion on the north slopes. (Auth) (LKH)

H 3

DISPOSAL SITE; BURIAL, SHALLOW; WASTES, SOLID; WASTES, LOW-LEVEL; TRENCHES; PRECIPITATION, METEOROLOGICAL; EROSION; INFILTRATION; CAPPING; MONITORING; RADIONUCLIDE MIGRATION; SOIL TRANSPORT; TRITIUM; PERCHED WATER; LEACHATES; WASTE TREATMENT; DISCHARGE; EFFLUENTS, LIQUID; SURFACE WATERS; STREAMS; CREEKS; DOSE COMMITMENTS; RADIATION DOSE; METHODS; RECOMMENDATIONS; PUMPS; SEEPAGE; FIELD STUDIES

<108>
Keller, B.L., and C.R. Groves, Idaho State University, Pocatello, ID.

Theoretical Problems in Defining Dispersal in Small Mammals Occupying the Subsurface Disposal Area, Idaho National Engineering Laboratory Site (Dispersal and Density of Small Mammals on the Radioactive Waste Management Complex Idaho National Engineering Laboratory Site). (N)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 32-33) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 67-73) 371 pp. (IDO-12087).(1978, December; 1979, April)

Enumeration of dispersal is of importance at the Subsurface Disposal Area (SDA) due to the potential for small mammals to serve as a vector for movement of radioactive materials. Dispersing individuals may leave prime habitat and enter a dispersal sink where short term survival is possible. If the SDA is a dispersal sink, it should be possible to document (1) large spring and fall catches on its perimeter, (2) inward movement during winter, and (3) a massive loss of colonizers during the winter. If the SDA is prime habitat, outward movement to and beyond the perimeter in fall and spring, could be expected. It is postulated that the SDA is a sink due to continual disturbance of the area during radioactive waste interment and the nature of the vegetation (a mosaic of predominantly crested wheat grass, AGROPYRON CRISTATUM, and Russian thistle, SALSOLA KALI, separated by heavily traveled roads). In order to estimate the number of animals which move off of the SDA, a massive marking and trapping effort has been initiated. Ketch-All, Longworth, and pitfall traps are being employed; these systems will be run continuously from fall through spring in areas adjacent to disturbed and undisturbed portions of the SDA. A moisture exclusion project involving distribution of up to 1 m of earth on several areas inside the SDA should allow differentiation between forced and natural dispersal of the most common rodents captured on the SDA. (Auth) (LKH)

MAMMALS; DISPOSAL SITE; RADIONUCLIDE MIGRATION; THEORETICAL STUDIES; FIELD STUDIES; POPULATIONS; PLANTS; GRASSES; BURROWING ANIMALS; ECOLOGY; ECOLOGICAL STUDIES

<109>
Kelly, T.E., U.S. Geological Survey, Albuquerque, NM.

Evaluation of Monitoring of Solid-Waste Burial Sites at Los Alamos, New Mexico. (2)

USGS Open File Report 75-406; 82 pp. (1975, January)

Low-level wastes have been buried at Los Alamos Scientific Laboratory since 1943. There have been 8 major sites, some containing only one specific type of waste. Unfortunately, inadequate records make exact description and contents of some of the pits impossible. In most of the areas, monitoring was not done and should be begun, with test holes, soil and water analysis, as well as a check of the flora and fauna in and around the disposal sites. (JS)

This report describes the burial sites at Los Alamos Scientific Laboratory with respect to location of pits, type of waste, pit design, and monitoring programs, if any. (DR/JS)

Cs 137; Pu 239; Sr 90

ALPHA PARTICLES; AQUIFERS; BURIAL; BOREHOLES; BETA PARTICLES; CONTAINMENT; CONTAMINATION; DISPOSAL SITE; DOSE RATE; DRAINAGE; DRILLING; ENVIRONMENT; EXCAVATION; FIELD STUDIES; FRACTURES; RADIATION, GAMMA; CESIUM; GEOLOGIC DEPOSITS; GEOLOGIC STRATA; GEOLOGY; GROUND WATER; HYDROLOGY; INSPECTION; IRRADIATION; JOINTS; LEAKAGE; MAINTENANCE; MONITORING; RADIATION SOURCES; POLLUTION, WATER; POLLUTION, SOIL; PERCHED WATER; OVERBURDEN; RADIOACTIVE MINERALS; RADIONUCLIDE MIGRATION; SITE SURVEILLANCE; TRENCHES; WELLS; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, NONRADIOACTIVE; WASTES, RADIOACTIVE; WASTES, SOLID; WASTE DISPOSAL

<110>
Kendall, E.W., J.D. McKinney, and G. Wehaems, EG and G Idaho, Inc., Idaho Falls, ID; ERDA-Idaho

DISPOSAL SITE

<110> CONT.
Operations Office, Idaho Falls, ID.

Operational and Engineering Developments in the Management of Low-Level Radioactive Waste at the Idaho National Engineering Laboratory. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 699-716), 1214 pp. (1979)

The Radioactive Waste Management Complex (RWMC) of the Idaho National Engineering Laboratory is a site for shallow land disposal and storage of solid radioactive waste, currently operated for ERDA by EG and G Idaho, Inc. The facility has accepted radioactive wastes since July 1952. Both transuranic and non-transuranic wastes are handled at the complex. This paper describes the operational and engineering developments in waste handling and storage practices that have been developed during the 25 years of waste handling operations. Emphasis is placed on aboveground transuranic waste storage, subsurface transuranic waste retrieval, and beta/gamma compaction disposal. Proposed future programs for the RWMC including a Molten Salt Combustion Facility and Production Scale Retrieval Project are described. (Auth)

BURIAL, SHALLOW; WASTES, SOLID; WASTE DISPOSAL; DISPOSAL SITE; WASTES, RADIOACTIVE; WASTES, TRANSURANIC; STORAGE, ABOVEGROUND; RETRIEVABILITY; WASTE PROCESSING; WASTE TREATMENT; COMPACTION; COMBUSTION; WASTE STORAGE; WASTE MANAGEMENT; REVIEWS

<111>
Keys, W.S., D.E. Eggers, and T.A. Taylor, U.S. Geological Survey, Denver, CO.

Borehole Geophysics as Applied to the Management of Radioactive Waste -- Site Selection and Monitoring. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 9, (pp. 955-992), 1214 pp. (CONF-770512). (1979)

The U.S. Geological Survey is conducting research on borehole geophysics, including the aplication of well logging to the investigation of radioactive waste disposal sites. During the past 18 years, eight such sites have been studied. Geophysical well logging provides in situ measuring techniques which can be used to supplement conventional coring and water sampling techniques in both site-selection studies and in the monitoring of operating disposal sites. Some of the advantages of well logging over conventional techniques include the relatively large volume of rock investigated and the ability to measure temporal changes. Logging also reduces the amount of expensive coring required. Logs provide a continuous record of data that can be correlated from hole to hole. Data from geophysical logs can be interpreted in terms of lithology, elastic moduli, bulk density, porosity, moisture content, water quality, and the location and orientation of fractures. After a site is in use, borehole geophysics provides a means to monitor changes in moisture content, water level, and radionuclide concentration in either cased or open holes. Water samples, usually taken by conventional methods through wells, provide data only on the permeable intervals below the water table. Gamma spectral logging techniques provide data on the vertical and lateral distribution of contaminants. Radionuclides that have migrated have been identified at several sites. Detection limits on the order of 0.2 pCi/gm have been attained for Co 60 and Cs 137. Examples of case studies using borehole geophysics are given, including work at Maxey Flats, KY and Oak Ridge National Laboratory's Burial Ground 5; in the latter example, in-hole gamma spectrometry demonstrated the presence of 180 pCi/gm Cs 137 at unexpected depths below the burial ground (63.4 m). Borehole geophysical evidence indicates the Cs is migrating through a system of fractures and solution openings beneath Burial Ground 5. The paper lists a number of other gamma-emitting radioisotopes that can be identified via in-hole gamma spectrometry. Present and future emphasis of this research will be on improvements in spectral analysis for scintillation detectors, especially the establishment of a data base of characteristic spectra for individual radioisotopes, including the more common fission and activation products, under different hole conditions. (Auth) (LKH)

Co 60; Cs 137

GEOPHYSICAL SURVEYS; EQUIPMENT; INSTRUMENTS; METHODS; DISPOSAL SITE; RADIONUCLIDE MIGRATION; GEOLOGY; HYDROLOGY; BOREHOLES; LOGGING, WELL; SITE SELECTION; MONITORING; SITE SURVEILLANCE; LITHOLOGY; DENSITY; ELASTIC MODULUS; POROSITY; MOISTURE CONTENT; FRACTURES; RADIONUCLIDES; CONCENTRATIONS; WASTES, RADIOACTIVE; COBALT 60; CESIUM 137; LOGGING, GAMMA; BURIAL, SHALLOW; WASTE MANAGEMENT; FIELD STUDIES; REVIEWS

<112>
Kato, G.B., L. Fraley, Jr., and O.D. Markham, Colorado State University, Fort Collins, CO; Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Concentrations of the Transuranic Radionuclides Plutonium 238, Plutonium 239, 240, Americium 241, Curium 242, and Curium 244 in Abiotic and Biotic Components of the Test Reactor Area Radioactive Leaching Ponds (Transuranic Concentrations in Selected Biotic and Abiotic Components of the INEL Test Reactor Area Ponds). (2)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W. J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 66-66) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 15-27) 371 pp. (IDO-12087). (1978, December; 1979, April)

In June 1976, sampling of the radioactive leaching pond and environs at the Test Reactor Area of INEL was initiated to determine the concentration of Pu 238, Pu 239, 240, Am 241, Cm 242, and Cm 244 in selected components of this freshwater ecosystem. Abiotic and biotic components sampled were: filtered water, seston, net plankton, periphyton, sediments, macrophytes, and shoreline vegetation. Also sampled were aquatic and semi-aquatic arthropods and

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DISPOSAL SITE

<112> CONT.
muscle tissue and gastrointestinal tracts from waterfowl maintained on the pond system. Samples were collected June-August 1976 (when transuranic activity was being intermittently released to the pond) and July-August 1977 (when no transuranic activity was in the effluent). Dissolved oxygen, conductivity, and temperature were also measured during these periods. Concentrations of the measured radionuclides in filtered water were in the fCi/ml range and values were similar for both sampling periods; for seston, net plankton, and periphyton, concentrations were in the pCi/g range, representing concentration ratios of 10(E+5)-10(E+6) for both periods. Aquatic and semi-aquatic insects had reduced concentrations (fCi/g-pCi/g) compared to concentrations in the periphyton and sediments; furthermore, concentrations were greatest in those insects collected from areas on or beneath the ERDA pond surface. All macrophyte and shoreline vegetation had concentrations in the fCi/g-pCi/g range, with the submerged portions of macrophytes containing more transuranics than the emergent portions. Muscle tissues of waterfowl and barn swallows inhabiting the pond area had transuranic concentrations at or below detectable limits. GI tracts of waterfowl were the only tissues with consistently detectable radionuclide levels. Greatest concentrations of all nuclides investigated were in sediment, periphyton, and plankton. The data for arthropods and waterfowl suggests an inverse relationship between nuclide concentration and trophic level. Further work is planned. (LKB)

Pu 238; Pu 239; Pu 240; Am 241; Cm 242; Cm 244

PLUTONIUM; AMERICIUM 241; CURIUM; ECOSYSTEMS, AQUATIC; SURFACE WATERS; MICROORGANISMS; SEDIMENTS; PLANTS; PONDS; HOLDING PONDS; INSECTS; INVERTEBRATES; BIRDS; TRANSURANICS; EFFLUENTS, LIQUID; UPTAKE; CONCENTRATIONS; CONCENTRATION FACTORS; ENVIRONMENTAL EXPOSURE PATHWAY; FOOD CHAINS; WASTES, TRANSURANIC; WASTES, LIQUID; FIELD STUDIES; ECOLOGY; WATERFOWL; BIOLOGICAL STUDIES

<113>
Law Engineering Testing Company, Marietta, GA.

Report on Maxey Flats Geohydrologic Investigation. (2)

(1976, March)

This report is a review of documents relating to the geohydrology of the Maxey Flats disposal site and the effectiveness of waste containment at the site. After review of the Kentucky Department of Human Resources' (KDHR) six-month study of radiation concentrations and transport mechanisms at Maxey Flats, it was concluded that small amounts of radioactivity may be migrating off-site; however, this radioactivity is no threat to public health. The study indicates no widespread contamination, since the higher levels measured during the study are within or near the range of normal background activity. Data from the study are insufficient to determine the extent, if any, of Pu migrating off-site and do not support the hypothesis of subsurface migration of Pu. Review of a paper by G. Lewis Meyer of the EPA, interpreting the Pu data collected during the KDHR study, concluded that Meyer's assessment of the capacity of the groundwater system to transport radionuclides was not well-founded. A proposal by the USGS for a five-year hydrologic study at Maxey Flats was favorably reviewed; it was recommended that data obtained during the study be released only after formal review by the USGS, and that a review board composed of USGS, KDHR, and Nuclear Engineering Co. representatives be formed to follow the progress of the study. Based upon the data reviewed for this study, it was concluded that no conditions have ever occurred at the site which were hazardous to public health or the environment, and that the present program of trench cover inspection and water pumping should virtually eliminate transport of contaminants by groundwater. (LKB)

REVIEWS; SITE EVALUATION; RADIONUCLIDE MIGRATION; WASTES, LOW-LEVEL; DISPOSAL SITE; GROUND WATER; HYDROLOGY

<114>
Leggett, R.W., W.D. Cottrell, and R.W. Dickson, Oak Ridge National Laboratory, Health and Safe Research Division, Oak Ridge, TN.

Formerly Utilized MED/AEC Sites Remedial Acti. Program Radiological Survey of the Seaway Industrial Park, Tonawanda, New York, Final Report. (3)

DOE/EV-0005/6; 49 pp. (1978, May)

The report describes the results of a radiological survey of the Seaway Industrial Park, Tonawanda, New York, where 6000 cu yd of uranium processing residues from the adjacent Haist property were dumped in 1974 as landfill. The survey was undertaken to determine whether the present radiological status of the site is consistent with current radiation protection guidelines and to determine the extent of movement of radioactive residues from the property by natural means such as surface runoff. Most of the radioactivity detected at Seaway was in three areas. Area A (10 acres) had an average Ra concentration of 10 pCi/g, with radioactivity extending to a depth of two feet. Ra in areas B and C (2 acres total) averaged 18 pCi/g. Mud samples from drainage paths to the Niagara River had Ra concentrations up to 26.6 pCi/g; one sample from about 100 ft north of area A had 80 pCi/g. Water samples from on-site and from the drainage system contained only small amounts of U, Th, and Ra. External gamma radiation at one meter above the surface ranged from 8-80 uR/hr (36 uR/hr average); except for two small areas, external gamma was in the 8-16 uR/hr range, which is near background. The survey indicates no immediate health hazards on the site. Potential hazards could result from continuous exposure to the highest external gamma levels measured (equivalent to 670 mrem/hr); in certain areas of the site, construction of buildings could result in Rn-daughter concentrations greater than 0.15 WL. (LKB)

Total Ion Concentration; Emanation Rate

Ra 226; U 234; U 235; U 238; Th 228; Th 230; Th 232

TAILINGS; RADIATION HAZARDS; SURFACE CONTAMINATION; EMANATION; GASES; RADON; INSPECTION; URANIUM; RADIUM; SITE SURVEILLANCE;

DISPOSAL SITE

<114> CONT.
WASTES, INDUSTRIAL; WASTES, RADIOACTIVE; POLLUTION, SOIL; POLLUTION, WATER; SITE EVALUATION; RADIATION DETECTORS; MEASUREMENTS; CONCENTRATIONS; FIELD STUDIES

<115>
Leggett, R.W., F.F. Haywood, H.W. Dickson, D.L. Anderson, C.A. Golden, W.D. Cottrell, and W.P. Fox, Oak Ridge National Laboratory, Oak Ridge, TN.

Formerly Utilized MED/AEC Sites Remedial Action Program, Radiological Survey of the Ashland Oil Company (Former Maist Property), Tonawanda, New York, Final Report. (2)

DOE/EV-0005/6; 63 pp.(1978, May)

This report describes the results of a radiological survey of the former Maist property, Tonawanda, New York, which was a uranium ore tailings dump from 1944-46 and is currently used by Ashland Oil, Inc. for oil refining operations. The survey was undertaken to determine whether the present radiological status of the property is consistent with current radiation protection guidelines and to determine the extent of movement of radioactive residues from the property via natural means such as surface run-off. Soil sample analyses indicate that the highest concentrations of radium in the soil occur in the southeastern part of the site. Samples from that area at 2-6 foot depths contained as much as 200-500 pCi/g of Ra. Average Ra concentration for the southeastern third of the site was 35 pCi/g; the northwestern third averages 13 pCi/g Ra, but contamination is nearer the surface, and external gamma radiation and radon emanation appear to be higher than elsewhere on-site (up to 190 uR/hr.). Uranium concentrations ranged from near background to as much as 1.2 wt%; concentrations exceeded source material level (0.05 wt%) in 18 of 66 core holes. Water samples showed levels well below their CGn's for all radioisotopes measured. Mud samples from drainage paths between the site and the Niagara River contained 1.2-8.3 pCi/g Ra. Highest concentration of U in mud samples was 32.5 pCi/g, near a residue dump on Seaway. Residues on the site appear to pose no health hazard, as buy or land use continues in the present manner. Construction of buildings on the site could result in Rn concentrations of 0.15 WL or more inside, and gamma radiation exposure as much as 4 times the U.S. average dose equivalent from background. (LKE)

Ra 226; Rn; U 238; Th 232; Ac 227; K 40

URANIUM; RADIUM; RADON; TAILINGS; RADIATION HAZARDS; EXPOSURE, EXTERNAL; POLLUTION, SOIL; POLLUTION, WATER; POLLUTION, AIR; CORES; SURFACE CONTAMINATION; EMANATION; GASES; RADIATION, GAMMA; INSPECTION; SITE SURVEILLANCE; WASTES, INDUSTRIAL; WASTES, RADIOACTIVE; FIELD STUDIES

<116>
Lomenick, T.F., Oak Ridge National Laboratory, Oak Ridge, TN.

Burial Ground Technology. (7)

ORNL-5508; Environmental Sciences Division

Annual Progress Report for Period Ending September 30,1978, (pp. 65-78), 197 pp.(1979, April)

As part of the Burial Ground Technology effort, field studies conducted in FY 1978 include: identification of Sr 90 inputs to White Oak Creek, evaluation of the status of intermediate-level waste in disposal areas as regards the watershed, evaluation of preventive and corrective measures taken in ORNL Solid Waste Disposal Areas (SWDAs), and investigation of the mechanisms of radionuclide-sediment association. A comprehensive sampling program designed to identify and evaluate all Sr 90 sources that make significant contributions to White Oak Creek in its reach between monitoring stations 2 and 3 was carried out in December 1977. On the basis of longitudinal profiles of Sr 90 in the creek, four major sources of Sr 90 discharge have been identified: Waste Ponds 3539 and 3540, the Sewage Treatment Plant, the Northwest Tributary, and SWDA 6. Relative contributions from these sources, based on December 1977 data, were 28.1%, 38.0%, 7.5%, and 34.0%, respectively. Sr 90 discharges for December were 0.051 Ci from Waste Ponds 3539 and 3540, 0.072 Ci from the Sewage Treatment Plant, 0.016 Ci from the Northwest Tributary, and 0.072 Ci from SWDA 6. In the intermediate-level waste disposal areas an effort has been made to upgrade existing monitoring wells and access roads. Over 90 well water samples were collected, revealing average Co 60 concentrations of 87.5-0.09 pCi/ml; Sr 90, Cs 137, and H 3 do not appear to be present in significant concentrations in the peripheral groundwaters. Twenty-one additional monitoring wells have been installed, and investigation of Co 60 migration in the unsaturated zone has been initiated. Evaluation of the SWDAs showed that 49 solid waste trenches in bentonite seal area III (SWDA 6) contained free water. Water samples from 20 trenches and 2 monitoring wells in the area indicate that the levels of Co 60 Cs 137, and gross alpha are relatively low. Concentration of Sr 90 exhibits significant variations; measurements in 1978 are generally higher than those in 1976. Bentonite seals were installed in area I of SWDA 5 and areas II, III, and IV of SWDA 6 to reduce rainwater infiltration. Sealing of area III appears to be ineffective, possibly due to a rise in the water table. A literature survey and laboratory studies have been conducted to evaluate various grouting techniques for trench sealing. Based on the literature survey, sodium silicate, cement, and clay grout materials have been selected for further study. Distribution of Sr 90, Cs 137, and Co 60 in stream sediments was examined to determine the usefulness of these sediments for locating and monitoring radionuclide contamination in White Oak Creek. Grain size distribution of Sr 90 and Cs 137 showed minima in the fine sand-coarse silt fractions (where relatively inert quartz dominates the sediment mineralogy). Modelling activities during the year included computer analysis of the hydrologic behavior of the White Oak Creek watershed, development of surface water models, and simulations of subsurface hydrology. Significant progress was made in investigations of the use of halocarbons as groundwater tracers. A new aspect of this work is the use of a homologous series of compounds to determine the porosity of geologic media. (LKE)

Grain Size Distribution; Total Ion Concentration

Sr 90; Co 60; Cs 137; H 3

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DISPOSAL SITE

<116> CONT.
DISPOSAL SITE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; TRENCHES; LEAKAGE; WATER TABLE; SEAL MATERIALS; GROUND WATER; STREAMS; RADIONUCLIDE MIGRATION; CREEKS; GROUTING; BENTONITE; SITE SURVEILLANCE; MONITORING; WELLS; SEDIMENTS; MODELS; MODELS, MATHEMATICAL; COMPUTER PROGRAMS; HYDROLOGY; SURFACE WATERS; FIELD STUDIES; THEORETICAL STUDIES; LABORATORY STUDIES; WASTE MANAGEMENT; WASTES, SOLID; UNSATURATED ZONE; TRACERS; HALOCARBONS

<117>
Lomenick, T.F., and K.E. Cowser, Oak Ridge National Laboratory, Oak Ridge, TN.

Land Burial of Solid Waste at Oak Ridge National Laboratory. (1)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, 635 pp. (TID-7628). (1962, March)

Burial Ground No. 4 at Oak Ridge National Laboratory is located in the Conasauga Shale which underlies Melton Valley. Water level measurements taken in auger holes showed that the water table ranges from 2 to 15 feet below ground surface at various places around the burial ground and that radioactive wastes are in contact with ground water much of the time. Water samples taken from nearby wells, springs, intermittent streams, and seeps were found to contain radionuclide contaminants and relatively high concentrations of chemical ions such as Na^+, Cl^-, NO_3^-, SO_4^{--}. Seeps appear to form at the downslope end of burial trenches when water enters through more permeable backfill and fails to drain through the less permeable trench bottoms and walls. Monitoring stations were installed on White Oak Creek above and below Burial Ground No. 4. Sampling at these stations showed that Burial Ground No. 4 contributed radiocontaminants in quantities so small as to be undetectable. Criteria for selection and testing done for a new burial ground are discussed. Requirements included location in the Conasauga Shale, relatively flat topography, proximity to laboratories, access on private roads, adequate depth to ground water, mapping of ground water table, monitoring changes in ground water table and hydraulic conductivity of the Conasauga Shale. New trench design was introduced utilizing a sloped bottom 6" gravel layer and sump with tamped shale and asphalt caps. (CAB)

Good discussion of site selection procedures and trench design. (DH/CAB)

Ru 106; Co 60; Pu 239; Pu 240; Cs 137; Sr 90; Po 210; Zr 95

CONTAMINATION; RADIONUCLIDE MIGRATION; MONITORING; SURFACE WATERS; TRENCHES; SITE SELECTION; IONS; SHALES; GEOLOGY; HYDROLOGY; TOPOGRAPHY; DESIGN; DISPOSAL SITE; SEEPAGE; FIELD STUDIES

<118>
Los Alamos Scientific Laboratory, Environmental Studies Group, Los Alamos, NM.

Environmental Surveillance at Los Alamos During 1976. (3)

LA-6801-MS; 60 pp. (1977, April)

This report describes the result of environmental monitoring at LASL during 1976. Measurements of external penetrating radiation averaged 118 mrem/yr off-site and reached a maximum of 800 mrem/yr on site. Annual mean atmospheric tritium oxide concentration was 15 X 10(E-12) uCi/ml regionally, 23 X 10(E-12) uCi/ml at perimeter, and 60 X 10(E-12) uCi/ml on-site. Other measurements from LASL environs: atmospheric long-lived gross-alpha concentration 1.3 X 10(E-15) uCi/ml, gross-beta 69 X 10(E-15) uCi/ml; atmospheric Pu 238 concentration 0.5 X 10(E-18) uCi/ml, Pu 239 11.9 X 10(E-18) uCi/ml; annual mean atmospheric U concentration 59 pg/m(E+3). Activity in surface and groundwater samples was below applicable ERDA Concentration Guides. Samples from potable water wells met all standards, except for one well which was contaminated by natural arsenic. Calculated maximum individual whole-body dose from tritium water vapor was 0.76 mrem/yr, contributing 0.25 man-rem to Los Alamos County. Argon 41 values were 3.1 mrem/yr or 1.8 man-rem, while C 11, N 13, and O 15 together contributed 22 mrem/yr or 1.9 man-rem. Los Alamos County receives approximately 2750 man-rem from natural sources. Ecological studies of rodents living near a Cs 137-contaminated effluent stream channel showed that exposures to harvest mice were as much as 50 times background, with an average dose of 26 mrad/d. Other species received 3-18 times less exposure. Other studies included erosion rate and soil Cs 137 distribution studies in Mortandad Canyon, and a study of U in soil, plants, and animals near Dynamic Test Site E-F. In July there was an accidental release of tritium gas equivalent to 22,000 Ci. The gas dispersed without detectable effects on personnel, plants, or air in the vicinity. (LKH)

Total Ion Concentration

H 3; Sr 90; Cs 137; Pu 238; Pu 239; Am 241; Ar 41; C 11; N 13; O 15; U 235; U 238

WASTES, RADIOACTIVE; POLLUTION, WATER; MEASUREMENTS; POLLUTION, AIR; MONITORING; GROUND WATER; RADIOACTIVITY; DISPOSAL SITE; DOSE RATE; EFFLUENTS, CHEMICAL; EFFLUENTS, AIRBORNE; NUCLEAR FACILITIES; TRITIUM; PLUTONIUM; SURFACE WATERS; BIOTA; FIELD STUDIES

<119>
Los Alamos Scientific Laboratory, Los Alamos, NM.

The Los Alamos National Environmental Research Park. (3)

Report, 37 pp. (1978)

An overall description of the Los Alamos National Environmental Research Park is given. The Laboratory and Park site occupies 111 sq km on the Pajarito Plateau, which is between the Jemez Mountains to the west and the Rio Grande Valley to the east. A series of relatively narrow mesas separated by deep, steep-sided canyons trending east-southeast from the Jemez Mountains characterized the Pajarito Plateau. The geology of the area consists of siltstones and sandstones

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overlain by a variety of volcanic rocks, ranging from tuffs to basalts. Various formations range from 250 to over 1000 m in thickness. The surface of the Plateau is dissected by ephemeral streams flowing down the canyons. Stream flow ranges from 10 to 500 liters/s depending on the season. The master stream, Rio Grande, has a discharge ranging from 1.7 cu m/s to 691 cu m/s. Ground water in the Park occurs in three modes: water is alluvium in the canyons; perched water is basalt; and the main aquifer is conglomerates. The soils in the area fall into one of three types: Aridisols, Alfisols and Entisols. Los Alamos climate is semiarid, continental mountain with an annual average precipitation of 45 cm. The temperatures range from -2.8 to 19.9 degree C for the year. Diverse ecosystems exist in the area as a result of the elevation gradient of 1500 m. Six major vegetative complexes in the area are: subalpine grassland, spruce-fir, mixed conifer, ponderosa pine pinon-juniper, and juniper-grassland. About 350 plant species have been identified, 17 species of small mammals, and 187 species of birds have been identified in the area. A number of important archeological sites are also in the area. Environmental research at the Park aims at determining distribution and transport processes in natural systems receiving material from solid wastes, and liquid and gaseous effluents. To that end, radiation ecology studies are being performed in three of the canyons and determinations of low levels of radioactive materials and trace quantities of stable elements are done. (HDV)

Stratigraphic Unit Thickness; River Flow Rate; Mean Precipitation

ALLUVIUM; AQUIFERS, CONFINED; ASHFLOWS; BASALTS; BIOSPHERE; BIRDS; DISPOSAL SITE; DRAINAGE BASINS; ENVIRONMENT; GEOLOGY; GROUND WATER; HYDROLOGY; METEOROLOGY; PERCHED WATER; RADIONUCLIDE MIGRATION; SEDIMENTS; SOILS; PLANTS; WASTE MANAGEMENT; WASTES, RADIOACTIVE; REVIEWS

<120>
Los Alamos Scientific Laboratory, Los Alamos, NM.

Development Activities on Shallow Land Disposal of Solid Radioactive Waste, January-December 1976. (2)

LA-6856-PR; 8 pp. (1977, June)

This report summarizes shallow land burial activities at LASL during 1976. A brief listing of publications and presentations for the year is included. A program was initiated to develop a technique for evaluating the long-term adequacy of existing TRU waste burial grounds. Radionuclide release and transport mechanisms specific to the burial ground at Area G, TA-54, were identified; review of potential natural release processes indicates the likelihood of probabilistic events [10(E-6)-10(E-7)] are low enough to be discounted. Movement by soil moisture would involve transport times greater than the half-life of Pu 239; release by soil erosion to the depth of buried wastes would require 50,000-150,000 years under present conditions. Modeling of plant uptake by the currently natural species shows it would require 5000 years to raise surface Pu levels to about that of present fallout. An evalution of site monitoring practices has been in progress since 1973 in disposal areas A, B, C, D, E, F, G, and T; a soil moisture monitoring program at Area G, TA-54 is collecting data on changes in water content with depth and time in fill overlying waste and in tuff surrounding disposal shafts. A second program, for collection of meteorological data, is in the construction phase. Methods are being identified for the measurement of very small quantities of radionuclides in site and in vitro. Core drilling of burial sites for geologic data and geophysical surveys of the local structure and stratigraphy have been carried out. Geologic mapping of new burial pits is being conducted. The Radioactive Waste Burial Technology Program, initiated for FY 1977, will focus on identifying mobilization/migration processes specific to acid environments, and on engineering methods for preventing migration. A literature search on non-radioactive hazardous waste disposal is planned; criteria will be developed for selecting burial site locations based on potential radionuclide migration pathways. (Auth) (LKH)

WASTES, TRANSURANIC; WASTES, LOW-LEVEL; BURIAL; RADIONUCLIDE MIGRATION; PLUTONIUM; PLANTS; UPTAKE; MONITORING; TUFFS; METEOROLOGY; PREDICTIONS; MODELS; MEASUREMENTS; METHODS; INSTRUMENTS; CORES; DRILLING; GEOLOGY; GEOPHYSICAL SURVEYS; REVIEWS; ECOLOGICAL STUDIES; FIELD STUDIES

<121>
Nancy, C.W., Rockwell International, Rockwell Hanford Operations, Richland, WA.

Long-Term Low-Level Waste Management: An Integrated Environmental Program. (2)

Waste Management and Fuel Cycles '78, R.G. Post (Ed.), Proceedings of a Symposium, Tucson, AZ, March 6-8, 1978, (pp. 427-436), 661 pp. (1978, March)

Presented is the long-term low-level waste program at Hanford. The program is divided into two phases; technology-development and operational. Phase 1 will evaluate and expand the existing knowledge of low-level waste-storage/disposal sites so as to provide data for models for predicting changes at the sites; will identify and evaluate alternative waste management methods; and will develop and demonstrate technology for long-term management that is safe, cost effective, and environmentally sound. An environmental impact statement will result from this phase. The operational phase will be the design, construction, and operation of the appropriate facilities. Already in the storage/disposal sites are 900 kilocuries of mixed fission products and 600 kg Pu, which is surrounded by 10 million cu yd of contaminated soils and sediments in the area. Future operations are expected to add only a small amount to the inventory. The tasks under the first phase are: program management, data base system, site characterization of area to determine the location and concentration of radionuclides in the ground, field instrument development, risk assessment, support studies and assessments, and technology development and demonstration. This program will be integrated with the Hanford defense high-level waste program, engineered

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<121> CONT.
facilities decontamination and decommissioning program, and current(interim) low-level waste management programs. (NDV)

Waste Volume

COMPUTERS; CONTAMINATION; DISPOSAL SITE; ENVIRONMENTAL IMPACT STATEMENTS; GEOLOGY; HAZARD ANALYSIS; HYDROLOGY; FISSION PRODUCTS; MONITORING; RADIONUCLIDE MIGRATION; SOILS; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; REVIEWS

<122>
Marine, I.W., and C.B. Krapp, Savannah River Laboratory, Aiken, SC.

Simulated Seepage Basin Flow Studies with Soil-Filled Columns. (T)

DP-1412; Savannah River Laboratory Environmental Transport and Effects Research, Annual Report, FY-1975, (pp. 22-1 - 22-8) (DP-1412). (1975)

During 1970, the fluid level in one of seepage basins at Savannah River Plant began to rise indicating the soil column around the basin had become plugged. A series of soil column experiments were run to determine the cause and to attempt to find an answer. Six columns with basin spoil pile soil were set and conditioned with calcium sulfate solution. Then, the following solutions were fed through one column each: Calcium sulfate (pH 6.3); nitric acid (pH 2); sodium hydroxide in two columns (pH 10.7); basin water (pH 10.7); and calcium hydroxide (pH 10.8). After 18 runs, those columns having the sodium ion fed through had hydraulic conductivities 20 to 50 times lower than the calcium sulfate control column. The hydraulic conductivities of the nitric acid and calcium hydroxide columns were only about 2 times less than the control column. While columns with solutions of pH 10.7 plugged, pH alone was not a sufficient cause to bring about plugging. In an attempt to repair the plugging in the sodium hydroxide column, nitric acid and calcium hydroxide were tried. Calcium hydroxide had no effect while nitric acid did increase the permeability. Conclusions from the laboratory studies are: sodium ion is the most important contributor to plugging; when the pH is about 11, sodium ion enhances plugging; and nitric acid or acidified basin water returns soil plugged with sodium ions to its unplugged rate. Basin water with a pH of 6 has no apparent effect on unplugging soil. Hence, only massive acidification programs will repair plugged seepage basins. (NDV)

pH; Hydraulic Conductivity

ACIDS; CHEMICAL PROPERTIES; DISPOSAL SITE; GEOCHEMISTRY; HYDRAULICS; LABORATORY STUDIES; RETENTION PONDS; SEEPAGE PITS; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, LIQUID

<123>
Marine, I.W., and R.K. Hoot, Jr., Savannah River Laboratory, Aiken, SC.

Summary of Hydraulic Conductivity Tests in the SRP Separations Areas. (T)

DP-1412; Savannah River Laboratory Environmental Transport and Effects Research, Annual Report, FY-1975, (pp. 21-1 - 21-8) (DP-1412). (1975)

Laboratory and field studies were conducted to determine the hydraulic conductivity of the Barnwell and McBean Formations at the Savannah River Plant Separations Areas. Five hydrologic units are of importance in the ground water model and they are: 1) the Barnwell Formation which usually contains the water table and consists of reddish-brown sands, clayey sands, and sandy clay; 2) the tan clay, which forms a leaky confining bed at the base of the Barnwell; 3) the McBean Formation which receives the water through the tan clay and consists of an upper yellow clayey sand and a lower calcareous clayey sand with occasional dissolution cavities; 4) the Green Clay which is a low permeability confining bed; and 5) the Congaree Formation which consists in the upper zone of a fine sand layers interbedded with clay layers. Pumping tests in the McBean Formation indicated that vertical leakage of water was an important factor in supplying water to the drawdown cone and so only methods considering leakage were used. The median values for hydraulic conductivity in the Barnwell Formation by all methods (laboratory and field tests) were about 0.5 m/day (1.8 ft/day). The laboratory tests for the McBean indicated a conductivity of 0.5 m/day while the field test showed a median value of 0.18 m/day (0.6 ft/day) or about 1/3 lower than laboratory tests. (NDV)

Hydraulic Conductivity

AQUIFERS, CONFINED; AQUIFERS, UNCONFINED; DRAWDOWN; FIELD STUDIES; GEOLOGY; GROUND WATER; HYDRODYNAMICS; HYDROLOGY; LEAKAGE; LABORATORY STUDIES; WASTE MANAGEMENT; WATER TABLE; WELLS

<124>
Markham, O.D., U.S. Energy Research and Development Administration, Environmental Sciences Branch, Idaho Falls, ID.

Radioactive Contamination near the Radioactive Waste Management Complex, Idaho National Engineering Laboratory Site. (T)

IDO-12079; Summaries of the Idaho National Engineering Laboratory Site Ecological Information Meeting, O.D. Markham (Ed.), (pp. 20-25), 68 pp., (IDO-12079). (1975, July 10)

Since 1952, solid radioactive waste has been stored beneath the soil surface in the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex. These wastes have consisted of fission and activation-contaminated waste from Idaho National Engineering Laboratory (INEL) Site operations and transuranic contamination waste from the Rocky Flats facility near Golden, Colorado. As of late 1972, transuranic waste is no longer interred beneath the soil surface but is placed in retrievable storage in an above-ground facility, the Transuranic Storage Area (TSA). An initial survey of the environment near the SDA began in late 1972. Soil samples were taken from two depths (0-8 and 8-8 cm) and up to 11 deer mice (PEROMYSCUS MANICULATUS) were collected from each of 34 sampling locations near the perimeter of the SDA. Lower concentrations of transuranics were encountered downwind of the SDA and resulted from wind transport of contaminated

<124> CONT.
dust particles. The maximum soil concentration northeast of the SDA were 1.59 dpm Am 241/g, 0.46 dpm Pu 239/g, and 0.05 dpm Pu 238/g. The minimum concentrations in this area were 0.05 dpm Am 241/g, 0.08 dpm Pu 239/g, and 0.01 dpm Pu 238/g. Background soil levels in the INEL site vicinity average <0.01 dpm Am 241/g, 0.005 dpm Pu 239/g and 0.007 dpm Pu 238/g. The higher concentrations of transuranic isotopes in the soil occurred in the drainage channel surrounding the SDA. The maximum concentrations on the perimeter were 113 dpm Am 241/g, 81 dpm Pu 239/g, and 1.9 dpm Pu 238/g. The minimum concentrations on the perimeter were 0.13 dpm Am 241/g, 0.06 dpm Pu 239/g, and 0.006 dpm Pu 238/g. It was concluded that Pu and Am on the perimeter were deposited either when water from melting snow flooded the SDA in 1962 and 1969 or from annual localized SDA runoff from rain and melting snow. The maximum activation and fission isotope concentrations in soil samples also occurred on the perimeter of the SDA in a drainage channel. In general, the deer mice tissues had low concentrations of isotopes in most of the samples at or near the minimum detection limits. Most of the activity was associated with the hide and GI tracts. However, a few tissue samples on the perimeter of the SDA did have much higher concentrations than were present in samples from other locations and in the soil where the animals were collected. These animals apparently had access to higher concentrations of isotopes inside the SDA. (BAF)

WASTES, SOLID; WASTE STORAGE; SITE SURVEILLANCE; WASTES, TRANSURANIC; BURIAL; FISSION PRODUCTS; ACTIVATION PRODUCTS; SOILS; SAMPLES; ANIMALS; RODENTS; MICE; RADIONUCLIDE MIGRATION; AMERICIUM 241; PLUTONIUM 239; PLUTONIUM 238; BACKGROUND RADIATION; DRAINAGE; FLOODING; PRECIPITATION, METEOROLOGICAL; CESIUM 137; COBALT 60; CERIUM 144; ANTIMONY 125; RUTHENIUM 106; STRONTIUM 90; TISSUES; GASTROINTESTINAL TRACT; SKIN; BIOLOGICAL STUDIES; FIELD STUDIES

<125>
Markham, O.D., Radiological and Environmental Sciences Laboratory, Environmental Sciences Branch, Idaho Falls, ID.

Activation and Fission Products in the Environment Near the Idaho National Engineering Laboratory Radioactive Waste Management Complex. (3)

IDO-12085; 19 pp.(1978, April)

In order to assess the environmental impact of the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex, small mammals and soil samples were collected near the SDA in 1972-73 and analyzed for activation and fission nuclides. Levels of radioactivity in deer mice (PEROMYSCUS MANICULATES) were generally below detectable limits except in samples collected on the perimeter of the area, where total radioisotope concentrations of 2026 and 415 pCi/g were obtained from hides and GI tracts, respectively. Detectable radionuclides in the soil were primarily Cs 137, Co 60, Ce 144, Sb 125, Ru 106, and Sr 90. Soil concentrations of these nuclides at the perimeter were as follows: Cs 137 average 7.8 pCi/g, maximum 16.1 pCi/g (12 times background); Co 60 average 6.7 pCi/g, maximum 11.3 pCi/g; Ce 144 average 1.2 pCi/g, maximum 1.9 pCi/g; Sb 125 average 0.1 pCi/g, maximum 0.3 pCi/g; Ru 106 average 0.3 pCi/g, maximum 0.7 pCi/g; Sr 90 average 6.8 pCi/g, maximum 26.4 pCi/g. At 350 m from SDA, average Co 60 concentration was 0.8 pCi/g; Cs 137 (2.3 pCi/g) and Sr 90 (1.6 pCi/g) were 2-3 times the background. It was concluded that the storage of radioactive waste at the INEL Radioactive Waste Management Complex has had little effect on the concentrations of activation and fission products in the environment near the SDA. (Auth) (LKH)

Cs 137; Co 60; Ce 144; Sb 125; Ru 106; Sr 90; Cs 138; Ce 141; Zr 95; Nb 95; Mn 54; Co 57; Ru 103

BIOTA; SOILS; WASTE STORAGE; ENVIRONMENT; FISSION PRODUCTS; ACTIVATION PRODUCTS; RADIONUCLIDES; CONCENTRATIONS; CESIUM; COBALT; RUTHENIUM; STRONTIUM; FIELD STUDIES; BIOLOGICAL STUDIES; ECOLOGICAL STUDIES

<126>
Markham, O.D. (Ed.), Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Ecological Studies on the Idaho National Engineering Laboratory Site. 1978 Progress Report. (3)

IDO-12087; 371 pp.(1978, December)

The report describes ecological research conducted at Idaho National Engineering Laboratory during 1978. Studies which relate to radioactive waste management aspects have been abstracted separately. The studies include both the animals and vegetation on site. Most of these have been combined with the same studies presented in IDO-12086, PROCEEDINGS OF THE SYMPOSIUM ON THE IDAHO NATIONAL ENGINEERING LABORATORY ECOLOGY PROGRAMS, held at Jackson Lake Lodge, Grand Teton National Park, September 10-12, 1978, and may be accessed under that report number. (LKH)

See also IDO-12086.

ECOLOGY; LABORATORY STUDIES; FIELD STUDIES; THEORETICAL STUDIES; MODELS; MAMMALS; WATERFOWL; INVERTEBRATES; PLANTS; EFFLUENTS, AIRBORNE; EFFLUENTS, LIQUID; WASTES, RADIOACTIVE; UPTAKE; CONCENTRATIONS; DISPERSION; BIOSPHERE; BIOTA; BIRDS; RADIATION EFFECTS; ENVIRONMENTAL EXPOSURE PATHWAY; FOOD CHAINS; REVIEWS; ECOLOGICAL STUDIES

<127>
Harter, W.L., E.I. duPont de Nemours and Company, Aiken, SC.

Ground Disposal Practices at the Savannah River Plant. (2)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967, (pp. 95-105), 666 pp. (STI/PUB/156).(1967)

A description of the general ground waste disposal practices at SRP are detailed in this report. The discussion is based on experience in solid waste land burial since 1953. The contaminated waste buried at the time of this report contained approximately

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<127> CONT.
1.5 million curies of activation and fission product radionuclides along with 9,000 curies of transuranic elements. Low-level wastes which do not include transuranic activity exceeding 100 millicuries per waste container is buried in 6 meter deep trenches located 4 to 12 meters above the water table. Transuranic wastes are placed in concrete containers and then buried. Alpha waste is segregated from beta and gamma waste and the beta and gamma waste is further segregated into high and low level categories. The average cost for land burial was estimated to be 35 dollars per cu m. At the time this report was written, significant levels of activity resulting from migration had not been observed along the flood plains of the adjacent tributaries. The report also contains a discussion of the success of the seepage pit program at SRP including cost estimates, the observance of tritium breakthrough at the pits closest to the tributary, and the operational procedures adopted. (Auth) (JC)

This report is chiefly a general summary without a great amount of hard data. (DB/JC)

Ion Exchange Capacity; Depth to Water Table

Sr 90; Cs 137; H 3

ADSORPTION; CLAYS; FISSION PRODUCTS; GEOLOGY; GROUND WATER; OUTCROPS; WASTES, RADIOACTIVE; WASTE DISPOSAL; WASTES, TRANSURANIC; SEEPAGE PITS; TRENCHES; WASTES, LOW-LEVEL; ECONOMICS; BURIAL; COSTS; REVIEWS

<128>
Matuszek, J.M., P.V. Straisa, and C.F. Baxter, New York State Department of Health, Radiological Sciences Laboratory, Division of Laboratories and Research, Albany, NY; New York State Department of Commerce, Division of Industrial Sciences and Technologies, Albany, NY; New York State Energy Research and Development Authority, New York, NY.

Radionuclide Dynamics and Health Implications for the New York Nuclear Service Center's Radioactive Waste Burial Site. (3)

CONF-760310; STI/PUB/433; IAEA-SM-207/59; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (pp. 359-372), 826 pp. (IAEA-SM-207/59, CONF-760310, STI/PUB/433). (1976)

The waste burial site at the Western New York Nuclear Service Center has been in operation since 1963, storing solid low-level wastes in trenches cut into fine-grained silt and clay soil (silty till). In spite of preventative measures, by late 1973 water levels in 3 trenches had risen to within a few cm of the covering material. In 1973-74 a study of the problem was conducted by NYSERDA and the EPA. Activities of HTO, Sr 90, and Cs 137 were measured in trench water and core samples using a large-volume Ge(Li) crystal for gamma-spectrometry and chemical analysis for alpha- and beta-emitters. Tritium concentration from pore water peaked in the cover-soil 1.5-2 m below the surface. Sr 90 and Cs 137 were most concentrated immediately below the surface. Slant-hole core samples showed tritium migration to be less than 0.3 m, while Sr 90 had migrated approximately 20 cm. It was concluded that 1) radionuclide migration in the soil was relatively minor, 2) groundwater movement is not significant, 3) rising trench water levels were probably due to rainwater infiltration, and 4) radioactivity near the surface was not necessarily due to trench water, but may have been the result of spills during burial activities, trench digging, or effluents from a nearby fuel reprocessing plant. By January 1975, trench water was 1 m above the undisturbed soil level, and radioactivity in local streams was up. Removal, treatment, and release of water from the trenches was begun. The estimated maximum individual body dose for the released water is 3 x 10(E-4) mrem; total body-population dose is about 0.3 person-rem. Deaths expected from this discharge, based on BEIR Committee risk estimates are less than 10(E-6). Release of untreated trench water would not have a statistically significant health effect. (LKH)

Migration Rate; Total Ion Concentration

Cs 137; Sr 90; H 3

TRITIUM; TRENCHES; TILL; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; DOSE RATE; RADIOACTIVITY; CESIUM; DISPOSAL SITE; GROUND WATER; FLOODING; OVERFLOWS; POLLUTION, WATER; POLLUTION, SOIL; RADIONUCLIDE MIGRATION; SAFETY; SOILS; CLAYS; STREAMS; STRONTIUM; MEASUREMENTS; SAMPLES; CHEMICAL ANALYSIS; FIELD STUDIES

<129>
McGiff, T.J., L. Fraley, Jr., and O.D. Markham, Colorado State University, Fort Collins, CO; Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Iodine 129 Distribution in Vegetation on the Idaho National Engineering Laboratory Site. (3)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arther (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1976, (pp. 38-39) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 108-118) 371 pp. (IDO-12087). (1978, December; 1979, April)

A study is in progress to determine the concentration of I 129 and the ratio of I 129 to I 127 in vegetation at the INEL site and to assess the potential transfer through the food chain to man. During August 1978, samples of big sagebrush (ARTEMISIA TRIDENTATA) and mixed grasses were collected at 16 locations 1-80 Km from the Idaho Chemical Processing Plant (ICPP) along transects running northeast and southeast of the plant (predominant wind direction); three background locations were also sampled. At each location replicate samples of sagebrush and up to 4 samples of grasses were collected. Only the current year's growth of sagebrush was collected, and grasses were clipped at ground level; all samples were air dried. Neutron activation techniques were utilized to estimate amounts of I 129 and I 127 in the vegetation. Prior to activation, the iodine was separated from the bulk sample in order to reduce by-product activity. This was accomplished by dry oxidative combustion of the sample and collection of the volatile iodine on activated charcoal. The iodine was sealed in a quartz activation ampoule and activated along with a I 129 and I 127

<129> CONT.
comparitor standard solution to produce radioactive I 130 and I 128. Following activation, the iodine was further purified by solvent extraction separations and precipitated to facilitate detection. A determination of the amount of I 127 and I 129 in the isolated iodine was accomplished by comparing the results of gamma spectrographic analysis of the isolated iodine with that of the standard. The results of this study will enhance the reliability of estimates of I 129 content in biota on the INEL Site, add information on the long-term environmental behavior of I 129 and improve the reliability of I 129 dose estimates for man. (Auth) (LEM)

I 129; I 127

IODINE 129; PLANTS; FOOD CHAINS; ENVIRONMENTAL EXPOSURE PATHWAY; GRASSES; EFFLUENTS; AIRBORNE; ISOTOPE RATIOS; RADIONUCLIDE MIGRATION; FIELD STUDIES; LABORATORY STUDIES; UPTAKE; BIOLOGICAL STUDIES

<130>
McLendon, H.R., Savannah River Plant, Aiken, SC.

Soil Monitoring for Plutonium at the Savannah River Plant. (B)

Health Physics 28:347-350.(1975, April)

Seven onplant and offplant soils were collected and analyzed for Pu 238 and Pu 239. Four of the soil samples were at the plant perimeter while three were at a distance of 160 kilometers from the plant. The analyzed samples were composite samples of 10 cores collected at each location. Each core measured 30 cm by 7.6 cm diameter, and was cut into four segments representing 0-5 cm, 15-22.5 cm, and 22.5 to 30 cm depths. Results of the initial seven samples showed that approximately 90% of the Pu was contained in the top 15 cm. An additional 50 onsite samples were collected to the 15 cm depth. The results showed a background value for this section of the country of approximately 2 mCi/sq km. Samples taken within 2 Km of the plant had higher levels showing some plant contribution. The techniques and analytical procedures to analyze the soil data are discussed in detail. (LS)

Analytical techniques used by the author are discussed in detail along with the program. (DS/LS)

Pu 239; Pu 238

PLUTONIUM; SOILS; BACKGROUND RADIATION; TOPOGRAPHY; MONITORING; SAMPLING; LOGGING, RADIOACTIVITY; DEPOSITION; ION EXCHANGE; NUCLEAR FACILITIES; SEPARATION PROCESSES; ISOPLETHS; CHEMICAL ANALYSIS; EFFLUENTS; FIELD STUDIES; LABORATORY STUDIES

<131>
Meyer, T.L., U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC.

Recent Experience with the Land Burial of Solid Low-Level Radioactive Wastes. (2)

IAEA-SM-207/64; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (pp. 383-395), 828 pp. (1976)

Burial of solid low-level radioactive wastes at three sites in the eastern U.S. has not produced satisfactory containment. At these sites - Maxey Flats, KY, West Valley, NY, and Oak Ridge National Laboratory, TN - low permeability substrate and high rainfall (100+ cm/yr) has resulted in trench flooding and radionuclide migration off-site. Migration has been by (1) surface runoff, (2) interflow or lateral migration through the unsaturated zone, or (3) subsurface migration through joints, fractures, or sand lenses. The sorptive capacity of the substrate has been bypassed because of these types of migration, as opposed to intergranular flow. In each case, distance from the trench to the nearest surface discharge point via the interflow pathway is 15 m or less and distance via subsurface migration is 30 to 150 m. Hydrogeologic conditions at the sites have been altered by burial operations. Conclusions are that (1) fundamental changes in disposal methods are needed, (2) that the majority of the existing problems are correctable, (3) that new criteria are needed for waste segregation, treatment, and packaging, and for site selection, evaluation, and operation, and (4) that the cost of waste disposal may increase if these criteria are implemented. (LEM)

BURIAL; WASTES, SOLID; WASTES, LOW-LEVEL; PRECIPITATION, METEOROLOGICAL; PERMEABILITY; RADIONUCLIDE MIGRATION; GROUND WATER; SURFACE WATERS; JOINTS; FRACTURES; SORPTION; TRENCHES; METHODS; WASTE TREATMENT; PACKAGING; COST BENEFIT ANALYSIS; FIELD STUDIES

<132>
Hilliard, J.B., O.D. Markham, and F.W. Whicker, Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO; U.S. Energy Research and Development Administration, Environmental Sciences Branch, Idaho Falls, ID.

A Radioecological Study of the Test Reactor Area Leaching Ponds. (3)

IDO-12079; Summaries of the Idaho National Engineering Laboratory Site Ecological Information Meeting, O.D. Markham (Ed.), (pp. 10-12), 68 pp., (IDO-12079).(1975, July 10)

Radiation levels at the Test Reactor Area (TRA) leaching ponds at the water surface are about 10-15 mR/hr and up to 200 mR/hr for unshielded sediments and algae along the banks. Background radiation is about 0.02 mR/hr for this area. Approximately 81,000 Ci of beta-gamma activity have been discharged to the TRA ponds since 1952; the 1974 average radionuclide concentrations in water discharged to the ponds consist of an assortment of fission and activation products. Dissolved oxygen ranges from 8.1 to 8.9 ppm, conductivity from 65 to 170 micro ohms/cm, and pH from 6 to 9. The objectives of the study in progress are: 1) to identify densities and species of birds utilizing the TRA pond area and their mean residence times; 2) to find a reasonable estimate of the maximum body burden possible for waterfowl, and to estimate the dose to Man as a result of consuming muscle tissue from such birds;

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DISPOSAL SITE

<132> COST.
3) to identify and measure radionuclide concentrations in the various pond compartments, and by sampling through time, determine if any seasonal variations are operating; and 4) to model I 131 uptake in swallows feeding on the TRA ponds and to ascertain if any growth rate effects exist as a result of such uptake. (RAP)

pH; Temperature; Thermal Conductivity

LEACHING; PONDS; BIRDS; BODY BURDEN; WATERFOWL; RADIATION DOSE; RAW; TISSUES; MUSCLES; INGESTION; SAMPLING; IODINE 131; UPTAKE; GROWTH; SEDIMENTS; ALGAE; BACKGROUND RADIATION; FISSION PRODUCTS; ACTIVATION PRODUCTS; TRITIUM; CESIUM 134; CESIUM 137; COBALT 60; ZIRCONIUM-NIOBIUM 95; SODIUM 24; RADIATION, GAMMA; BETA PARTICLES; NEUTRONS; CHROMIUM 51; WASTES, LIQUID; WATER; SAMPLES; PLANTS; INSECTS; ZOOPLANKTON; SEDIMENTS; HAZARD ANALYSIS; ECOSYSTEMS, TERRESTRIAL; ECOLOGY; ECOSYSTEMS, AQUATIC; FIELD STUDIES; ECOLOGICAL STUDIES

<133>
Hillard, J.B., F.W. Whicker, and O.D. Markham, Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO; Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Radionuclide Concentrations in a Barn Swallow Population Nesting near Radioactive Leaching Ponds (Barns Swallows Nesting Near Radioactive Leaching Ponds in Southeastern Idaho). (2)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 34-35) 72 pp. (IDO-12088); IDO-12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 1-16) 371 pp. (IDO-12087).(1978, December; 1979, April)

Concentrations of radionuclides in barn swallow (HIRUNDO RUSTICA) populations living in the vicinity of the Test Reactor Area (TRA) leaching pond at INEL have been measured. Frequency of occurrence of radionuclides was reported for three developmental stages weighing 0-10 g, over 10 g, and adults. Over 20 radionuclides were found in adults, but Se 75 was the only one found in all three developmental stages. Cr 51 exhibited the highest concentration of any nuclide, with 520 pCi/g whole body. Na 24 had relatively high concentrations, in spite of a 15 hr physical half-life. Cs 137 and K 40 were the only nuclides detectable in off-site control swallows. Internal dose rates increased by a factor of 8 from immatures to adults. Na 24 was the main dose contributor (72% of total); Cs 137 and I 131 were next. Ninety percent of the total internal dose in adults was from beta radiation. Concentration factors (CFs) were calculated for the three developmental stages with respect to filtered pond water. CFs were greater than one for all nuclides except Cr 51, La 140, and Ba 140. The major internal dose contributors (Cs, Na, I) showed significant increases (P=0.05) as the swallows developed. Another experiment found that hatching and development of young influenced the dose rate in the nest. A 2.5 fold increase was observed, from 84 mRad/day in eggs to 220 mRad/day in young. The external nest dose rate of 220 mRad/day for the young was about 20 times the internal dose rate. Since background radiation in southeast Idaho is 150 mR/yr, immature swallows at the TRA receive this amount in less than one day. Immature swallows received a mean dose of 5.8 rads during the nesting period. Growth rate analysis of TRA and control swallows showed that the mean growth rate constants did not belong to the same population (P=0.05). The first clutch of TRA birds had a significantly (P less than 0.05) lower mean growth rate of 0.436/day as compared to the controls with 0.460/day. Both clutches at TRA were also found to differ significantly (P less than 0.05), with the second clutch showing a larger growth rate. All growth rate values were within the range of values reported for this species in the literature. (LKH)

Total Ion Concentration

Se 75; Cr 51; Na 24; Cs 137; K 40; La 140; Ba 140; I 131

BIRDS; PONDS; HOLDING PONDS; CONCENTRATION FACTORS; DOSE RATE; RADIATION DOSE; RADIONUCLIDES; ENVIRONMENTAL EXPOSURE PATHWAY; EXPOSURE, INTERNAL; FIELD STUDIES; UPTAKE; EXPOSURE RATE; BIOLOGICAL STUDIES

<134>
Hillard, J.B., F.W. Whicker, and O.D. Markham, Colorado State University, Fort Collins, CO; Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Distribution and Avian Export of Gamma Emitting Radionuclides at the Test Reactor Area Leaching Ponds (Gamma Emitting Radionuclides of the Test Reactor Area Leaching Ponds). (2)

IDO-12088; Idaho National Engineering Laboratory Ecology Programs, O.D. Markham and W.J. Arthur (Eds.), Proceedings of a Symposium, Jackson Lake Lodge, WY, September 10-12, 1978, (pp. 63-64) 72 pp. (IDO-12088); IDO 12087; Ecological Studies on the Idaho National Engineering Laboratory Site 1978 Progress Report, O.D. Markham (Ed.), (pp. 28-46) 371 pp. (IDO-12087).(1978, December; 1979, April)

A study of three leaching ponds adjacent to the Test Reactor Area (TRA) at INEL was conducted to determine the seasonal distribution and ecological behavior of gamma emitting radionuclides and to estimate amounts of radioactive materials exported by the principal avian species using the ponds. Monthly physicochemical measurements showed high dissolved oxygen and low conductivity typical in the winter months, and no evidence of thermal stratification or oxygen depletion at depth. Fall and winter biomass estimates were obtained for the major pond compartments, including periphytos (the largest), seston, zooplankton, arthropods, emergent macrophytes, sedges (SCIRPUS spp.) and maniaquatic littoral vegetation (CIRSIUM spp. and VERONICA ANAGALLIS). An inventory of radionuclides in the various compartments indicated that 99% of the activity was associated with filtered water and sediments. The remainder was concentrated mainly in seston and periphyton. This inventory accounted for 258 Ci (35%) of the 731 Ci estimated to remain at the time of sampling; the remainder likely lies at greater depths in the sediments. Analysis of bird species inhabiting the pond area found that Cs isotopes were the most common radionuclides

<136> CONT.
in waterfowl muscle tissues and the principal potential dose contributors to man via consumption. Average radionuclide concentrations for Killdeer (CHARADRIUS VOCIFERUS), mourning doves (ZENAIDURA MACROURA), and blackbirds showed that Killdeer had the highest relative concentrations, and doves had the lowest of any bird sampled. Other birds investigated included spotted sandpipers (ACTITIS MACULARIA) and barn swallows (HIRUNDO RUSTICA), the latter potential radionuclide exporters during their fall migrations. Estimated avian radioactivity export rate for 1975 was 1340 uCi/yr for waterfowl (90% of this associated with external tissues), and total avian export was 1350 uCi/yr. If this rate were applied over the 25-yr lifetime of the ponds, 33-34 mCi would have been exported by 1978 (total activity discharged to the ponds in 1975 alone was 1200 Ci). In addition, many of the nuclides have short half-lives, which could limit their range of export. (LKH)

BIRDS; ENVIRONMENTAL EXPOSURE PATHWAY; PONDS; HOLDING PONDS; RADIOACTIVITY; RADIATION DOSE; DOSE RATE; DISPOSAL SITE; MICROORGANISMS; PLANTS; GRASSES; FIELD STUDIES; FOOD CHAINS; DISTRIBUTION; SEDIMENTS; SURFACE WATERS; UPTAKE; ECOLOGY; WATERFOWL; BIOLOGICAL STUDIES; CESIUM

<135>
Moffett, D., and R. Tellier, Rio Algom Ltd., Elliot Lake, Ontario, Canada; Elliot Lake Laboratory, Elliott Lake, Ontario, Canada.

Radiological Investigations of an Abandoned Uranium Tailings Area. (2)

Journal of Environmental Quality 7(3):310-316.(1978)

Presented are the results of an investigation of an abandoned Elliot Lake Tailings area. The Elliot Lake uranium district has been mined since 1956 and this activity has resulted in the disposal of almost 80 million metric tons of waste in 10 distinct tailings area. These tailings piles were considered to have been part of the degradation of the Serpent River water quality. The Elliott Lake area is in a valley of loose glacial till overlying bedrock which consists of graywacke, argillite, and siltstone. Solid samples came from two distinct zones on the tailings piles: sands, 35% passing through 75 um; and slimes, with over 65% passing through 75 um. Upon analysis significantly more Ra 226, Pb 210, and Po 210 were found in the slimes than in the sands. This is in contrast to uranium and thorium which showed no preference. All three isotopes have lower values in the 17 year old tailings than at deposition which can not be accounted for by decay alone. Hence, leaching is indicated. For liquid samples ground water was monitored. The water table in the area rises with the spring floods to a position just below the ground surface and then gradually drops during the summer months to a depth of 2 to 3 m. Some of the samples showed high acid, metal, soluble salts, and radioisotopes in the water. The relatively minor loadings of Ra 226 and Pb 210 are not, at present, a public health hazard since an adjacent lake is not a drinking water source. From monitoring done on all domestic water supplies there appears to be adequate dilution of both the polluted surface flows and any groundwater contamination. More study is required outside the tailings area for determination of possible contamination. (NDV)

Waste Volume; Grain Size Distribution; Depth to Water Table

Ra 226; Pb 210; Po 210; Th; U

ACIDS; BEDROCK; CONTAMINATION; DRINKING WATER; FIELD STUDIES; GROUND WATER; ISOTOPES; LEACHING; MONITORING; RADIONUCLIDE MIGRATION; TAILINGS; TILL; WASTE MANAGEMENT; WASTE DISPOSAL; WATER TABLE

<136>
Morrison, J.A., Atomic Energy of Canada Limited, Chalk River Environmental Authority, Chalk River, Ontario, Canada.

Canadian Experience and Policy in the Management of Radioactive Wastes. (2)

Modern Geology 6:19-27.(1976)

The current status of radioactive waste management in Canada is outlined by describing waste management practice and experience at CRNL (Chalk River National Laboratory) where the majority of the radioactive wastes are stored. The Project is located 125 miles west of Ottawa in the Perch Lake watershed. The watershed is in a rock-lined basin 2 km wide and 7 km long. Water leaves the area by Perch Creek at a flow rate of about 1 million gallons per day. The waste management areas are all in the basin on sandy deposits adjacent to main drainage path. These deposits are 10-25 m thick and the water table is 2-10 m below the surface. The sandy soil has a low ion exchange capacity of 1-3 meq/100 g. Strontium 90 is considered to be the most important radionuclide; it has been measured moving through the ground at 3% of the ground water flow rate. At CRNL 5.5 million gallons/day of slightly contaminated waste are dumped into the river with a 45 minute delay. Another [illegible],000 gallons are pumped to seepage pits, and still another 20,000 gallons of liquid waste with a high dissolved salt concentration are concentrated 10 fold and stored in underground stainless steel tanks in the Perch Lake Basin. High hazard liquid waste is stored in stainless steel tanks inside stainless steel lined concrete bunkers in the same basin. Medium hazard wastes were mixed with cement in steel drums and then buried in the Perch Lake Basin in an underground concrete monolith. The rate movement in the ground has been measured as 125 to 150 years in the Perch Lake area. A leaching rate of fission products was measured at 10 (E-8). Monitoring of the Sr 90 level in the river shows that only 3 to 7% comes from the Laboratory activities. Up to this point Canada has not had a radioactive waste problem but with the advent of nuclear power plants the problems will come into existence. Options being considered are storing irradiated fuel and reprocessing irradiated fuel. Disposition of liquid wastes, plutonium, and spent ion exchange resin will also have to be considered in developing programs for the next five to ten years. (NDV)

Stratigraphic Unit Thickness; Depth to Water Table; Ion Exchange Capacity

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Ar 41; Sr 90; H 3; I 131; Cs 137

ACCIDENTS; AIR; DISPOSAL SITE; DRAINAGE BASINS; EVALUATION; FISSION PRODUCTS; FUELS; GROUND WATER; ION EXCHANGE CAPACITY; LAND USE; LEACHING; LEAKAGE; MATERIALS RECOVERY; MAXIMUM PERMISSIBLE CONCENTRATION; NUCLEAR FACILITIES; RADIONUCLIDE MIGRATION; REPROCESSING; RESINS; RIVERS; SAFETY; RETARDATION FACTOR; SEEPAGE PITS; TRENCHES; WASTE DISPOSAL; WASTE MANAGEMENT; WASTE STORAGE; WASTES, GASEOUS; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, SOLID; LAKES; MONITORING; FIELD STUDIES

River Flow Rate; Hydraulic Velocity; Depth to Water Table

Ru 106; H 3; Sr 90; Cs 137; Co 60; I 129; Tc 99; U 238; Sb 125; I 131; Pu 239; Na 22; Mn 54; Bi 59; Bi 63; Zn 65; Se 79; Zr 93; Nb 93; Zr 95; Ag 108m; Ag 110m; Ra 226; Ra 228

AQUIFERS, UNCONFINED; CONTAMINANTS; CONTAMINATION; DIFFUSION; DILUTION; GROUND WATER; FIELD STUDIES; HYDROLOGY; MONITORING; RADIONUCLIDE MIGRATION; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WATER TABLE; WELLS

<137>
Myers, D.A., Battelle-Pacific Northwest Laboratories, Richland, WA.

Environmental Monitoring Report on the Status of Ground Water Beneath the Hanford Site, January-December 1977. (T)

BNL-2624; 94 pp.(1978, April)

Ground water at the Hanford Site was monitored as part of a comprehensive program to evaluate existing and potential pathways of exposure to contamination from site operations. Liquid radwastes, both low- and intermediate-level, percolate laterally and vertically through 150 to 300 feet of unconsolidated glaciofluvial and lacustrine sands, silts and gravel overlying the groundwater table. While moving in the ground water the radionuclides concentration is reduced by radioactive decay, ion exchange, diffusion and hydrodynamic dispersion. The ground water has been profoundly changed during the past 30 years by the disposal of more than 130 billion gallons of low-level waste and about 8 billion gallons of intermediate-level waste. Seven hundred wells were used for monitoring. Measurements of the gross beta (Ru 106) indicate the plume configuration is static but the size has shrunk slightly. The configuration of the H 3 plume has changed little in the last year. However, one well indicates the plume may have reached the Columbia River. Other wells show that after a peak concentration in 1969 the H 3 concentrations have declined to the 1975 level which is an apparent equilibrium point. Analyses of I 129 confirm that I 129 follows the flow paths of the other major contaminants and its levels of concentration are reduced by diffusion and dispersion with the ground water system. Tests for vertical distribution show that most of the contamination is in the upper portion of the aquifer, and a routine sampling program provides the highest estimate of contaminant concentrations. Concentrations of H 3 in drinking water are low compared to the guidelines. The ground water entering the Columbia River is diluted by a factor of about 1000; the river flow is 88,500 cfs and the unconfined aquifer flow rate is 100 cfs. Apparently there is no difference between the upstream and downstream concentrations except for Co 60. (MDV)

Appendix A contains the maximum, minimum, and average concentrations for gross beta, tritium, and nitrate. Appendix B lists total alpha, Sr, Cs, Co, U, Ru, Cr and Fl concentration in the unconfined aquifer.

Stratigraphic Unit Thickness; Waste Volume;

<138>
Myers, D.A., J.J. Fix, P.J. Blanet, J.R. Raymond, V.L. McGhan, and E.L. Hilty, Battelle-Pacific Northwest Laboratories, Richland, WA.

Environmental Monitoring Report on the Status of Ground Water Beneath the Hanford Site--January-December 1975. (3)

BNWL-2038; 27 pp.(1976)

This report discusses data collected between January and December 1975 at the Hanford Reservation, Washington, as part of the Ground Water Monitoring Program. Results to date indicate nitrate concentrations greater than the Public Health Service and EPA recommended standard of 45 mg/l continue to occur in the vicinity of the 200 Areas, near 100-F and N Areas, and in the east-central part of the Reservation, as well as along the Columbia River near the 100 Areas, and in the 300 Area. Concentrations of H 3 in the 100 Areas and U in the 300 Area continue above background. Detectable gross beta levels occurred only in the 100-N area, as a result of effluent from the 1301-N crib, and near the 100-B Area. Strontium 90, Co 60, I 129, Cs 137, and Ru 106 analyses show their presence outside the 200 Areas, but only in very low concentrations - usually less than 10% of ERDA Concentration Guides. The pattern and level of ground water contamination has changed only slightly since the last report. Some areas of contamination have expanded, notably the nitrate plume north of Gable Mountain and the plume south of the 200-E Area, the latter having a gross beta concentration above 1.0 pCi/ml at the southeast corner of the Area. (LKH)

Tables of data are provided as appendices and maps are in pocket.

Total Ion Concentration

H 3; Sr 90; Co 60; I 129; Cs 137; Ru 106; U

GROUND WATER; WASTES, RADIOACTIVE; TRITIUM; NITROGEN COMPOUNDS; AQUIFERS; PLUMES; CONTAMINATION; RADIOACTIVITY; MONITORING; FIELD STUDIES

<139>
Ohl, J.P., U.S. Geological Survey, Denver, CO.

Bibliography of Reports by U.S. Geological Survey Personnel on the Nevada Test Site and Related Subjects, July 1, 1976, to June 30, 1977, with Author and Subject Indexes. (3)

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<139> CONT.
USGS-474-258; 26 pp. (1977)

This bibliography includes all reports issued between July 1, 1976 and June 30, 1977 by personnel of the U.S. Geological Survey on the Nevada Test Site and related subjects and areas. A special feature of this bibliography is a partial list of USGS-474 series reports (USGS-474-210 through USGS-474-253) showing those reports in the series that have been issued since the last bibliography. Cross references show the alternative designation of these reports in the various administrative series. The remainder of the bibliography is set up on lines similar to those of previously issued bibliographies: USGS Administrative Series (Amchitka, Area 12, Long Shot, NTS, Offsite Studies, USGS Administrative Report (unnumbered)); USGS Formal Publications (USGS Bulletins, USGS Geologic Quadrangle Maps, USGS Geophysical Investigations Maps, USGS Open-File Reports, USGS Professional Papers); Journals and Other Outside Publications; Author Index; and Index. (Auth) (LKH)

An index map shows the area of the Nevada Test Site as it is divided into 7 1/2-min quadrangles; a second map of the site shows how it is divided into numbered areas. The locations of sites B, C, D, E, and F on Amchitka Island Supplemental Test Site are also shown.

DISPOSAL SITE; BIBLIOGRAPHIES; MAPS; GEOLOGY; HYDROLOGY; GEOPHYSICAL SURVEYS; GEOCHEMISTRY; RADIOCHEMISTRY; REVIEWS

<140>
Ophel, I.L.

Waste Disposal Operations at the Chalk River Project of Atomic Energy of Canada Limited. (2)

Ground Disposal of Radioactive Wastes, H.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959. University of California, Berkeley, CA, (pp. 80-86), 168 pp. (1961, July)

An overview of waste disposal operations at Chalk River is presented. Solid waste is handled in the usual manner. For liquid wastes there are several different pits used. Laundry and decontaminated waste are placed in a small open pit and only a few thousand gallons have been introduced. About 300,000 gallons/month of mildly acidic wastes have been pumped into the chemical waste pit for the past three years. After 20 months of operation the water level was stable at 8 ft. However, construction of a second pit disrupted the soil and the water level has not been as high since. Surface seepage from the pit was detected in a swamp 200 ft away after 8 months of operations. The main nuclides were Ru 106 and Rh 106. Reactor pit 2 receives waste from the fuel storage bays at a rate of 3 x 10(E+6) gallons/month. After 7 months of ese radionuclides were de.:t.J in a swamp. The seepage contained S 35 and Ru 106. A sampling system including dry monitoring boreholes, sampling boreholes, and soil samples, aids monitoring the movement of ground water. (MDV)

Waste Volume

Ru 106; Rh 106; Sr 90; S 35

CONTAINMENT; DISPOSAL SITE; PITS; RADIONUCLIDE MIGRATION; RUTHENIUM; RHODIUM; WASTE DISPOSAL; WASTE MANAGEMENT; WASTE VOLUME; WASTES, LIQUID; WASTES, LOW-LEVEL; BOREHOLES; SAMPLING; MONITORING; SEEPAGE; REVIEWS

<141>
Ozsuszky, F.J.P., and K. Schlosser, Osterreichische Verbundgesellschaft, Vienna, Austria; Osterreichische Studiengesellschaft fur Atomenergie, Vienna, Austria.

Future Management of Radioactive Wastes in Austria. (4)

CONF-700905; IAEA-SR-137/52; STI/PUB/264; Developments in the Management of Low- and Intermediate-Level Radioactive Waste, Proceedings of a Symposium, Aix-en-Provence, France, September 7-11, 1970, (pp. 213-224) (CONF-700905, IAEA-SR-137/52, STI/PUB/264). (1970)

At present the only radioactive waste producers in Austria consist of a nuclear research center, a few small research reactors, some laboratories, and some uses in industry and medicine. Erection of a 600 MW(e) nuclear power reactor is contemplated in the near future and planning for future radioactive waste management is described. It appears that current thinking does not include shallow land burial as an option. Underground storage of low- and intermediate-level wastes in caves and mines is the only type of storage mentioned. (CAB)

Discusses future management of Austrian nuclear wastes. No use of shallow land burial is discussed in any detail. (DH/CAB)

WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; REACTORS, PRESSURIZED WATER; WASTES, LIQUID; WASTES, SOLID; WASTE TREATMENT; REACTORS, BOILING WATER; WASTE STORAGE; WASTES, GASEOUS; THEORETICAL STUDIES

<142>
Phillips, S.J., Battelle-Pacific Northwest Laboratories, Richland, WA.

Characterization of 300 Area Burial Ground. (2)

PNL-2500 Part 5; Pacific Northwest Laboratory Annual Report for 1977 to the DOE Assistant Secretary for Environment, Part 5: Control, Technology, Overview, Health, Safety and Policy Analysis, (pp. 1.23-1.26). (1978, February)

Substantial quantities of high-level, transuranic, and other nuclear materials have been disposed of in solid waste burial facilities on the Hanford Reservation. The objective of this program is to develop the technologies required to conduct comprehensive geologic, geophysical, biologic, and computer model analysis of risk associated with the alternatives of either designating sites for permanent storage or removing wastes and contaminated sediments from the reservation. Geophysical instrumentation capable of effective collection and real-time processing of data from burial sites has been designed; fabrication of components is proceeding. The following systems have been used: ground-penetrating radar, acoustic holography, acoustic reflection and refraction, magnetics, ferro-magnetic

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detection, and thermal infrared inertia. Prototype development of an optimum ground-penetrating radar, magnetic, and ferromagnetic detection system has produced a unique geophysical system capable of conducting surveys in high acoustic attenuation, high dielectric, partially indurated and dessicated sediments. Contaminated sediment samples from burial sites have been collected, and materials adsorbed on mineral grains have been analyzed by optical microscopy, x-ray fluorescence, neutron autoradiography, and electron microprobe techniques. Fluid migration is the primary transport mode of radioactive material in shallow land burial sites. Determinations of both fluid and vapor phase flux as well as mass and energy balance are required to define worst case hazard scenarios. Each atmospheric and in situ transport controlling factor is monitored by a system that will be used to collect ambient data and data from controlled field conditions simulating increased precipitation. Laboratory analyses of nonisothermal liquid and vapor flux of anisotropic heterogeneous flow systems are also being conducted under controlled conditions. Two nonisothermal energy balance computer models have been developed to evaluate and predict factors controlling long-term stability of various waste forms. In vivo dosimetry of burrowing rodents has been conducted to assess the in situ dose of gamma neutron emitters. Beta-gamma spectroscopy analysis has delineated radionuclide uptake in plant tissues. A typical specimen from the 300 Area Burial Ground contained 54,800 dpm/g Ce 144, 10,000 dpm/g Ru 106, 7400 dpm/g Cs 137, 32,800 dpm/g Zr 95, 7600 dpm/g Mn 54, and 10,600 dpm/g Zn 65. In future work it is planned to: 1) survey all designated burial sites and specifically define the location and composition of waste and containment structures; 2) core drill all burial sites to determine the extent of waste migration; 3) define additional waste-sediment geochemical reactions; 4) monitor one annual cycle of field energy and mass balance parameters; 5) establish quantitative nonisothermal fluid and vapor phase flux in anisotropic heterogeneous sediments; 6) model liquid and vapor phase flow systems and develop long-term predictive scenarios; 7) assess biologic transport and define biologic waste containment alternatives; and 8) develop decontamination and decommissioning alternatives and recommendations. (Auth) (LKH)

Total Ion Concentration

Ce 144; Zn 65; Mn 54; Cs 137; Ru 106; Zr 95

WASTE STORAGE; MANGANESE 54; CESIUM 137; ZIRCONIUM 95; ZINC 65; CHEMICAL ANALYSIS; GROUND WATER; SEDIMENTS; SOILS; CERIUM 144; RUTHENIUM 106; DISPOSAL SITE; WASTES, SOLID; WASTES, TRANSURANIC; WASTES, HIGH-LEVEL; WASTES, RADIOACTIVE; BURIAL, SHALLOW; WASTE MANAGEMENT; WASTE DISPOSAL; WASTE RETRIEVAL; GEOPHYSICAL SURVEYS; GEOCHEMISTRY; RADIOCHEMISTRY; RADIONUCLIDE MIGRATION; MONITORING; MODELS, MATHEMATICAL; ANIMALS, BURROWING; RADIATION DOSE; UPTAKE; PLANTS; RADIONUCLIDES; DECONTAMINATION; DECOMMISSIONING; REVIEWS; THEORETICAL STUDIES; FIELD STUDIES; BIOLOGICAL STUDIES; ECOLOGICAL STUDIES; LABORATORY STUDIES

<183>
Phillips, S.J., A.E. Reisenauer, W.H. Rickard, and G.A. Sandness, Battelle-Pacific Northwest Laboratories, Richland, WA.

Initial Site Characterization and Evaluation of Radionuclide Contaminated Solid Waste Burial Grounds. (3)

BNWL-2184; 59 pp. (1977, February)

A literature review was conducted for the 300 Area and Nye Burial Grounds on the Hanford Reservation in accordance with plans for their decommissioning. Acoustic, radar, thermal, infrared, magnetic, and metal detection surveys were carried out and their applicability to site characterization studied. Drilling techniques and equipment were tested for soil and radioactive waste analysis, and to determine patterns of contaminant migration. Monitoring of sediment-fluid interactions and radionuclide flux in the unsaturated zone is also being conducted. Identification of biota on the burial grounds has been made and monitoring is planned to determine dose rate and biological pathways of radionuclides. Preliminary sediment fluid potential and field content measurements show no significant transport of contaminants toward the saturated zone. A computer model has been developed to illustrate fluid transport characteristics of the burial ground sediments. Data from biological studies indicates the potential exists for the spread of contaminants by burrowing animals or by the root systems of plants, although no such effects were actually observed. Recommendations include: development of a ground-penetrating radar system accurate to a depth of at least 7 meters, development of a computer acquisition and processing system for geophysical data, perfection of computer models for predicting radionuclide transport, use of detailed drilling and radiochemical analysis procedures to evaluate near-surface radionuclides and their sediment relations, and more extensive evaluation of radioactive dose rates and pathways to man. (LKH)

Density; Hydraulic Conductivity

BIOTA; DECOMMISSIONING; DISPOSAL SITE; DOSE RATE; DRILLING; ENVIRONMENTAL EXPOSURE PATHWAY; EQUIPMENT; GEOCHEMISTRY; GEOPHYSICAL SURVEYS; HYDROLOGY; METHODS; MODELS; MONITORING; RADIOCHEMISTRY; RADIONUCLIDE MIGRATION; SITE EVALUATION; STORAGE, GEOLOGIC; PITS; TRENCHES; UNSATURATED ZONE; WASTE MANAGEMENT; ANIMALS, BURROWING; INTRUSION; VEGETATION; ROOTS; FIELD STUDIES; THEORETICAL STUDIES; MODELS; RECOMMENDATIONS

<184>
Price, W.H., and K.R. Fecht, Atlantic Richfield Hanford Company, Richland, WA.

Geology of the 241-A Tank Farm. (2)

ARH-LD-127; 13 pp. (1976, April)

This document is a summary of the geologic features of the Hanford Reservation 241-A Tank Farm accompanying geologic maps and cross-sections. The purpose of this investigation is to provide information for the evaluation of aspects of tank leaks. Data for the maps and section are based on 500 samples from 23 dry and 5 water wells which have been sampled at one-to five-foot

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intervals. Samples have been classified by grain size, CaCO3 content, and visual inspection. The 241-A Tank Farm sections include approximately 233 feet of unconsolidated Pleistocene glacio-fluvial deposits and 107 feet of the middle (gravel and sand) unit of the Pliocene Ringold Formation. Typical grain size distribution and calcium carbonate content for the Middle Ringold are 17% pebbles and cobbles, 22% very coarse sand, 20% coarse sand, 13% medium sand, 10% fine sand, 8% very fine sand, 9% clay and silt and 1.6% CaCO3. The upper and lower units of the Ringold are missing beneath 241-A, and top of the Columbia River Basalt Group lies about 80 feet below the bottom of the prepared cross-sections. The water table at 241-A is within the Ringold Formation, 231 feet below the base of the tanks. (LEH)

Eight geologic cross-sections are included in the report as separate plates.

Calcium Carbonate Content; Grain Size Distribution; Stratigraphic Unit Thickness; Depth to Water Table

TANKS; GEOLOGIC FORMATIONS; GEOLOGIC MAPPING; GEOLOGIC STRATA; SOILS; SEDIMENTS; DISPOSAL SITE; GROUND WATER; WATER TABLE; BASALTS; ROCKS; SITE EVALUATION; FIELD STUDIES

<185>
Reichert, S.O., Savannah River Laboratory, Explosives Department, Aiken, SC.

Geology and Hydrology for Disposal of Radioactive Wastes into the Ground at the Savannah River Plant. (2)

DP-381; 28 pp.(1958, December)

Data obtained from monitoring wells show that seepage basins are effectively percolating and decontaminating large volumes of low-level radioactive liquids at the Savannah River Plant. Stratigraphic panel diagrams and hydrologic maps give a good picture of the factors that are important in evaluating the performance of seepage basins and burial pits. A general method is outlined for determining the proper placement of a seepage basin or burial ground area and for evaluating and monitoring its performance. (JT)

Report presents only generalized superficial data on the geology and hydrology at Savannah River Plant with respect to radioactive waste disposal. Four hydrologic maps and four stratigraphic panel diagrams are presented. (DH/JT)

pB

GEOLOGY; SANDS; CLAYS; GRAVELS; GRANITES; SCHISTS; SLATES; HYDROLOGY; WASTE DISPOSAL; *WASTES, LOW-LEVEL; WASTES, LIQUID;* WASTES, SOLID; DECONTAMINATION; SEEPAGE PITS; BURIAL; SITE SELECTION; SITE EVALUATION; MARLS; GLAUCONITE; FIELD STUDIES

<186>
Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV; DOE Nevada Operations Office, Las Vegas, NV.

An Assessment of the Nevada Test Site for Low-Level Waste Management. (3)

NVO-193; 88 pp.(1978, February)

A summary is presented of description information, facilities, and operating practices at the Nevada Test Site (NTS). The NTS and its buffer zones total 18,392 square kilometers of controlled area. The low population density in the surrounding area, rugged topography providing physical barriers, and arid climate are all factors which contribute to the effective operation of NTS radioactive work management sites. Geological and hydrological conditions at NTS assure that radionuclides will not migrate beyond NTS boundaries until radioactive decay reduces radioactivity to harmless levels. NTS is not only a feasible location for surface and near-surface storage of low-level radioactive wastes, but also a potential site for underground storage of higher level wastes. The same conditions for storing radioactive debris from past underground nuclear detonations apply to storage of radioactive wastes in this area that is committed to controlled access for an indefinite time into the future. Low-level and TRU radioactive wastes are now being received from other DOE organizations for burial or storage at NTS. A considerable volume of residual waste from past atmospheric nuclear detonation tests and nuclear rocket engine tests remains on the surface at numerous inactive NTS radioactive waste management sites. This waste should be consolidated for burial at the Area 3 crater and the Area 5 radioactive waste management sites, respectively. Waste will continue to be generated by testing and research operations at NTS. (Auth) (RAP)

SITE SELECTION; WASTES, LOW-LEVEL; WASTES, TRANSURANIC; BURIAL; STORAGE, GEOLOGIC; WASTE MANAGEMENT; SITE EVALUATION; METEOROLOGY; HYDROLOGY; GEOLOGY; TRANSPORTATION; MONITORING; FIELD STUDIES

<187>
Richard, W.H., and E.L. Klepper, Battelle-Pacific Northwest Laboratories, Richland, WA.

Burial Strategies. (2)

BNWL-2033; Ecological Aspects of Decommissioning and Decontamination, (pp. 50-53), 61 pp. (BNWL-2033).(1976, June)

Decommissioning and decontamination procedures will produce large volumes of low-level waste, such as rubble from building materials. Disposal of these high-volume, low-level wastes can most effectively be done by shallow burial. Properly engineered burial potentially has the following advantages: 1) overburden provides effective shielding from ionizing radiation, 2) wastes are covered sufficiently well to prevent resuspension by wind, and 3) wastes will not be available to leaching by precipitation wastes into groundwaters. Techniques currently in use involve digging a large trench, placing wastes in the bottom of the trench and covering the wastes with backfill material which consists of a mixture of cobbles and topsoil. These techniques permit shielding and protection from resuspension by

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wind and soil water transportation by a vegetation cover. However, no barriers to root or burrowing animal penetration are provided. A modified burial technique that provides a barrier to biological invasion of wastes involves stockpiling the cobbles separate from the topsoil. Gravels are laid into the waste trench in a deep layer in order to discourage biological penetration. Sufficient soil is laid over the cobbles to hold water provided by annual precipitation. This topsoil is planted to a stable vegetation cover which will transpire the stored soil water each year and prevent wetting and leaching of the burial wastes. Other buried barriers to prevent biological invasion of buried wastes include buried asphalt or concrete layers and layers of soil treated with materials toxic to roots. Surface barriers can also be constructed. (Auth) (HT)

Burial site engineering for wastes to be produced by the decommissioning and decontamination of facilities is discussed. (DR/HT)

OVERBURDEN; PLANTS; LEACHING; PRECIPITATION, METEOROLOGICAL; GROUND WATER; SOILS; BACKFILLING; TRENCHES; BURIAL; BIOTA; WASTES, LOW-LEVEL; FIELD STUDIES; BIOLOGICAL STUDIES

<148>
Rogers, V.C., G.E. Sandquist, and J. Byrne, IPT Corporation, University of Utah, Salt Lake City, UT.

Leaching of Radioactive Materials at the Salt Lake City Uranium Mill Tailings Site. (3)

Transactions of the American Nuclear Society 21:98.(1975)

The extent of contamination to the ground was determined at the old Vitro mill site. Between the years 1951 and 1968 the mill processed 1.7 million tons of uranium ore and the tailings were distributed over 96 acres. The major hazard is the presence of Ra 226 and its daughters. Since the pile is near industrial and residential areas, a recommendation has been made to move the pile. Also, the dirt beneath the pile must be moved as a result of leaching. Core samples were taken to the depth of 9 feet in soil that is a moderately wet sand for the first 3 feet, a very wet sand-clay mixture for the next two feet, and a drier sand-clay below 5 feet. Core samples were taken in 1973 and 1975, and both showed significant activity to the depth of 5 ft. The activity was higher in the 1975 cores, and particularly in the 2 to 4 and 5 to 6 ft intervals. The increased activity is probably a reflection of additional surface and near-surface water in the region. Soil samples from the 1975 cores contained significantly more moisture than the corresponding cores from 1973. From the curves Rn 222 also had the same distribution as Ra 226. (MD)

Ra 226

RADON; CONTAMINATION; DECONTAMINATION; DISPOSAL SITE; LEACHING; CORES; SOILS; SANDS; CLAYS; TAILINGS; FIELD STUDIES; WASTES, RADIOACTIVE; WASTES, GASEOUS; SAMPLES; MOISTURE; DECOMMISSIONING

<149>
Root, R.R., and I.W. Marine, Savannah River Laboratory, Aiken, SC.

A Conceptual Geohydrological Model of the Separations Area. (3)

DP-1455; Environmental Transport and Effects Research Annual Report, 1976, T.V. Crawford (Comp.), (pp. 63-68), 256 pp. (DP-1455).(1977, May)

Subsurface drilling around the F-Area and H-Area of the Savannah River Plant confirms the existence of two areally extensive clay layers and several discontinuous clay and sand-clay layers. These clay deposits are interbedded between the beds of clayey and silty sand that make up most of the subsurface deposits. The subsurface lithology is divided into five geohydrologic units. These are, vertically downward, (1) the Barnwell Formation, consisting of sands, clayey sands and sandy clays; (2) a tan clay; (3) the McBean Formation consisting of an upper yellow clayey sand and a lower calcareous sand; (4) a green clay; and (5) the Congaree Formation consisting of fine sand layers interbedded with clay. Two geohydrological cross sections are provided. (Auth) (JT)

The areas under investigation are located to the east and west of the solid waste storage area. Correlation of wells drilled in these areas would, therefore, include the area underneath the solid waste storage area. (DR/JT)

Hydraulic Conductivity

GEOLOGY; HYDROLOGY; CLAYS; SANDS; CALCIUM CARBONATE; HYDRAULIC CONDUCTIVITY; SILTS; GEOLOGIC FORMATIONS; GRAIN SIZE DISTRIBUTION; STRATIGRAPHY; FIELD STUDIES

<150>
Routson, R.C., Battelle-Pacific Northwest Laboratories, Richland, WA.

A Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944 to 1967. (2)

BNWL-1466; 59 pp.(1973, March)

Large volumes of waste liquids were disposed of in the sediments on the Hanford Reservation during the more than twenty years of operation. The low-level wastes, 5 X 10 (E-5)uc of beta-emitters/l, were discharged to natural, low depressions such as swamps and allowed to percolate into the groundwater. Intermediate-level wastes, 5 X 10(E-5) to 100 uC/l, were placed in underground structures (cribs) to percolate through the sediment. The high-level (greater than 100 uC/l) were stored in underground tanks. The sediments in the Hanford area are thick glaciofluviatile, thin "Palouse Soil" and the Ringold Formation. The clay in these sediments contained montmorillonite, chlorite, and mica. The clay from the Ringold also had a fraction of kaolinite. Three zones of disposal were delineated; the vadose zone above 20 feet depth (unsaturated); the vadose zone below 20 feet (lower vadose zone); and the saturated

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zone. The lower vadose zone was the most desirable for waste disposal because of minimal chance of organism contact. The second most desirable zone was the saturated zone. Radionuclides normally found in the waste were Sr 90, Cs 137, Pu, Co 60, Ru 106, transition metals, rare earths, and H 3. For most of the study the maximum permissible concentration (MCP) of Sr 90 was considered to be the limiting factor. Since the lower vadose zone is where most of the long-lived radionuclides are stored, a large research effort at Hanford has been devoted to studying radionuclide retention. The three categories of research are: 1) attain maximum retention of radioactive wastes; 2) predict breakthrough of radioactive wastes into the groundwater; and 3) evaluate possible removal mechanisms of previously sorbed radionuclides. Under maximum retention ion exchange (particularly with clays), precipitation (rare earths' and transition metals' hydroxides) and replacement are considered. Also, experimental methods for sorption measurement are discussed. Prediction of breakthrough is considered empirically as well as theoretically. Possible removal mechanisms are leaching, diffusion, and particulate transport. For the saturated zone the increase in water table elevation and attendant changes in the flow system, introduction of radioactive contamination into the groundwater, and introduction of nonradioactive contaminants are considered. Some consideration is given to the upper vadose zone. (HDV)

H 3; Sr 90; Cs 137; Co 60; Pu; Ru 106; Rare Earths

ABSORPTION; ALLUVIUM; ALPHA PARTICLES; ANIMALS; ANIONS; AQUIFERS, CONFINED; ATMOSPHERE; BETA PARTICLES; BREAKTHROUGH DISTRIBUTION; CATIONS; COMPUTER PROGRAMS; CONTAINMENT; DECONTAMINATION; DISPOSAL SITE; EQUATIONS; EXHAUST GASES; GROUND WATER; HYDROLOGY; INHALATION; ION EXCHANGE CAPACITY; KAOLINITE; LABORATORY STUDIES; LEACHING; LITHOLOGY; MAXIMUM PERMISSIBLE CONCENTRATION; MODELS, MATHEMATICAL; MONTMORILLONITE; pH; PLANTS; PREDICTIONS; HALF-LIFE, RADIOLOGICAL; RARE EARTHS; RETENTION PONDS, RIVERS; SEDIMENTS; SOILS; CLAYS; SURFACE CONTAMINATION; TANKS; THEORETICAL STUDIES; UNSATURATED ZONE; WASTE DISPOSAL; WASTE STORAGE; WASTE WATER RESERVOIRS; WASTES, HIGH-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, TRANSURANIC; WATER TABLE

<151>
Routson, R.C., and D.A. Cataldo,
Battelle-Pacific Northwest Laboratories,
Richland, WA.

Tumbleweed and Cheatgrass Uptake of Technetium 99 from Five Hanford Project Soils. (3)

BNWL-2183; 16 pp.(1977, January)

Uptake of Tc 99 by tumbleweed and cheatgrass was measured for five Hanford Site soils, at initial concentrations of 1.0 pg/g of Tc 99 added to the soil as pertechnetate and traced with Tc 95m at one, two, and three month intervals. Uptake after three months was 23-82% of added Tc for tumbleweed and 10-69% for cheatgrass. The soils varied from a loamy sand to loam and had cation exchange capacities from 5 to 23.7 meq/100 g. In order of decreasing uptake of Tc by tumbleweed the soils were the Ritzville, Warden, Rupert, Burbank, and Lickskillet. Concentrations of Tc in tumbleweed shoots were from 0.06 to 0.33 ng/g and from 0.05 to 0.36 ng/g for cheatgrass shoots. Shoot concentration decreased with increasing time of harvest. This may result from the rapid depletion of soil Tc concentration following plant uptake. Concentration ratios were calculated based on estimated average soil concentration during each harvest period. Values ranged from 76 to 390 for tumbleweed and 58 to 421 for cheatgrass. Concentration ratios versus harvest time were constant for all soils except the Lickskillet, where they decreased from the first and second to the third month for both tumbleweed and cheatgrass. Possible explanations are discussed. In a separate experiment, Tc 95m activity values were increased by a factor of 50 in Burbank and Rupert soils and the uptake, shoot concentrations, and concentration ratios compared with those for the low Tc 95m concentrations. The results showed good agreement, and indicated that Tc 95m was useful as a tracer and that neither Tc toxicity nor radiation effects were factors in the initial experiment. (Auth) (LKH)

Clay Content; Ion Exchange Capacity; pH; Total Organic Carbon Content

Tc 99; Tc 95m

VEGETATION; RADIONUCLIDE MIGRATION; UPTAKE; BIOLOGICAL TRANSPORT; TECHNETIUM 99; TECHNETIUM 95m; TRACERS; SOILS; LOAM; CONCENTRATIONS; ION EXCHANGE CAPACITY; WASTE MANAGEMENT; LABORATORY STUDIES

<152>
Sanders, B., Union Carbide Corporation, Y-12 Plant, Oak Ridge, TN.

Assessment of Solid Low-Level Radioactive Waste Management. (1)

Y/DD-238; 11 pp. (1977, April 29)

Solid low-level waste management at Oak Ridge Y-12 plant is discussed. The plant lies within the 37,000 acre ERDA reservation which is in the Valley and Ridge Subregion of the Appalachain Highlands Physiographic Province. The geologic strata consist of highly deformed, unmetamorphosed, sedimentary rocks which give rise to soils (ultisol) that are relatively infertile. Streams in the reservation feed the Clinch River which in turn delivers water to the Tennessee-Ohio-Mississippi River system. Precipitation to feed the rivers falls on the average 50 to 60 inches annually. The general vegetation of the area is classified in the oak-hickory association. Oak Ridge Y-12 plant occupies 600 acres of land in Bear Creek Valley 3 miles from the city of Oak Ridge. Three burial grounds are used for disposal of radwastes at the plant. Burial Ground 1-4 is used to dispose of low-level radioactive material of low economic value such as wood, paper plastics, filters, metal drums. About 1000 tons of this waste are generated annually which uses about 0.1 acre/yr, so the area is sufficient for the next 60 years. Burial Ground 2-8 is filled with accountable, recoverable, pure depleted uranium. This type of waste is generated at the rate of about 800 tons/year and the

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burial ground will be sufficient for the next 30 years. Burial Ground 2-C takes materials contaminated with enriched uranium or natural thories and the materials are the same types in Burial Ground 1-A. With 500 tons generated annually the current area usage is 0.1 acre/year, which will be sufficient for about 50 years. All time estimates are made on the assumption of continuous usage. Another burial ground is used for classified materials which are generated at a rate of 250 tons/year and require 0.03 acre/year for disposal. From monitoring programs uranium in the drinking water is less than 2 X 10(E-7), which is well below 3 X 10(E-5) uCi/cc s. Hence, no deleterious effect on the environment has been noted. (NDV)

This is a revision; previous copy already in data base.

BURIAL; DISPOSAL SITE; DOSE RATE; ENVIRONMENT; FIELD STUDIES; GEOLOGY; HYDROLOGY; LAND USE; MAXIMUM PERMISSIBLE CONCENTRATION; METEOROLOGY; MONITORING; REVIEWS; SITE SURVEILLANCE; SOILS; TRENCHES; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID

<153>
Stearns, Conrad and Schmidt Engineers, Long Beach, CA.

Study of Engineering and Water Management Practices that will Minimize the Infiltration of Precipitation into Trenches Containing Radioactive Waste. (2)

ORP-LV-78-5; 85 pp.(1977, September 17)

A study was done to evaluate and compare existing practices in use at sanitary landfills, hazardous waste disposal facilities, and experimental burial sites, and to apply these practices to commercial low-level radioactive waste sites. Surface infiltration can be controlled with a multilayer cover: 1) a compacted soil cover over the wastes, mounded; 2) an impervious cap of clay, concrete, asphalt, plastic, or similar material; 3) a protecting layer of soil; and 4) a layer of gravel. Covers of this type would protect the wastes from surface infiltration and are themselves protected from exposure to environmental extremes and root damage from plants. Infiltration of precipitation through the surface soil between trenches and horizontally into the trenches can be minimized through the use of berms and drainage ditches to divert surface runoff; construction of impermeable curtains or other barriers could be used to inhibit horizontal water flow. Three types of recommendations are given: remedial steps that could be taken at existing sites and ongoing burial operations; new or improved practices that could be implemented during the design and operation of future site; and post-closure practices. (RAP)

TRENCHES; WASTES, LOW-LEVEL; BURIAL; INFILTRATION; SOILS; ROCKS; LEAKAGE; GROUND WATER; SURFACE WATERS; RADIONUCLIDE MIGRATION; TOPOGRAPHY; HYDROLOGY; CLAYS; CONCRETES; ASPHALTS; PLASTICS; GRAVELS; PLANTS; ROOTS; PRECIPITATION, METEOROLOGICAL; WELLS; MOISTURE; DRAINAGE; RUNOFF; FLOODING; FRACTURES; GROUTING; COMPACTION; WASTES, ORGANIC; MONITORING; SITE SURVEILLANCE; REVIEWS

<154>
Stevens, P.R., and G.D. Debuchananne, U.S. Geological Survey, Reston, VA.

Problems in Shallow Land Disposal of Solid Low-Level Radioactive Waste in the United States. (2)

Bulletin of the International Association of Engineering Geology 14:161-171.(1976)

Migration of radionuclides has been documented from 4 of the 11 principal shallow land burial sites for solid low-level wastes in the U.S.: Oak Ridge National Laboratory, Maxey Flats, Idaho National Engineering Laboratory, and Western New York Nuclear Services Center. At ORNL, burial trenches were constructed parallel to slope, often below the water table, and seeped Ba, Cs, Pu, and Sr into the watershed. Average annual concentrations of H 3 and Sr 90 measured at White Oak Dam from 1969-73 ranged from 28-56% and 114-173% respectively of the MCG's for these nuclides. Uptake by plants on the burial ground has been demonstrated, leaf litter in one case reaching 1 X 10(E+6) dpa/gm dry wt. At Maxey Flats, Kentucky, the hydrogeology is poorly understood; all of the rock units immediately under the site are aquitards. Waste burial there began in 1963. By 1972, elevated levels of Pu were detected in surface soil, soil cores 90 cm deep, monitoring wells, and streams; leachates from trenches include H 3, Mn 54, Co 60, Zn 65, Sr 89, Sr 90, Ru 106, Sb 125, I 131, Cs 134, Cs 137, Ac 228, U 239, U 238, Pu 238, and Pu 239. Radionuclide migration appears to be by surface runoff and by leachate movement through the soil and into the water table. In 1974, approximately 1700 sediment, rock, and water samples from 90 observation wells in and near the INEL burial ground were collected and tested. It was concluded from the tests that radionuclide migration had taken place as a result of infiltration of precipitation and runoff water which occasionally flooded the pits and trenches. At Western New York NSC, seepage of water through some trench covers in 1975 indicated they had become filled with water. Some seepage drained to nearby streams. Although the levels of radioactivity released were not considered hazardous, to reduce further seepage water was pumped from the trenches, filtered, and discharged. At each of the burial grounds studied, hydrogeology was complex, and in the cases of NSC, ORNL, and Maxey Flats, locations were in aquitards with high fracture porosity in humid climates. Also, at these sites seasonal fluctuations of the water table may produce trench flooding. INEL and ORNL are poorly located, the former in a topographic low subject to seasonal flooding, the latter in an area crossed by surface runoff during wet periods. (LKH)

Tables presenting a summary of the hydrogeologic conditions for both federal and commercial shallow land burial sites are included.

H 3; Sr 89; Sr 90; Ru 106; Mn 54; Zn 65; Sb 125; Co 58; Co 60; I 131; Cs 134; Cs 137; Pu 238; Pu 239; Pu 240; Zr 95; Nb 95; Po 210; Am 241; Ac 228; U 234; U 238

WASTES, LOW-LEVEL; WATER TABLE; GROUND WATER; EFFLUENTS; AQUITARD; BURIAL; DRAINAGE CHARACTERISTICS; DRAINAGE; GEOLOGY; HYDROLOGY; POLLUTION, WATER; POLLUTION, SOIL; RADIONUCLIDE MIGRATION; SITE EVALUATION; WASTES, RADIOACTIVE;

<156> CONT.
POROSITY; PERMEABILITY; SEEPAGE; REVIEWS; FIELD STUDIES; ECOLOGICAL STUDIES

<155>
Struxness, E.G., Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN.

Detailed Assessment of Solid and Liquid Waste Systems - Hazards Evaluation. (U)

Personal communication (1960, May 31)

The groume disposal operations and facilities and their effectiveness are described and assessed in terms of fission product movement out of White Oak Creek drainage area into the Clinch River. Sampling indicated that the daily gross beta values of the settling basin effluent range from 30 to 3000 c/m/ml and the corresponding values for White Oak Dam are 2 to 200 c/m/ml. Four pits are used at the Oak Ridge National Laboratory (ORNL). By using a liquid budget it was found that Pit 2 lost on the average 3900 gal/day through seepage. Since Pit 2 and 3 had been in service for some time the water table had stablized, so the permeability of the 30 feet of weathered shale was 2.9 gal/day with a gradient of 10 ft in 100. The leakage rate from Pit 2 was 3900 gal/day. Dispersion of stable chemical waste constituents and well logging are discussed. If all the nitrate discharge to the pits reaches the Clinch River it would be 0.036 ppm or 1% of the maximum permissible concentration. Waste was found to move laterally from Pits 2 and 3 at a rate of about 2 to 6 ft/day along the strike of the shale. The average concentration of Ru 106 in the streams in 1957 was 0.011 uc/ml and in 1958, 0.0087 uc/ml. It was also found that only 1 Ci/yr of Sr 90 is contributed to White Oak Creek. From studies done on these pits better locations, construction techniques, and fixation materials can be employed. The waste treatment plant handles volume ranging from 2 x 10(E+8) to 3 x 10(E+8) gal/yr containing less than 2 x 10(E-6) Ci/gal. It was found that adding clay increased the removal of Sr 90 to 94% and total rare earths to 86%. Various clay concentrations were tried with a number of different radionuclides. The burial grounds are described, but since they are used for solid radioactive wastes they contribete minor amounts of radioactivity to White Oak Creek. The distribution of fission products in the sediments of White Oak Lake and the intermediate-pond is illustrated. Losses of Sr 90 from the lake bed by solution transport were determined by leaching some of the sediment in the laboratory. Losses by sediment transport were determined from information on the mineralogical character of the sediment, the specific radionuclide affinity of minerals, and the total radionuclide activity discharge to the river. The pattern of lake bed vegetation was monitored from season to season. It was found that the pattern increased in complexity with each growing season. Also, the plants were maintaining the same concentration of radionuclides, especially Sr 90, over a period of 3 yrs. When the insect population was examined it was found that they had a larger accumulation of Cs 137 than Sr 90. The concentrations in the plants and the insects showed specific relationships and provided an interesting example of biological interplay. (MDV)

The report contains numerous tables.

Depth to Water Table; Stratigraphic Unit Thickness; Intrinsic Permeability; Hydraulic Gradient; Leakage Rate; Bulk Density; Mean Precipitation; pH; Distribution Coefficient; Percent Adsorption

Sr 90; Sr 89; Ru 106; Rare Earths; Cs 137; Zr 95; Nb 95; Ba 137; Rh 106; Y 90; Sb 125; Pm 147; Co 60; Ce 144; Po 210; Ra 903

BIOSPHERE; BURIAL; CONTAINMENT; CONTAMINATION; DAMS; DILUTION; DISPOSAL SITE; DRAINAGE BASINS; ENVIRONMENT; EVALUATION; EVAPORATION; FIELD STUDIES; FISSION PRODUCTS; FRESHWATER SYSTEMS; RADIATION, GAMMA; GROUND WATER; INSECTS; LABORATORY STUDIES; LEACHING; LEAKAGE; MAXIMUM PERMISSIBLE CONCENTRATION; MONITORING; OVERFLOWS; PERMEABILITY; pH; PONDS; POROSITY; SEASONS; SHALES; SITE EVALUATION; SEDIMENTS; STREAMS; WASTE DISPOSAL; WASTE DISPOSAL; WASTES, LIQUID; WASTES, RADIOACTIVE; WASTES, SOLID; WATER TABLE; LOGGING, WELL; WELLS; SORPTION; CLAYS; SEEPAGE PITS; ECOLOGICAL STUDIES

<156>
Tamura, T., L.D. Eyman, A.M. Stueber, and D.S. Ward, Oak Ridge National Laboratory, Oak Ridge, TN.

Progress Report of Disposal Area Studies at Oak Ridge National Laboratory: Period of October 1, 1975 to September 30, 1977. (U)

ORNL-5518; 92 pp.(1980, January)

Studies on migration of radioactive waste and preventive measures at ORNL are presented. Cobalt 60 migration from trenches 5 and 7 and pit 8 was a result of t... mobilizing agent tetramethyl ester of EDTA. It was noted that the soil did not adsorb the cobalt on the clays but on the Fe and Mg oxides and insoluble organics. The Mg-Co 60 association was the strongest of the three possible, with a correlation of 0.9570. In Solid Waste Disposal Area (SWDA) 6, two techniques for determining the annual Sr 90 discharge were compared. The two methods were the difference between the annual precipitation and evapotranspiration and stream-monitoring. Higher values were obtained using stream-monitoring. This was ascribed to a malfunctioning monitoring station. However, sources such as the flood plain of White Oak Creek, soil along the creek channel and disposal areas 1 and 3 may also be contributing Sr 90. In SWDA 5, Pu 238 and Cs 288 as well as Sr 90 were found to be leaching into the soil. To prevent further leaching, underground dams and a bentonite surface were placed in the area of the trenches. Halocarbons such as CCl3F and CBr2F2 were used to trace ground water movement at three different well-known hydrologic sites and at SWDA 6. Except for the first area, agreement was good between the tracers and the known hydrology. Expansion tests were run on the bentonite to evaluate the effectiveness of the surface seals. Ground water transport models were determined to take into account convective transport, hydrodynamic dispersion, chemical adsorption, and radioactive decay. (MDV)

Total Ion Concentration; Mean Precipitation; Specific Activity

Sr 90; Cs 288; Pu 238; Co 60

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ACIDS, ORGANIC; ADSORBENTS; BENTONITE; CLAYS; CONTAMINATION; DISPOSAL SITE; FIELD STUDIES; GROUND WATER; LABORATORY STUDIES; MODELS, MATHEMATICAL; PARTICLE SIZE; RADIONUCLIDE MIGRATION; HALOGENS; SOILS; SURFACE WATERS; WASTE MANAGEMENT; WASTES, RADIOACTIVE; MONITORING; PITS; TRENCHES; BURIAL; WASTES, SOLID

<157>
U.S. Department of Energy, Chicago Operations Office, Chicago, Illinois.

Formerly Utilized MED/AEC Sites Remedial Action Program Radiological Survey of Site A, Palos Park Forest Preserve, Chicago, Illinois - Final Report. (2)

DOE/EV-0005/7; 87 pp.(1978, April)

Site A, in the Palos Park Forest Preserve, was the location of experimental reactors CP-2 and CP-3 from 1943 to 1956, when the last operations were transferred to Argonne National Laboratory and the site razed. Plot M, a one acre burial ground for low-level waste from Site A, was decommissioned in 1956 after the entire plot was covered by a one-foot thick concrete slab and two feet of soil. In 1963, abnormal alpha and beta activities were detected in surface soil samples near Plot M; various surveys were subsequently conducted. This survey was intended to determine the reasons for elevated tritiated water concentrations in some of the wells in the Forest Preserve and whether other radionuclides have migrated from their original locations. The only significant environmental exposure pathway observed is that of tritium moving from the plot via the dolomite aquifer to individuals using picnic wells in the area; possible dose from this pathway is estimated at 0.7 mrem/yr. Time of travel through this pathway is about 20 months. Total tritium content of Plot M is on the order of 3000 Ci. No tritium has been detected in the principal waterways draining the Plot - the Illinois and Michigan Canal, Des Plaines River, and Chicago Sanitary and Ship Canal. Elevated U and Pu concentrations were found on the surface 50-200 feet north of Plot M; average values were 10 pCi/g for U and 0.2 pCi/g for Pu. Small amounts of other radionuclides have been detected in bore holes beneath the concrete cap covering Plot M, but concentrations are too low to pose a hazard. The only radionuclide in Site A samples attributable to operations at the Site is tritium; concentrations ranged from less than 0.03 pCi/g to 61.7 pCi/g. (LKH)

Total Ion Concentration

H 3; Cs 137; Co 60; Sb 125; Eu 155; Sr 90; U 234; U 235; U 238; Pu 238; Pu 239

TRITIUM; URANIUM; PLUTONIUM; WASTES, LOW-LEVEL; SITE SURVEILLANCE; ENVIRONMENTAL EXPOSURE PATHWAY; AQUIFERS; DOSE RATE; POLLUTION, SOIL; POLLUTION, WATER; RADIONUCLIDE MIGRATION; FIELD STUDIES

<158>
U.S. Public Health Service, Division of Water Supply and Pollution Control, Denver, CO.

Radiological Content of Colorado River Basin Bottom Sediments, August 1960-August 1961. (3)

PB-266 212; 62 pp.(1963, June)

Between August 1960 and August 1961, three basinwide radiological surveys of bottom sediments from the Colorado River Basin were conducted. Collections included 254 samples representing 121 sampling stations and 89 samples from 20 background stations (not influenced by uranium mining or milling). All samples were analyzed for Ra 226 content; samples collected in the first survey were also analyzed for gross alpha and gross beta. Samples were obtained by Ekman dredge, Petersen dredge, or by hand. Background Ra values were 0.6-2.1 pCi/g (1.1 pCi/g average), gross alpha background was 3.1-13 pCi/g (7.9 pCi/g average), and gross beta background was 19-84 pCi/g (48 pCi/g average). Main-stem Colorado River sediments averaged 10 pCi/g gross alpha, 43 pCi/g gross beta, and 1.7 pCi/g Ra; sediment immediately below uranium mills averaged 46 pCi/g gross alpha, 97 pCi/g gross beta, and 6.6 pCi/g Ra. Overall averages for the Colorado Basin were 13 pCi/g gross alpha, 44 pCi/g gross beta, and 2.4 pCi/g Ra. About 40% of all sediments sampled equaled background levels, and 50% were between 1 and 4.5 times background. The study shows that Lake Mead (16 pCi/g gross alpha, 55 pCi/g gross beta, 2.9 pCi/g Ra) has been the final repository for most of the contaminated sediments. Proposals for future study include analysis of bottom sediment cores from Lake Mead to determine Ra contents of sediments deposited before and after the advent of extensive uranium mining and milling, and a study of the distribution of dissolved Ra in river water, suspended and bottom sediments, and aquatic biota. (LKH)

Total Ion Concentration

Ra 226

URANIUM; MILLING; MINING; SEDIMENTS; RADIUM; WASTES, RADIOACTIVE; WASTES, INDUSTRIAL; RIVERS; DRAINAGE BASINS; POLLUTION, WATER; LEACHING; FIELD STUDIES

<159>
Weir, A.H., A.J. Francis, and P. Colombo, Brookhaven National Laboratory, Upton, NY.

Characterization of Trench Water at the Maxey Flats Low-Level Radioactive Waste Disposal Site. (2)

BNL-NUREG-22838; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Vol. 2, (pp. 747-764), 1218 pp. (BNL-NUREG-22838).(1977, May)

Currently the United States Geological Survey is conducting a study of the hydrogeological and geochemical behavior of commercially operated low-level radioactive waste disposal sites. The data collected from this study will be used to establish criteria for selection of new sites for disposal of radioactive wastes. As part of this study, water samples from trenches at the Maxey Flats, Kentucky site were analyzed at Brookhaven National Laboratory to determine the source terms of the radionuclides and other components in solution in the trenches. Procedures for collection and filtration of

<159> CONT.
the samples under anoxic conditions are described. The samples were analyzed for inorganic, radiochemical, and organic constituents. The inorganic analysis includes the measurements of pH, specific conductance, alkalinity, and various cations and anions. The radionuclides were measured by the gross alpha, gross beta, tritium, and gamma activities, followed by specific measurements of strontium 90 and plutonium isotopes. The organics were extracted, concentrated, and identified by gas chromatography/mass spectrometry. Considerable quantities of organics were detected in all of the trench waters sampled. Specific organics were found in most of the trenches; however, the organic composition of the trench waters vary. The presence of a variety of organic compounds in trench water suggest that they may play an important role in the transport of radionuclides. (Auth)

Sixty-one organic compounds identified in trench water samples are listed in tabular form.

pH; Specific Conductance

Am 241; Cs 137; Cs 134; Ba 50; Zn 65; Na 22; Co 60; H 3; Sr 90; Pu 238; Pu 239; Pu 240

WASTES, LOW-LEVEL; TRENCHES; WASTE DISPOSAL; SITE SURVEILLANCE; WATER; SAMPLES; FILTRATION; ORGANIC COMPOUNDS; pH; MINERALS; SPECIFIC CONDUCTANCE; ALKALINITY; ANIONS; CATIONS; ALPHA PARTICLES; BETA PARTICLES; TRITIUM; RADIATION, GAMMA; STRONTIUM 90; SEPARATION PROCESSES; SPECTROMETRY; TEMPERATURE; CHEMICAL ANALYSIS; RADIOCHEMISTRY; RESIDUES; CALCIUM; IRON; LITHIUM; MAGNESIUM; MANGANESE; POTASSIUM; SODIUM; PLUTONIUM 238; PLUTONIUM 239; PLUTONIUM 240; AMERICIUM 241; CESIUM 137; MANGANESE 54; ZINC 65; SODIUM 22; COBALT 60; LEACHATES; RADIONUCLIDE MIGRATION; FIELD STUDIES

<160>
Weiss, R.J., A.J. Francis, and P. Colombo, Brookhaven National Laboratory, Upton, NY.

Study of Trench Water at Low-Level Radioactive Waste Disposal Sites. (2)

CONF-780622; American Nuclear Society Annual Meeting, Proceedings of a Symposium, San Diego, CA, June 18-22, 1978, (p. 77)(CONF-780622); Transactions of the American Nuclear Society 28:77.(1978, June)

The U.S. Geological Survey has been assigned the task of collecting data for developing criteria for the selection of new shallow land burial sites. As part of this effort, Brookhaven National Laboratory is conducting a study to characterize trench waters at various existing disposal sites. Goals are to define source terms of radionuclides and other solutes, to detect and characterize the radionuclides along groundwater flow paths, and to describe physical-chemical and biological properties that control radionuclide movement in the ground. Samples have been collected from Maxey Flats, KY, and West Valley, NY, under anoxic conditions and have been analyzed for pH, Eh, specific conductivity, DOC, major anions and cations, gross alpha, gross beta, H 3, gamma scan, Sr 90, and Pu isotopes. Results show that there are large differences in the composition of water from different trenches. H 3 concentrations of 2 x 10(E+5)-7 x 10(E+9) pCi/l were found in all samples; Co 60, Sr 90, and Cs 137 were found in most samples, and Pu [concentration up to 2 x 10(E+4) pCi/l] was found in several samples. Considerable quantities (up to 6000 mg/l) of dissolved organics, mainly alcohols, aliphatic and aromatic acids, phthalates, adipates, and tributyl phosphate were found in trench waters. Also isolated were colonies of both aerobic and anaerobic (mostly facultative) bacteria. Preliminary experiments for measuring batch Kd's of selected radionuclides under anoxic conditions have been designed and are being conducted on trench water and soil samples. (LKH)

Total Ion Concentration

H 3; Sr 90; Co 60; Cs 137; Pu

DISPOSAL SITE; TRENCHES; SURFACE WATERS; GROUND WATER; CHEMICAL PROPERTIES; PHYSICAL PROPERTIES; RADIONUCLIDE MIGRATION; pH; Eh; CATIONS; ANIONS; TRITIUM; RADIOACTIVITY; STRONTIUM; PLUTONIUM ISOTOPES; ORGANIC COMPOUNDS; ACIDS; BACTERIA; SOILS; SAMPLES; DISTRIBUTION COEFFICIENT; WASTES, LOW-LEVEL; WASTE DISPOSAL; FIELD STUDIES; LABORATORY STUDIES

<161>
West, S.W., U.S. Geological Survey, Albuquerque, NM.

Disposal of Uranium Mill Effluent Near Grants, New Mexico. (3)

Geological Survey Professional Paper 424-D; Geologic Survey Research 1961, (pp. D-376 - D-379).(1961)

Disposal of uranium mill effluent at the Anaconda Company Bluewater Mill, 9 mi NW of Grants, NM, became a problem soon after the mill was constructed in 1952. Radioactive contaminants in the waste typically include 2.83 x 10(E-8) uCi/ml gross alpha, 1.61 x 10(E-5) uCi/ml natural U, 2.70 x 10(E-8) uCi/ml Th 230, and 6.62 x 10(E-7) uCi/ml Ra 226; other significant chemical constituents include 1350 ppm Cl, 6650 ppm SO4, 1050 ppm Na, and 100 ppm NO3. Surface methods of disposal were found to be hazardous to the potable ground water, so injection of the waste into an unused non-potable aquifer below the main aquifers was investigated, with the assistance of the U.S. Geological Survey and the State Engineer. Principal aquifers in the region are the San Andres Limestone, the underlying Glorieta Sandstone (both Permian), and alluvium and basalt (Quaternary) along the Rio San Jose. A disposal well was drilled to a depth of 2511 ft and cored continuously below 885 ft; the injection interval was between 950 and 1823 ft in the Meseta Blanca and San Ysidro members of the Yeso Formation, with selected zones in that interval non-perforated. Layers of sandstone, limestone, anhydrite, and gypsum from 638 to 950 ft act as a barrier to the upward flow of waste fluids. An initial injection test indicated that vertical leakage is negligible, but that one or more faults in the area create barriers to lateral migration, possibly leading to buildup of pressure in the disposal zone. Possible effects were not measurable due to halts in injection at critical times. Indications are that the well will not take more than 1000 gal/min by gravity injection; apparent coefficient of transmissibility of the sandstones in the lower Yeso is 10,000

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DISPOSAL SITE

<161> COST.
gal/day/ft. Routine injection of mill effluent began December 1960. (LKH)

Depth to Water Table; Stratigraphic Unit Thickness; Transmissivity

WELLS, INJECTION; URANIUM; MILLS; EFFLUENTS, LIQUID; AQUIFERS; HYDROLOGY; GEOLOGY; STRATIGRAPHY; CORES; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, LIQUID; FAULTS; FIELD STUDIES

<162>
Western, A.W., D.H. Hall, and J.S. Coogan, Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV; Environmental Monitoring and Support Laboratory, Las Vegas, NV.

Deepwell Disposal of Transuranic Contaminated Liquid Waste at the Nevada Test Site. (2)

CONF-761020; Waste Management '76, R.G. Post (Ed.), Proceedings of a Symposium, Tucson, AZ, October 3-6, 1976, (pp. 188-199), 370 pp. (CONF-761020).(1976, October)

This paper discusses the disposal of low-level liquid wastes at the Nevada Test Site (Yucca Flat) via injection into an old nuclear weapons detonation cavity. Since the total fission product of testing at the Yucca Flat area prior to July 1975 was over 1.9 X 10(E+8) Ci plus 5.6 X 10(E+6) Ci in activation products, the effects of added low-level wastes are felt to be almost unmeasurable. Low-level liquid transuranic wastes (mostly Pu 238) generated by the ERDA experimental farm near the northern boundary of NTS are collected in a 25,000 gal holding tank until they can be transported by tank truck to the disposal well. Routine environmental monitoring is carried out by the already existing NTS surveillance program, including 23 continuous air sampling and 51 ground and surface water sampling sites. The hydrogeology of the Yucca Flat Basin has been extensively studied by the USGS. Estimated time of passage for groundwater through the Cenozoic tuffs underlying the NTS, into the underlying aquifer, and into the Amargosa Valley where it is used in agriculture, is from several thousand to about 2 million yrs. Approximately 25,000 gal of contaminated water has been pumped down hole so far. (LKH)

WELLS, INJECTION; WASTES, TRANSURANIC; WASTES, LIQUID; EXPLOSIONS, NUCLEAR; CAVITIES; WASTES, LOW-LEVEL; WASTE DISPOSAL; PLUTONIUM; HYDROLOGY; AQUIFERS; RADIONUCLIDE MIGRATION; FIELD STUDIES; PREDICTIONS

<163>
Ahlstrom, S.W., H.J. Serne, B.C. Bontson, and W.H. Cearlock, Battelle-Pacific Northwest Laboratories, Richland, WA.

Methods for Estimating Transport Model Parameters for Regional Groundwater Systems. (U)

BNWL-1717; 15 pp.(1974)

This report describes methods developed for estimation of dispersion and sorption coefficients for soils on a regional scale, by means of their correlations with easily measurable soil parameters. In this paper, permeability was chosen as the independent variable for the saturated zone of the Hanford aquifer. Experimental data for derivation of dispersion coefficients were obtained from column studies of lysimeter and tank farm soil samples conducted in a previous investigation. Dispersion coefficients from these studies were 0.820-0.0037 cm(E+2)/min for tank soil and 0.0029-0.0040 cm(E+2)/min for lysimeter soil. Seepage velocities were 0.220-0.00868 cm/min in tank farm soil and 0.095-0.109 cm/min in lysimeter soil. A second study, of the distribution of Sr sorption coefficients, used data from 5 test wells. Transmissibility values from 60 to 2.5 X 10(E+5) ft(E+2)/day and permeabilities from 3.46 to 1300 ft/day were obtained in these wells. The data collected were correlated via linear regression analysis using a specially developed computer program, DISPER. Sixty-four percent of the variation in the Sr sorption coefficient was accounted for by variability in the corrected permeability. Maps of dispersion and sorption coefficient distributions are given. (LEM)

Permeability; Seepage Velocity; Transmissivity

Sr 90

COMPUTER PROGRAMS; MODELS; SORPTION; THEORETICAL STUDIES; EQUATIONS; MAPS; DISPERSION; AQUIFERS; SOILS; SATURATED ZONE; GROUND WATER; SEEPAGE; STRONTIUM; TRANSMISSIVITY; SORPTION

<164>
Miles, L.S., R.L. Caldwell, and W.B. Mills, Socony Mobil Oil Company, Inc., Dallas, TX.

Borehole Models for Nuclear Logging. (U)

Society of Petroleum Engineers Journal, 109-112.(1965, June)

It is concluded that heterogeneous borehole models are best suited for general use if variability in porosity as well as in borehole and formation fluids is required. If simplicity is essential a lattice-type model with removable rods for porosity change is superior to the layered model of Fokhrenko. The lattice-type model was used to simulated sandstone formations. Details of model construction are given. Results of steady-state measurement of thermal neutron count rate as a function of source-detector spacing are presented. (CAB)

A review and discussion of borehole geophysical modeling and testing. (DH/CAB)

BOREHOLES; GEOPHYSICAL SURVEYS; MODELS; POROSITY; GEOLOGIC FORMATIONS; MOISTURE; HYDRAULIC FLOW; GROUND WATER; SANDSTONES; THEORETICAL STUDIES

<165>
Anders, O.U., Dow Chemical Company, Analytical Laboratories, Midland, MI.

Low-Level Solidified Waste Characterization: The Scientific Basis for Physical and Chemical Testing. (U)

CONF-791129; Science Underlying Radioactive Waste Management, Proceedings of a Symposium, Boston, MA, November 26-December 1, 1978. (pp. 30-35), 77 pp. (CONF-791129-).(1979)

A discussion of the effects of specified parameters and a testing program for characterization of solid low-level radwaste is presented. Parameters considered are: leachability; environmental, chemical and heat stability; strength; specific radioactivity; radiation stability; specific gravity; uniformity; shape and size. The testing program is designed to generate performance criteria under "the worst possible conditions", as well as the "most likely case". A case is made for the need to standardize the testing for the various parameters and to develop guidelines for the determination of acceptable values of each parameter. (BDH)

A table presenting various material characteristics of solid, low-level waste is included. Listed in another table are the environmental forces active at a disposal site.

WASTES, LOW-LEVEL; WASTES, SOLID; LEACHING; ENVIRONMENT; PHYSICAL PROPERTIES; CHEMICAL PROPERTIES; EVALUATION; PREDICTIONS; LABORATORY STUDIES; REVIEWS

<166>
Koyasu, I., H. Yamamoto, and T. Inoue, Kyoto University, Department of Sanitary Engineering, Kyoto, Japan.

Evaluation of the Radioactive Wastes Disposal into the Deep Ocean. (U)

Health Physics 33:227-240. (1977, September)

A hazard assessment is given for deep sea disposal of low-level radioactive solid wastes which originate from nuclear power reactors in Japan. The model takes account of leaching characteristics of radionuclides from wastes solidified with cement. Two radionuclides, Cs 137 and Co 60, with typically different leaching characteristics were selected for the evaluation of the model. Maximum and average concentrations of the radionuclides in an upper mixed ocean layer were estimated and maximum doses for individuals and population doses for Japanese people were calculated. In order to evaluate an uncertainty of parameters in the model, a sensitivity analysis was performed. The discussions include: which parameter in an equation of the model most affects the average concentration of radionuclides in upper mixed layer and, to what degree the fluctuation of parameters due to the variation of environmental factors affects the concentration. Generally, the most sensitive parameter is the depth of the sea where the solidified wastes would be deposited. The concentration of

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ENVIRONMENTAL TRANSPORT

<166> CONT.
radionuclides in the surface water is not sensitively affected by the vertical diffusion coefficient. (Auth) (RAP)

Activity concentrations of Cs 137 and Co 60 in the surface ocean layer and calculated population doses are given in tables; two graphs show the concentration distributions in surface layers.

WASTE DISPOSAL; HAZARD ANALYSIS; WASTES, LOW-LEVEL; MODELS; LEACHING; CEMENTS; SOLIDIFICATION; WASTES, SOLID; RADIATION DOSE; EXPOSURE, INTERNAL; INGESTION; MAN; EXPOSURE, POPULATION; DEPTH; SURFACE WATERS; DIFFUSION; EQUATIONS; CONCENTRATIONS; CESIUM 137; COBALT 60; SEA DISPOSAL; THEORETICAL STUDIES

<167>
Baetsle, L., and P. Dejonghe, CEN, Mol, Belgium.

Investigations on the Movement of Radioactive Substances in the Ground. Part 3. Practical Aspects of the Program and Physiochemical Considerations. (1)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 198-210), 635 pp. (TID-7628). (1962, March)

This paper presents a continuation of experiments to simulate natural soil and groundwater conditions at a shallow land burial site in a populous area in order to determine migration and adsorption of radionuclides in solution. Testing was done on soils and groundwater to determine those parameters to be incorporated in the laboratory experiments. It was found that scraping away a near-surface organic layer for installation of storage tanks and burial of drums will drastically reduce strontium 90 adsorption capacity. Insolubilization tests were then required to reduce the possibility that strontium might reach the natural environment with its impaired ability to adsorb the strontium. Distribution coefficients are given for Cs, Sr, and Eu in different chemical media, e.g., demineralized water, tap water, and ground water. For demineralized water at a pH of 8 for Sr and Cs and a pH of 3 for Eu, the Kd values ranged from 0.6 to 22 ml/g (Sr), 28.0 to 226.0 ml/g (Cs), and 0.0 to 288.0 ml/g (Eu). Tap water at pH 7.7 for Sr and Cs and at pH 3 and 7.7 for Eu showed values ranging from 1.7-39.0 ml/g (Sr), 22.0-318.0 ml/g (Cs), 0.0-228.0 ml/g (Eu at pH 3), and 228.0-801.0 ml/g (Eu at pH 7.7). In ground water the distribution coefficients of Cs at pH 8 and pH 3 were 2.3 to 35.0 ml/g and 1.8 to 12.0 ml/g, respectively. Mean values for Cs at pH 8 = 11.8 with a standard deviation of 6.1 and at pH 3, Kd amounts to 5.2 with a standard deviation of 2.36. Sr showed Kd values of 0.81 to 160.0 ml/g at pH 7, and showed no absorption at pH 3. Europium Kd's ranged from 0.0 to 3100.0 ml/g for pH 8 and 17.0 to 290.0 ml/g for pH 3. The mean relative velocities for Cs, Sr, and Eu with respect to the ground water velocity were calculated at pH 8 and pH 3. Cesium had relative velocities of 0.021 at pH 8 and 0.004 for pH 3. Strontium values were 0.31 at pH 8 (static conditon), 0.184 (dynamic condition), and 1.0 at pH 3. Europium registered 0.0 for pH 8 and 0.0083 at pH 3. The daily leaching rate was 10(E-6) g/sq cm/day. (CAB) (CSP)

Continuation of a detailed study of a prospective shallow land burial site. (DS/CAB)

Distribution Coefficient; pH; Leaching Rate

Sr; Cs; Eu

SAMPLES; GROUND WATER; CHEMICAL ANALYSIS; SOILS; UNSATURATED ZONE; RADIONUCLIDE MIGRATION; ADSORPTION; DISTRIBUTION COEFFICIENT; pH; WATER; FRESHWATER SYSTEMS; LABORATORY STUDIES; SOIL TRANSPORT

<168>
Baker, D.A., J.E. Soldat, and B.C. Watson, Battelle-Pacific Northwest Laboratories, Richland, WA.

Population Dose Commitment Due to Radioactive Releases from Nuclear Power Plant Sites in 1975. (3)

PNL-2433; 127 pp. (1977, October)

Population radiation dose commitments have been estimated from reported radionuclide releases from commercial power reactors operating during 1975. Fifty-year dose commitments from one year exposure were calculated from both liquid and atmospheric releases for four population groups - infant, child, teenager, and adult - residing between 2 and 80 km from each site. Results are given in the form of tables showing the dose commitments for both liquid and airborne pathways for each age group and organ. Also included for each site is a histogram showing the fraction of the total population within the 2 to 80 km region around each site receiving various average dose commitments from the airborne pathways. 39 sites and 53 reactors were studied. The arithmetic mean for total dose from liquid pathways was 2.0 person-rem per site, and the mean for airborne pathways was 33 person-rem per site. Total dose commitments for all sites for 1975 are estimated at 76 person-rem via liquid pathways and 1300 person-rem via the airborne pathways. Doses from liquid pathways ranged from zero and near-zero for Monticello, MN and Dresden, IL releases to 16 person-rem for Quad-City, IL and 18 person-rem for Nine Mile Point, NY, mainly from Cs 134 and Cs 137. Doses from airborne pathways ranged from 3 X 10(E-5) person-rem for Cook, MI to 750 person-rem at Millstone Point, CT and 360 person-rem at Dresden; major contributors at these sites were Xe 133, Xe 135, and Kr 88. This study yields an average individual dose commitment of 0.02 millirem. (Auth) (LKH)

Cs 137; Cs 134; Xe 133; Xe 135; Kr 88

DOSE COMMITMENT; NUCLEAR FACILITIES; REACTORS; EFFLUENTS, AIRBORNE; ENVIRONMENTAL EXPOSURE PATHWAY; EFFLUENTS, LIQUID; WASTES, RADIOACTIVE; WASTES, INDUSTRIAL; RADIONUCLIDE MIGRATION; FIELD STUDIES

<169>
Barber, G., and Y. (Translator) Nugent, Station Centrale d'Agronomie, Versailles, France.

Radioelement Infiltration Forecast at the Line of the Ploughed Layer in Agricultural Soils. (2)

<169> COST.
ORNL-tr-4637; Retention and Migration of Radioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962, (11 pp.) (ORNL-tr-4637). (1963)

Infiltration of radionuclides in agricultural soils and forecasting their movement in the soils are discussed. Sorption of radionuclides may increase for a short period due to grasses and trees or decrease over a long period once the elements are in the subsoil. It is difficult to forecast Sr 90 and Cs 137 when no in situ data is available on normally cultivated soils. However, an estimate of how much of each radioelement migrates each year in the uppermost subsoil from a ploughed layer whose vertical distribution of radioelements is uniform may be made. In sandy soils with low exchange capacities the ratio representing Sr 90/exchangeable Ca in the soil, as well as the Sr 90/Ca ratio in plants would at first be greater than in argillaceous soils. This is assuming a large amount of exchangeable Ca in the argillaceous soil and the contamination patterns in the two soils are identical. However, losses of Sr 90 due to drainage would be more intense in sandy soil. It appears difficult to forecast which soil would have a higher accumulation line. Another problem in forecasting arises when water with a high CaCO3 content is used for irrigation; Sr 90 is accumulated in an exchangeable form without any rise in the exchangeable Ca level. Root attack may cause a dilution of Sr 90 in an additional amount of diffusible Ca. But the attack is not uniform and can not be taken into account when setting the norms for the maximum permissible contamination pattern before an in depth study can be done. (MDV)

Sr 90; Cs 137

SORPTION; AGRICULTURE; REVIEWS; CALCIUM; CONTAMINATION; DISTRIBUTION; INFILTRATION; IRRIGATION; PREDICTIONS; RADIONUCLIDE MIGRATION; SOILS; UPTAKE; WATER TABLE

<170>
Bondietti, E.A., Oak Ridge National Laboratory, Oak Ridge, TN.

Actinide Elements in Aquatic and Terrestrial Environments. (1)

ORNL-5504; Environmental Sciences Division Annual Progress Report for Period Ending September 30, 1978, (pp. 49-64), 197 pp. (1979, April)

A major emphasis of research at the Environmental Sciences Division on the actinide elements for the past two years has centered on Pond 3513, the former (up to 1975) final waste settling basin for Oak Ridge National Laboratory. While a complete interpretation of the behavior of the actinides in the pond still requires additional data, several important patterns appear. First, U concentration in the soluble phase is similar to other natural, hard water systems with closed drainages. This indicates that the *aqueous phase* of the pond is at equilibrium with U in the sediment, although the exact nature of the factors controlling solution levels are unknown. While soluble U concentrations averaged 1.9 X 10(E-6) mM, Pu, Am, and Cm concentrations were 10(E+6) to 10(E+8) lower. Plutonium concentrations averaged 9.5 X 10(E-11) mM, while Am and Cm concentrations were both about 2 X 10(E-12) mM. The Am(III) and Cm(III) molar concentrations were almost identical while Cm/Am radioactivity ratios were about 23/1. The average Pu concentration was only a factor of 3 lower than the value predicted by water solubility. Surprisingly, Am and Cm mass levels were lower than Pu levels. In addition to the abiotic data on Pond 3513, data for aquatic and terrestrial biota are being established. Small mammals from the pond's shoreline and frogs from the pond showed that relative to sediment or shoreline soils, Am and Cm are enriched over Pu in internal tissues. An ongoing study of fish accumulations of actinides indicates that fish with direct contact with the sediments contain more actinides than fish physically isolated from the sediment but in contact with the pond water column. One use of the comparative metabolism data being obtained is to estimate dose to bone from chronic exposure to Pu contaminated soil. In previous comparisons of Pu and Th in the White Oak Creek floodplain, the accumulation behavior by small mammals relative to soil was very similar. Consequently, if it is assumed that the lifetime accumulation of Pu from contaminated soil would be comparable to natural Th, and that appropriate dose calculations can be made. When the EPA-proposed soil Pu screening level of 0.2 uCi/sq m (top 1 cm depth) was applied to the results of a literature evaluation which indicated that people accumulate in 1 g of bone ash, 0.2% of the Th 232 in 1 g of "typical soil", a maximum dose rate of 1.7 mrad/yr from Pu0 was found to be accrued in skeletons of individuals exposed throughout their lifetimes. This dose rate is below the 3 mrad/yr EPA guideline. Comparative plant uptake behavior of Pu, Am, Th, and U from soil contaminated with these elements has also been studied since 1966. Results show that U is more available to plants than Th, Pu, and Am. Studies under greenhouse conditions demonstrate similar trends. In a study comparing plant uptake of added transuranics (Pu 239, Cm 244) with indigenous transuranics (Pu 239, Am 241), it was found that about two years were needed before freshly added isotopes showed similar uptake to isotopes present in soil for 35 years. (Auth) (LKH)

Total Ion Concentration

Pu 238; Cm 244; Pu 239; Am 241; Th 232; U

ACTINIDES; PONDS; URANIUM; PLUTONIUM; AMERICIUM 241; CURIUM; BIOTA; MAMMALS; AMPHIBIANS; SEDIMENTS; SOILS; FISH; ENVIRONMENTAL EXPOSURE PATHWAY; RADIONUCLIDE MIGRATION; SETTLING PONDS; RADIATION DOSE; UPTAKE; THORIUM; PLANTS; TRANSURANICS; ISOTOPES; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; ENVIRONMENT; FIELD STUDIES; LABORATORY STUDIES; MAN; ECOSYSTEMS; AQUATIC, ECOSYSTEMS, TERRESTRIAL

<171>
Booth, R.S., Oak Ridge National Laboratory, Oak Ridge, TN.

A Systems Analysis Model for Calculating Radionuclide Transport Between Receiving Waters and Bottom Sediments. (3)

ORNL-TM-4751; 33 pp. (1975, April)

ENVIRONMENTAL TRANSPORT

<171> CONT.
A four-compartment systems analysis model was developed to predict dynamic transfer between receiving water and bottom sediment for up to 60 radionuclides. The model was used to generate two tables, one providing factors by which observed equilibrium radionuclide concentrations in water can be multiplied to correct transfer to sediments, the other containing ratios of equilibrium radionuclide concentrations in sediments divided by the corresponding receiving water concentrations; this second table can be used to calculate external doses to man from fishing, snabathing, and alike. Dow to shortage of hard data, some numerical values for parameters had to be inferred from experimental procedures or durations of experiments, and some have the same value for every radionuclide and are independent of environmental conditions because no data are available. Therefore, the results presented are in the form of a sensitivity study. Results indicate that neglect of sediment interactions produces an overestimate of the total potential dose to man by overestimating receiving water concentrations, which in turn overestimates potential doses from major pathways (drinking water or eating fish) directly relating to the receiving water concentration. This would not be the case where exposure to radionuclides in sediments is the critical pathway. The results for Cs 137 show that neglecting sediment interactions could result in potential doses approximately 4 times too high form Cs 137 in potable water and edible fish from lakes in the northeast. In addition, increasing the Kd value of a sediment from 27,000 to 270,000, which reflects measured variations between various freshwater environments, increases this factor from approximately 4 to approximately 25. (LKH)

MODELS; MODELS, MATHEMATICAL; RADIONUCLIDES; CONCENTRATION FACTORS; CRITICAL PATHWAY; EQUATIONS; EQUILIBRIUM CONSTANT; EXPOSURE, EXTERNAL; EXPOSURE, INTERNAL; RADIONUCLIDE MIGRATION; SEDIMENTS; SURFACE WATERS; THEORETICAL STUDIES

<172>
Bourg, A.C.M., and R.H. Filby, Washington State University, Trace Element Laboratory, Nuclear Radiation Center, Pullman, WA.

Isotopic Exchange of Zinc 65 with Stable Zinc Adsorbed on Reference Clay Minerals. (3)

Geochimica et Cosmochimica Acta 40:1573-1578.(1976)

The distribution of stable zinc between clay and water phases was determined for samples of illite, montmorillonite, and kaolinite of low organic content using Zn 65 as a tracer. The minerals were studied without separation into fractions of various particle size. All particles were larger than 0.1 um in diameter. Ratios of Zn 65 (II) specific activities in the solid phase to that in the aqueous phase were 0.84 + or - 0.17 for illite, 1.18 + or - 0.33 for montmorillonite, and 1.07 + or - 0.28 for kaolinite (95% confidence limit). Thus for each clay, after shaking for 1 hr, the specific activity of the solid phase was equal (at the 95% confidence limit) to that of the aqueous phase. Zinc in solution is in equilibrium with zinc adsorbed on the clay particles; from the standpoint of this type of test, the specific activity approach to the transport of Zn 65 (II) at the water reference clay interface is valid. The results of this study are additional evidence that observed changes in Zn 65 specific activity at the sediment-water interface are due to factors other than the mineral itself. Commonly accepted causes of such changes are the presence of stable zinc in forms other than Zn (II) in the aqueous phase, and the presence of organic matter in the sediments. (LKH)

Zn 65

ZINC; CLAYS; ILLITE; MONTMORILLONITE; KAOLINITE; TRACERS; ADSORPTION; RADIONUCLIDE MIGRATION; DISTRIBUTION; LABORATORY STUDIES

<173>
Bredehoeft, J.D., and G.F. Pinder, U.S. Geological Survey, Lakewood, CO; U.S. Geological Survey, Arlington, VA.

Mass Transport in Flowing Groundwater. (2)

Water Resources Research 9(1):194-210. (1973, February)

The mass transport equation and the equation of motion have been coupled and solved numerically using finite difference techniques for a saturated isothermal groundwater system in which there are no chemical reactions. A case history of groundwater contamination at Brunswick, Georgia, illustrates the use of this physical chemical model in predicting and controlling the future movement of contaminants. The principal artesian aquifer in the Brunswick area is composed of permeable zones in the Ocala and underlying limestones of Claiborne age. Three of these zones are: upper water-bearing zone, which is approximately 100 ft thick and generally contains freshwater; the lower water-bearing zone, which ranges in thickness from approximately 20 to 100 ft and which generally contains freshwater; and the brackish water zone, which underlies the lower zone. The extent of the aquifer is virtually unknown. (Auth) (CSF)

One of the first widely used formulations of mass transport equations in porous media. It is clear and comprehensive. A very useful case history is included. (DH/GO)

ADVECTION; DISPERSIVITY; COMPUTER CODES; SATURATION; AQUIFERS, CONFINED; GROUND WATER; CONTAMINATION; CONTAMINANT TRANSPORT; THEORETICAL STUDIES; EQUATIONS; MAPS; MODELS, MATHEMATICAL; MASS BALANCE; WATER TABLE; GEOLOGIC FORMATIONS

<174>
Brown, D.J., Isochem, Inc., Richland, WA.

Migration Characteristics of Radionuclides through Sediments Underlying the Hanford Reservation. (2)

CONF-670512; STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria (pp. 215-228, 666 pp.

<174> CONT.
(CONF-670512, STI/PUB/156). (1967, June)

The migration characteristics and spatial distribution of radionuclides in the sediments underlying the Hanford Reservation were determined from field monitoring and laboratory studies. Sediment samples that were obtained by core drilling a low-intermediate-level radioactive liquid waste disposal facility at the time of its decommissioning, and repeated ten years later, showed over 99.9% of the long-lived radionuclides to be contained within the upper ten meters of the 60 meter thick vadose zone underlying the facility. All radionuclides with half lives of less than one year, except ruthenium 103 and strontium 90, decayed to below minimum detectable limits before they reached the regional groundwater table. The relative permanency of fixation of the long-lived radionuclides was attested to by laboratory leaching studies. Equilibrium coefficient and soil column tests indicated that the trace amounts of strontium 90 and cesium 137 that were leached from sediments underlying the disposal facility were resorbed in the saturated zone below the water table. Ruthenium 106, technetium 99, and tritium were not readily sorbed on sediments. The movement of these nuclides was traced for distances of up to fifteen miles by routine analysis of well water samples. (Auth) (RT)

This study of radionuclide migration characteristics in the sediments underlying the Hanford Reservation could have applications in predicting similar migration properties of waste nuclides at other low-intermediate-level radioactive liquid disposal sites. (DR/RT)

Distribution Coefficient

Sr 90; Cs 137; Ru 106; Co 60; I 125; C 14

RADIONUCLIDE MIGRATION; DISTRIBUTION COEFFICIENT; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; SEDIMENTS; VADOSE ZONE; RUTHENIUM; STRONTIUM; TECHNETIUM; TRITIUM; CESIUM; COBALT; IODINE; CARBON; RADIONUCLIDES; FIELD STUDIES; LABORATORY STUDIES

<175>
Christenson, C.W., and R.G. Thomas, Los Alamos Scientific Laboratory, Los Alamos, NM.

Movement of Plutonium through Los Alamos Tuff. (2)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 268-281), 635 pp. (TID-7628). (1962, March)

Ammoni: citrate and other plutonium bearing waste solutions were disposed of in seepage pits at Los Alamos Scientific Laboratory beginning during the work on the Manhattan Project. This practice was carried on into four pits regularly up until 1952. The results of a detailed coring, liquid sampling, and volumetric moisture content study are presented in this report. A thirty foot deep investigation pit was constructed nearby the former pits and horizontal three inch holes were drilled from the pit to locations coinciding with the center of a former seepage pit. Core samples taken from these holes were analyzed for gross alpha activity. The holes were cased with 2 1/4 inch plastic pipe and ground tuff was backfilled into the annular space by air injection and the holes were sealed at the ends along the outside of the casing. At each selected depth a pair of holes were drilled: one for installation of a moisture probe, the other for the installation of a vacuum cup sampling device designed to evacuate moisture from the region surrounding the holes. The results of the alpha activity investigation revealed that the alpha activity in general decreased with increasing depth of 20 feet largely through fractures in the tuff. Localized alpha activity anomalies were found to be associated with crevices in the tuff. The results of the moisture study presented in tabular form substantiates the observation that flow of waste solutions at depth occur chiefly along fractures and crevices in the tuff. Tap water and waste solutions were added to the pits for experimentation purposes during the study. (JC)

The report presents detailed volumetric moisture data in the vicinity of the Los Alamos Scientific Laboratory waste burial site and provides insight as to the nature of subsurface plutonium migration. (DR/JC)

Hydraulic Conductivity; Ion Exchange Capacity; Volumetric Water Content

PLUTONIUM; SOILS; TUFFS; CLAYS; GEOLOGY; WASTES, RADIOACTIVE; SEEPAGE PITS; PERMEABILITY; RADIONUCLIDE MIGRATION; SITE EVALUATION; HYDROLOGY; UNSATURATED ZONE; FRACTURES; FIELD STUDIES

<176>
Dotson, W.L., and D.E. Peterson, Hanford Engineering Development Laboratory, Westinghouse Hanford Company, Richland, WA.

Tennessee and Cumberland River Basins Radionuclide Transport - A Case Study. (3)

HEDL-SA-1087; CONF-760622; Proceedings of an American Nuclear Society Conference, Toronto, Ontario, Canada, June 13-18, 1976, (3 pp.). (1976)

Hanford Engineering Development Laboratory has developed a computer code to simulate the elements of radionuclide transport in order to evaluate the cumulative environmental impact of nuclear facilities in or near the year 2000, and has applied it to the Tennessee and Cumberland River basins. Factors considered include: plume rise and stack height, plume depletion processes, dry and wet deposition, decay rates, surface deposition and long-term build-up, estimates of radionuclide burdens associated with suspended sediment, sediment deposition, dissolved ions, as well as concentrations in local lakes, ponds, reservoirs, and locally recharged shallow groundwater. The results indicate radiation doses and dose commitments lower than those encountered in nature. (LWH)

MODELS; MODELS, MATHEMATICAL; COMPUTER CODES; DOSE COMMITMENTS; BASINS, DRAINAGE; HYDROLOGY; RADIONUCLIDE MIGRATION; ATMOSPHERE; RIVERS; SEDIMENTS; LAKES; SURFACE WATERS; THEORETICAL STUDIES; ENVIRONMENTAL IMPACTS; EFFLUENTS, AIRBORNE; DEPOSITION; GROUND WATER; CONCENTRATIONS; RADIATION DOSE; PREDICTIONS

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ENVIRONMENTAL TRANSPORT

<177>
Duguid, J.O., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Hydrologic Transport of Radionuclides from Low-Level Waste Burial Grounds. (T)

Environmental Sciences Division Publication 1057; 21 pp. (1977)

This paper reviews and summarizes observations of hydrologic and chemical behavior at shallow land burial grounds resulting from burial operations. In fine-grained geologic formations and in soils in humid regions, perching of the water table can be produced by trench excavation and filling with material more permeable than the surrounding soil and rock, resulting in trench overflow and/or groundwater mounding below or within the waste. Examples are cited from sanitary landfills in Illinois, burial ground 4 at Oak Ridge National Laboratory (ORNL), the Savannah River Laboratory, and West Valley, NY. In the unsaturated zone, larger pore spaces where no flow occurs act as sinks for diffusing radionuclides, while the bulk of saturated flow is in the larger pores and fractures. Chemical factors leading to increased radionuclide motility are discussed. At ORNL, Cs 137 has been found in a fracture over 40 m from its source in an area where its adsorption coefficient is about 1 x 10(E+4), probably due to water flow through the fracture. Sorption of Sr 90 and Co 60 is ionic and strongly related to pH and competing cations, but Co 60 near intermediate-level waste disposal areas at ORNL has been found to be transported as a chelate with organics, mainly EDTA from decontamination operations. Relatively mobile Pu(+5) and Pu(+4) were found in one case in trench overflow water at ORNL at a concentration of about 35 dis/min/l; this may have resulted from oxidation by beta irradiation in the waste. Modeling radionuclide transport in saturated and unsaturated flow systems is discussed. It is concluded that current groundwater transport models are adequate for use in investigations of buried radioactive waste. Although chemical mechanisms are not well understood, site-specific distribution coefficients can be used for adequate simulations. Unsaturated and fractured media cannot at present be simulated reliably. (LFH)

MODELS; HYDROLOGY; GEOCHEMISTRY; BURIAL; WASTES, LOW-LEVEL; RADIONUCLIDE MIGRATION; PERCHED WATER; SATURATED ZONE; UNSATURATED ZONE; REVIEWS; DISPOSAL SITE; COMPLEXES; CHEMICAL PROPERTIES; FIELD STUDIES

<178>
Duguid, J.O., Oak Ridge National Laboratory, Oak Ridge, TN.

Annual Progress Report of Burial Ground Studies at Oak Ridge National Laboratory: Period Ending September 30, 1975. (T)

ORNL-5181; Environmental Sciences Division Publication No. 885; 50 pp. (1976, October)

This report summarizes research findings during report year 1975 for burial grounds at ORNL. Co 60-organic complexes which had been detected in ground water near Seepage Trench 7 were separated in columns using Sephadex(G-10) chromatographic gels, yielding two fractions, one greater than 700 MW, one less. Activity measurements showed that approximately 85% of the Co was in the fraction less than 700 MW. The complex may involve a natural organic compound such as fulvic acid or gallic acid, or may represent chelation with EDTA. Principle radionuclides present in ground water near Burial Ground 4 are Sr 90 and H 3. Average concentrations of Sr 90 at this site for the year ranged from 3.9 X 10(E-6) to 6.4 X 10(E-6) uCi/ml. Calculations of Sr 90 discharge from Burial Ground 4 into White Oak Creek predict a decrease accompanying decrease in precipitation. Stream monitoring data for 1974-75 do not bear this out, thus either the monitoring data must be incorrect or a new, as yet undetermined Sr 90 source must be present. Monitoring at White Oak Dam shows no equivalent Sr 90 increase, suggesting a malfunction of the stream monitoring station. No data were available on the effects of recent drainage improvements at Burial Ground 7. Sampling of seeps along the south edge of Burial Ground 5 yielded average concentrations of tritium of 0.2 uCi/ml and Sr 90 average concentrations of 1 X 10(E-5) uCi/ml. Two samples from the ends of inclined trenches averaged 7.1 X 10(E-5) uCi/ml, due to the "bathtub effect". Detailed analysis of alpha activity in water from Trench 83 showed the presence of Cm 244 (concentration 3.2 X 10(E-7) uCi/ml) and Pu 238 (concentration 3.2 X 10(E-8) uCi/ml). Measures were taken to reduce the volume of water moving through the burial ground. Four trenches were covered with polyvinyl chloride sheets; at the time of the report no data had been obtained on their effectiveness. Design of a bentonite-shale mixture for near-surface sealing of burial grounds was completed, approximately 10% bentonite being needed for adequate sealing. Two computer codes modeling water movement and radionuclide transport through porous media were completed. They are currently being applied to studies of waste behavior in Trench 7. (LFH)

Density; Permeability; Volumetric Water Content

Co 60; Sr 90; H 3; Pu 239; Pu 238; Sb 125; Cs 137; Cm 144; Am 241

GROUND WATER; TRENCHES; BURIAL; DRAINAGE; BENTONITE; COMPUTER CODES; WASTE DISPOSAL; MONITORING; PRECIPITATION, METEOROLOGICAL; SEAL MATERIALS; ASPHALTS; DISCHARGE; WASTES, RADIOACTIVE; STREAMS; RADIONUCLIDE MIGRATION; DIVERSION; STRONTIUM; CESIUM; TRITIUM; PLUTONIUM; SEEPAGE; FIELD STUDIES

<179>
Duguid, J.O., Oak Ridge National Laboratory, Oak Ridge, TN.

Groundwater Transport of Radionuclides from Buried Waste: A Case Study at Oak Ridge National Laboratory. (T)

WASH-1332(74); Proceedings of the Second EPC Environmental Protection Conference, Albuquerque, NM, April 16-19, 1974, Vol. 1, (pp. 511-529) (WASH-1332(74)). (1974, July)

Studies show that of the 5 burial grounds used in the past, the low-level solid waste burial ground 4 at ORNL is currently the main contributor of radionuclides to the local ground water. Elevation of the water table occurred after waste disposal at the burial

<179> CONT.
ground ceased in 1959. Subsequent disposal of uncontaminated fill on the site to depths of up to 20 feet increased surface permeability, as well as elevation. The increased infiltration rate and topography raised the water table even higher. Leaching rates of the buried waste increased; presently 1-2 Ci of Sr 90 are transported from the burial ground annually. Disposal of uncontaminated fill was discontinued in July 1973. Little information is available about the types, concentrations, locations, and quantities of radionuclides buried at the site, since all records were accidentally destroyed. Sr 90 is the main radionuclide released from the site; small amounts of Cs 137 tend to be fixed in the soil or bedrock. Sr 90 in the ground water ranges from 0.2-36.4 dpm/ml, with averages of 18.8 dpm/ml and 11.0 dpm/ml for the western and eastern portions of the drainage basin, respectively. Surface seeps formed by the "bathtub effect" of inclined waste trenches contain more than 400 dpm/ml Sr 90. Studies are currently being conducted to determine engineering methods that will reduce radionuclide discharge from this burial ground. (LSH)

Leaching Rate; Total Ion Concentration

Sr 90; Cs 137

TRENCHES; GROUND WATER; STRONTIUM; CESIUM; LEACHING; RADIONUCLIDE MIGRATION; PERMEABILITY; WATER TABLE; DRAINAGE BASINS; WASTES, RADIOACTIVE; SEEPAGE; FIELD STUDIES

<180>
Duguid, J.O., and M. Reeves, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

A Comparison of Mass Transport Using Average and Transient Rainfall Boundary Conditions. (3)

Finite Elements in Water Resources, Proceedings of an International Conference, Princeton, NJ, July 1976, (11 pp.), 400 pp. (1976, July)

A saturated-unsaturated zone code is applied to tritium transport mainly in unsaturated zones using time dependent rainfall boundary conditions. Some difficulty was encountered due to the small dispersion coefficients. (00)

Good illustration on the use of the author's code on mass transport given in ORNL-4928. (ON/00)

UNSATURATED ZONE; SATURATED ZONE; ADVECTION; DISPERSION; RADIOACTIVE DECAY; TRITIUM; RADIONUCLIDE MIGRATION; PRECIPITATION, METEOROLOGICAL; MODELS, MATHEMATICAL; THEORETICAL STUDIES

<181>
Elprince, A.M., C.I. Rich, and D.C. Martens, King Faisal University, Department of Soils and Water, Al-Hassa, Saudi Arabia; Virginia Polytechnic Institute and State University, Department of Agronomy, Blacksburg, VA.

Effect of Temperature and Hydroxy Aluminum Interlayers on the Adsorption of Trace Radioactive Cesium by Sediments Near Water-Cooled Nuclear Reactors. (1)

Water Resources Research 13(2):375-380. (1977, April)

A functional relationship between the adsorption of trace concentrations of cesium and temperature was derived and the effect of hydroxy Al interlayers on such a relationship was established. The effect of temperature on ion exchange for reference minerals is well established. However, soils vary from the reference minerals so the ion exchange results may not be completely applicable. Many soils are acidic and the soil clays usually develop "islands" of positively charged hydroxy aluminum polymeric groups which partially fill the interlayer space. These polymeric groups drastically decrease the cation exchange capacity. The soil clay of interest is the intergradient 2:1-2:2 layer silicates. First a theoretical development is presented and the equilibrium distribution coefficient was derived. Sediment samples were taken from rivers near the Savannah River Plant. Sediments with high quartz content have a low cation exchange coefficient, and those with low quartz content, a high cation exchange coefficient. The equilibrium distribution coefficient (Kd^e) is low for low cation exchange coefficient and high for a high cation exchange coefficient. The values range from 18.3 to 130.1. Removing the Al hydroxy layer increases the Kd^e on an average of 238%. In the presence of the Al hydroxy layers temperature will cause Cs sorption to decrease. This relationship is linear. The mechanism is associated with the H_3O^+ competing for the same positions in the clay lattice. (SDV)

ACIDS, CATION EXCHANGE CAPACITY; CLAYS; COMPLEXES; DISPOSAL SITE; EQUATIONS; EQUILIBRIUM CONSTANT; FIXATION; IONS; LABORATORY STUDIES; LATTICE; SAMPLES; SEDIMENTS; SOILS; TEMPERATURE; DISTRIBUTION

<182>
Emery, R.M., D.C. Klopfer, and R.C. Weiner, Battelle-Pacific Northwest Laboratories, Richland, WA.

The Ecological Behavior of Plutonium and Americium in a Freshwater Ecosystem: Phase 1, Limnological Characterization and Isotopic Distribution. (8)

BNWL-1950 (Part 2); Pacific Northwest Laboratory Annual Report for 1976. Part 2. Ecological Sciences, R.E. Vaughan, et al, (pp. 96-99), 239 pp. (BNWL-1950, Part 2). (1976, December)

A shallow freshwater waste disposal pond was examined to determine the distribution of plutonium and americium to plants, animals, and sediments associated with the pond. Plutonium processing wastes have been discharged into the pond for about 30 years. The mean concentrations of Pu 238, Pu 239 and 40, and Am 241 were 194, 195, and 93 pCi/g dry weight, respectively. Levels of Pu and Am in interstitial water were low, between 0.5 and 12 pCi/g dry weight of sediment, and exist mainly in cationic or nonionic form. Concentrations of Pu and Am in the pond water were about 0.01 and 1.1 pCi/l, respectively, and were associated mainly with particulates. Decomposing algae are the principal concentrators of plutonium and americium, but the remaining biota exhibited lower

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<182> CONT.
concentrations. Ratios of Pu 238 to Pu 239, 240 and Am 241/Pu are generally higher in the biota than in the sediments, but are lower in the pond water. (CAB) (JTE)

Only indirectly related to shallow land burial in that it discusses the movement of americium and plutonium in the hydrosphere and uptake by biota and sediments. (DB/CAB)

Pu 238; Pu 239; Pu 240; Am 241

PLUTONIUM; AMERICIUM 241; SEDIMENTS; ISOTOPE RATIOS; PONDS; BIOTA; FISH; UPTAKE; WASTE DISPOSAL; DISPOSAL SITE; FIELD STUDIES; FRESHWATER SYSTEMS; MICROORGANISMS; WASTES, TRANSURANIC

<183>
Finlayson, B.A., University of Washington, Seattle, WA.

Water Movement in Desiccated Soils. (2)

International Conference on Finite Elements in Water Resources, Proceedings of a Conference, Princeton, NJ, July 1976, (800 pp.). (1976, July)

This paper is addressed to understanding the mathematical difficulties involved in very dry (desert) unsaturated zones and to finding methods to overcome them. One dimensional hydraulic flow and mass transport are treated. (00)

Useful analysis of movement of water in unsaturated zones and numerical problems for unsaturated flow are discussed. (DB/00)

UNSATURATED ZONE; ADVECTION; DISPERSION; DESERTS; NUMERICAL METHODS; SOLUBILITY; THEORETICAL STUDIES; RADIONUCLIDE MIGRATION; SOIL TRANSPORT

<184>
Fowler, E.B., W.L. Polzer, and E.H. Essington, Los Alamos Scientific Laboratory, Los Alamos, NM.

Characteristics of Wastes and Soils Which Affect Transport of Radionuclides Through the Soil and Their Relationship to Waste Management, July 1, 1976 to September 30, 1977. (3)

NUREG/CR-0127; LA-7311-PR; 52 pp. (1978, June)

In order to properly evaluate waste handling, storage, and burial practices the rate and degree of movement of radioactive nuclides through soils and other geologic media must be discerned. Reported on are Los Alamos Scientific Laboratory efforts in this area from July 1976 to September 1977. Preliminary results indicate that in a four-month period of waste storage no sorption of plutonium and only slight sorption of americium by soils occurred when they were interacted with a raw waste, and about 50% of the soluble uranium was sorbed by the soils. For treated waste no increase in the concentration of plutonium was observed during the same time period. Also characterized by physical and chemical properties was the waste and waste/soil solutions. More work is expected to be done on this project and further coordination with other national laboratories will occur. (NDV)

The appendices contain radiochemical procedures, chemical analytical procedures, statistical evaluation, radiochemical data, chemical and physical data, and an annotated bibliography.

Pu 238; Pu 239; Pu 240; Am 241; U 238; U 235; U 236; U 233; U 234

SORPTION; BEDROCK; SOILS; WASTES, RADIOACTIVE; RADIONUCLIDE MIGRATION; PHYSICAL PROPERTIES; CHEMICAL PROPERTIES; WASTE STORAGE; WASTE MANAGEMENT; FIELD STUDIES

<185>
Francis, C.W., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Movement of Radiostrontium in Soils. (1)

TID-27568; Radiostrontium Movement in Soils and Uptake in Plants. U.S. Department of Energy, Technical Information Center, Oak Ridge, TN, Ch. 2, (pp. 18-42), 131 pp. (TID-27568). (1978)

The movement of Sr 90 in soils is discussed with emphasis on transport mechanisms and proper measurement of these mechanisms. The processes by which Sr 90 moves in the soil are: 1) mass flow; 2) diffusion; 3) mechanical mixing; 4) biological transfer. For soils that are noncultivated and sandy-acidic radionuclide migration is controlled by the mass flow mechanism. Diffusion becomes more important in soils with heavier textures, such as clayey soils. Only in agricultural soils does movement as a result of mechanical mixing appear to be significant. Biological transfer is the least understood of the processes governing radionuclide migration. The vertical rate of movement in the soil appears to be indirectly related to both the exchangeable calcium content and cation-exchange capacity of the soil. Adding fertilizers increases both parameters and as a consequence decreases Sr 90 movement. On the other hand, excessive treatment with fertilizers enhances the movement of Sr 90 particularly for soils with cation-exchange capacities of less than 10 meq/100 g. Strontium will diffuse faster when soil water and salt content increase. The diffusion rate of strontium decreases as the organic matter and pH decrease. Apparently transport is controlled more by advection and dispersion within the carrier fluid than adsorption-desorption exchanges with soil matrix. Models and Fick's diffusion equation are included in the presentation. (NDV)

CATION EXCHANGE CAPACITY; CLAYS; COMPLEXES; DIFFUSION; DISTRIBUTION; EQUATIONS; FIELD STUDIES; GROUND WATER; INFILTRATION; MODELS, MATHEMATICAL; ORGANIC COMPOUNDS; RADIONUCLIDE MIGRATION; REVIEWS; SOILS; STRONTIUM

<186>
Francis, C.W., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Radiostrontium Movement in Soils and Uptake in Plants. (2)

TID-27568; 131 pp. (1978)

<186> CONT.
A critical review of the results of many international investigations of the chemistry of radiostrontium in the soil and of the factors that affect its availability to plants is presented. Covered in the discussion is the distribution of fallout strontium 90 in soil profiles, movement of Sr 90 in soils, strontium soil reaction products, plant uptake of strontium from nutrient solutions, strontium uptake by plants as influenced by soil properties, and soil amendments affecting Sr 90 uptake by plants. Two chapters in the book have been abstracted separately. (NDV)

SOILS; SORPTION; ACIDS, ORGANIC; BIOSPHERE; CALCIUM; CATION EXCHANGE CAPACITY; CHEMICAL PROPERTIES; CLAYS; DIFFUSION; DISTRIBUTION; EQUATIONS; FIELD STUDIES; FIXATION; GROUND WATER; HUMIC ACIDS; INFILTRATION; ION EXCHANGE; CATIONS; LABORATORY STUDIES; MOISTURE; pH; PHYSICAL PROPERTIES; PLANTS; UPTAKE; STRONTIUM; RADIONUCLIDE MIGRATION; SOILS; REVIEWS

<187>
Francis, C.W., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Strontium Soil Reaction Products. (2)

TID-27568; Radiostrontium Movement in Soils and Uptake in Plants. U.S. Department of Energy, Technical Information Center, Oak Ridge, TN, Ch. 3, (pp. 43-62), 137 pp. (TID-27568). (1978)

Concepts and theories of strontium soil reactions are presented in this discussion. Early hypotheses put forth the idea that releases of strontium to neutral or alkaline soils would cause the strontium to be sorbed onto and/or coprecipitated by the soil carbonates. Water-insoluble phosphates, silicates, and sulfates were suggested by other hypotheses as the reason strontium was held in the soil. In acid soil strontium retention is thought to be the result of several processes: irreversible sorption onto iron and aluminum sesquioxides, occlusion by soil organic matter, and the diffusion into interlayer clay minerals. Studies on a variety of soils indicate that contrary to most accepted thought more than 90% of strontium is held in exchangeable forms. The exception to this finding is the Coastal Plain soils from the southeastern United States which may retain as much as 50% in a nonexchangeable form. A good discussion of organic-matter reaction products and plant uptake with respect to time is also presented. (NDV)

SORPTION; ACIDS, ORGANIC; CLAYS; DIFFUSION; FIXATION; HUMIC ACIDS; ION EXCHANGE; MODELS; PLANTS; RADIONUCLIDE MIGRATION; PRECIPITATION, CHEMICAL; SOILS; THEORETICAL STUDIES; UPTAKE; REVIEWS

<188>
Freeze, R.A., IBM, Thomas J. Watson Research Center, Yorktown Heights, NY.

Three-Dimensional, Transient, Saturated-Unsaturated Flow in a Groundwater Basin. (2)

Water Resources Research 7(2):347-365. (1971, April)

A three dimensional finite difference model has been developed for the treatment of saturated and unsaturated transient flow in small nonhomogeneous anisotropic geologic basins. The uniqueness of the model lies in its inclusion of the unsaturated zone in a basin-wide model that can also handle both confined and unconfined saturated aquifers under both natural and developed conditions. The integrated equation of flow is solved by the line-successive-overrelaxation technique. The model allows any generalized region shape and any configuration of time-variant boundary conditions. (Auth)

A significant paper, now classic, that unifies the hydraulic flow in saturated and unsaturated zones into a single formulation and solves the resultant mathematical equations using finite difference techniques. (DS/JO)

UNSATURATED ZONE; SATURATED ZONE; ANISOTROPY; HYDRAULIC FLOW; GROUND WATER; EQUATIONS; THEORETICAL STUDIES; COMPUTER CODES; MODELS, MATHEMATICAL; AQUIFERS; WATER TABLE; HEAD PRESSURE; INFILTRATION

<189>
Fukui, M., Kyoto University, Research Reactor Institute, Kumatori-cho, Sennan-gun, Osaka, Japan.

Evaluation of a Combined Sorption Model for Describing Cesium Transport in a Soil. (2)

Health Physics 35(4):555-562. (1978, October)

A mathematical model is presented and evaluated in the description of cesium reaction and transport in the soil. The model is derived so the two stages; fast adsorption-desorption based on ion exchange, and slow reaction restricted by diffusion of cesium into the lattice of minerals are taken into account. A solution for these equations is provided by the finite difference method with quasilinearization technique. A numerical analysis is also provided. To aid in the evaluation of the model, column experiments were run. A column containing fine quartz sand with 40% porosity and a dispersion coefficient of 11.1 sq cm/hr was used. The breakthrough curves indicate the two-stage model is quite capable of describing the effluent concentration distribution of the cesium solutions for both adsorption and desorption. This model is flexible and may be adapted to incorporate the various transformation mechanisms of other radionuclide sorption on a soil. (NDV)

Porosity; Dispersion Coefficient

Cs 137

ADSORPTION; BREAKTHROUGH DISTRIBUTION; DISPERSIVITY; EQUATIONS; ION EXCHANGE; DIFFUSION; LABORATORY STUDIES; MODELS, MATHEMATICAL; RADIONUCLIDE MIGRATION; SOILS, SAND; WASTE DISPOSAL

<190>
Gifford, F., U.S. Weather Bureau, Oak Ridge, TN.

Meteorological Parameters in Waste Disposal. (3)

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ENVIRONMENTAL TRANSPORT

<191>
TID-7517 (Part 1A): Sanitary Engineering Aspects of the Atomic Energy Industry. Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 57-59) (TID-7517, Part 1A).(1956, October)

Meteorologists become interested in the problem of waste disposal either when the atmosphere is used as a vehicle for the transport and diffusion of waste products or when the disposal of wastes into some other medium can be shown to depend on atmospheric processes. An area of concern is in connection with waste disposal in open pits, since the rate of evaporation from such pits is atmosphere-dependent. Fundamentally, the rate of any kind of material taken up by the atmosphere is controlled by the initial gradient of the property and the strength of the air turbulence. Wind variability, turbulence, is controlled largely by vertical atmospheric temperature gradients. This turbulence can be classified into four regimes of mean wind speed and thermal stability and are known as the "Brookhaven turbulence types". Classical theories of conduction and aerodynamic boundary layer conclude a property is dispersed most rapidly when: turbulence intensity is greatest; degree of thermal stability is least; mean wind speed is greatest; and the gradient of the property is greatest. These theories also try to account for secondary effects such as roughness of ground surface and rate of deposition or absorption on the ground. To determine the evaporation rate, the necessary data were collected and calculations by three complementary methods were performed. The three methods are: Weather Bureau evaporation pan; U.S. Geological Survey evaporation; and use of one or more "mass transport" theories. In the field study at Oak Ridge, a multipronged approach was used due to small size of the pits, and the hilly nature of the surrounding terrain which may cause dispersion effects. (WDV)

ABSORPTION; AIR; ATMOSPHERE; DIFFUSION; DISPERSIVITY; EVAPORATION; FIELD STUDIES; METEOROLOGY; PRECIPITATION, METEOROLOGICAL; SEEPAGE PITS; UPTAKE; WASTES, RADIOACTIVE

<191>
Greig, R.A., D.R. Wenzloff, and J.B. Pearce, Middle Atlantic Coastal Fisheries Center, Sandy Hook Laboratory, Highlands, NJ.

Distribution and Abundance of Heavy Metals in Finfish, Invertebrates and Sediments Collected at a Deepwater Disposal Site. (8)

Marine Pollution Bulletin 7(10):165-167, (1976, October)

Samples of benthopelagic fish, invertebrates, and sediments were collected in the general area of deepwater disposal site No. 106 off New York Bight and analyzed for heavy metals. Specimens of ANTIMORA ROSTRATA, MERATONURUS ARMATUS, HALOSAUROPSIS MACROCHIR, SYNAPHOBRANCHUS KAUPI, GEPTOH QUIQUEDENS, SERIOLA, HYGOPHUM HYGOMI, and STEPHANOLEPSIS HISPIDUS were analyzed for Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, and Zn. A comparison of Hg levels in muscle from A. ROSTRATA collected at site No. 106 and in specimens collected off Cape Hatteras in 1971-72 and in 1881 showed similar values (0.62 ppm for an average length of 81 cm); because of this lack of variation, the other values for metals may also represent normal levels in deepwater fish. Comparison with other studies indicates that deepwater fish may have less metal in usable tissue than those from the continental shelf. Additional studies of midwater and surface fish are being made to determine if they may act as a link for transport of heavy metals and other contaminants from surface waters to depths. Analysis of sediment samples showed Cd less than 1.25 ppm, Cr 6-16.7 ppm, Cu 6.5-25.9 ppm, Ni less than 7.5 ppm to 33.1 ppm, Pb 7.5-15 ppm, and Zn 19.5-87.9 ppm. Future collections may provide data on possible accumulation of metals due to ocean disposal operations and terrigenous export seaward via the Hudson Shelf Valley. (ERH)

Total Ion Concentration

FISH; METALS; CADMIUM; MERCURY; LEAD; ZINC; CHROMIUM; COPPER; NICKEL; SEA DISPOSAL; WASTES, RADIOACTIVE; DISPOSAL SITE; WASTES, INDUSTRIAL; BIOTA; CRUSTACEANS; CHEMICAL ANALYSIS; CONTAMINANT TRANSPORT; FOOD CHAIN; FIELD STUDIES; BIOLOGICAL STUDIES

<192>
Haeggblom, H., Aktiebolaget Atomenergi, Stockholm, Sweden.

Calculations of Nuclide Migration in Rock and Porous Media, Penetrated by Water. (2)

AE-RF-77-3260; 60 pp.(1977, September 13)

Some physical and mathematical models are given for migration of nuclides in rock and porous media penetrated by water. The cases considered are thermal convection due to the decay heat from radioactive sources and transport due to the hydraulic gradient connected with the geographic structure. The model for thermal convection is highly simplified but is conservative compared to the often made adiabatic assumption which limits convection effects to a region characterized by a high ratio between buoyant and viscous forces. The piezometric head and corresponding gradients are calculated by analytical methods. It is shown that the solutions are strongly dependent upon the variation of the permeability with depth. The special features of migration in cracks are studied. A computer program, MINUTE, was developed [illegible] calculations. Times for trans[illegible] test nuclides to the ground [illegible]ated using appropriate [illegible]presentative Swedish depos[illegible] earjins are discussed. (/

THEORETICAL STUDIES; RADIONUCLIDE MIGRATION; ROCKS; REPOSITORY; MODELS, MATHEMATICAL; PERMEABILITY; POROSITY; DEPTH; THERMAL PROPERTIES; CONVECTION; TIME FACTOR; DISTRIBUTION COEFFICIENT; FRACTURES; LEACHING; GROUND WATER; DENSITY; EQUATIONS; COMPUTER PROGRAMS; TOPOGRAPHY

<193>
Hagan, P.G., and F.J. Miner, Dow Chemical Company, Rocky Flats Division, Golden, CO.

Leaching Effects of Water on Rocky Flats Wastes. (2)

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<193> CONT.
CBDL-960329-0004, Internal Report: 15 pp.(1972, June 16)

A study was undertaken to measure the leaching effects of Arco water on Rocky Flats wastes. The isotope of interest in the tests was plutonium. Also, two sources of water were used; ground water from Arco (pH of 9.34) and untreated water collected from the Rocky Flats sources (pH of 7.46). After 42 days of leaching, the Arco water had an average plutonium equilibrium solubility of 0.13 ug/l and an average pH of 11.0. The Rocky Flats water had an average plutonium equilibrium solubility of 0.69 ug/l and an average pH of 11.5. Process treatment plant wastes had an equilibrium value of 0.02 ug/l and a pH of 12.0. The most lowest concentration of plutonium occurred in a waste group consisting of insulation, and sand and slag residues from the casting furnaces and reduction process. The values from this group were 0.05 ug/l and pH range of 6.8 to 9.9. The miscellaneous waste of the next group (glass, metals, contestibles) had a plutonium equilibrium solubility of about 0.58 ug/l and a pH of 8.0. For graphite wastes from production casting molds, the plutonium solubility is 73,000 ug/l with pH of 2.1. From the data a distinct solubility and pH correlation is discerned--those wastes with low solubility have relatively high pH values. The reason for low pH values of the graphite wastes is attributed to the nitric acid leach given prior to discard. Although the graphite is washed with water, not all the nitric acid is removed. If the information is to be extended beyond plutonium solubility to the behavior of plutonium in the environment, more information on leached plutonium species and exchange behavior with the soil is necessary. (NDW)

pH

Pu

CONTAINMENT; CONTAMINATION; GROUND WATER; LABORATORY STUDIES; LEACHING; pH; PLUTONIUM COMPOUNDS; RADIONUCLIDE MIGRATION; SOLUBILITY; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, RADIOACTIVE

<194>
Higgins, G.H., Lawrence Livermore Laboratory, Livermore, CA.

Evaluation of the Ground-Water Contamination Hazard from Underground Nuclear Explosions. (U)

Journal of Geophysical Research 68(10):1509-1519.(1959, October)

Contamination of ground water as a result of underground nuclear explosion has been minimized due to the formation of silica glass by the explosion, and the ion exchange properties of the fission products in earth minerals and water. Extent of silica glass around detonation area is approximated by 15 W(E=1/3) ft, where W is the amount of nuclear explosive detonated in kilo ton equivalents. The parameters identified as influencing ion transport are (a) the capacity of the minerals to undergo ion exchange, (b) the distribution of various ionic species, and (c) the kinetics of ion transport. The occurrence and nature of aquifers is reviewed in general terms. Data are presented on the capacities and distribution coefficients of several soil and mineral types for cesium, strontium, yttrium, plutonium, cerium, and ruthenium. (Auth) (JT)

Discussion is limited to the hydrological impact of underground nuclear detonations. Significant data are presented on the distribution coefficients of various minerals for fission products. (DR/JT)

Distribution Coefficient; Ion Exchange Capacity

GROUND WATER; CONTAMINATION; EXPLOSIONS, NUCLEAR; RADIONUCLIDES; RADIONUCLIDE MIGRATION; SOILS; MINERALS; ION EXCHANGE CAPACITY; DISTRIBUTION COEFFICIENT; GLASS; REVIEWS

<195>
Hogg, T.J., J.W.B. Stewart, and J.B. Bettany, University of Saskatchewan, Saskatchewan Institute of Pedology, Saskatoon, Saskatchewan, Canada.

Influence of the Chemical Form of Mercury on its Adsorption and Ability to Leach through Soils. (U)

Journal of Environmental Quality 7(3):440-445.(1978)

The adsorption of Hg in two different soils is discussed. When mercury enters the soil profile it may be adsorbed, precipitated, volatilized, leached or taken up by plant roots. The primary process is adsorption and it usually determines how much mercury remains in the soil solution. Adsorpton of mercury is dependent on the chemical species of Hg, the amount and chemical nature of inorganic and organ soil colloids, soil pH, and the type of cations on the exchange complex. Which of these factors is most important is difficult to determine, however, the adsorption in general can be described in terms of the Langmuir equation. Two soils were selected for the experiments, an Orthic Dark Chernozemic Asquith loamy sand and an Orthic Black Chernozemic Oxbow loam. The Asquith soil had a pH of 6.6 in the upper 15 cm along with 85.9% sand, 5.3% silt, 8.8% clay and a cation exchange capacity of 7.23 meq/100 g. Similar characteristics for the Oxbow soil are: pH, 7.6; 23.9%; 30.7%; 45.0%; and 26.6 meq/100 g, respectively. The percent organic carbon in the Asquith is 0.7% and in the Oxbow is 2.9%. For each soil, values of adsorption maxima decreased from HgCl2 to PMA to MMC with the highest values occuring in the Oxbow (2,875 HgCl2, 719 PMA; 606 ug/g MMC vs 323; 309; 20 ug/g respectively) due to the greater clay and organic carbon content. In both soils the majority of the Hg remained in the 0-10 cm layer and 10% or less Hg was leached. Recovery of the Hg in the Asquith soil ranged from 69.0% for the MMC to 80.6% for the HgCl2. In the Oxbow soil 78.8% was recovered from the MMC and 93.1% was recovered for the HgCl2. Extraction experiments show little (0.3%) could be extracted by CaCl2, NH4OAc, EDTA, or DTPA. Results indicate that the Oxbow soil lost less Hg through volatilization than did the Asquith soil due to its ability to adsorb greater amounts. (NDW)

pH; Grain Size Distribution; Cation Exchange Capacity

ADSORPTION; CATION EXCHANGE CAPACITY; CHEMICAL

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<195> CONT.
PROPERTIES; CLAYS; COMPLEXES; ORGANIC COMPOUNDS; pH; CATIONS; EQUATIONS; SOILS, LOAM; SOILS, SANDY LOAM; WASTES, NONRADIOACTIVE; MERCURY COMPOUNDS; LABORATORY STUDIES

<196>
Holly, D.E., and P.H. Fenske, Palo Alto Laboratories of Isotopes, Earth Sciences Section, Palo Alto, CA.

Transport of Dissolved Chemical Contaminants in Groundwater Systems. (3)

CONF-660583; Memoir No. 110; Nevada Test Site, Eckel, E.B. (Ed.), Proceedings of the Technical Sessions of the 19th Annual Meeting of the Rocky Mountain Section, Geological Society of America, Las Vegas, NV, May 11-14, 1966. Geological Society of America, Inc., Boulder, CO, (pp. 171-183), 290 pp. (1968, May)

One dimensional half-space dispersive-convective medium analytical solutions for contaminant transport for two different boundary conditions are derived. One case is constant concentration at the origin, the other is decaying concentration at the origin (one subcase is natural radioactive decay, the other subcase is natural decay combined with artificial decay due to mixing with input dilutant). (00)

Analytical solutions presented are outdated, not very original, and better current treatments exist, e.g., Bear Book. (DB/00)

DISPERSION; GROUND WATER; EQUATIONS; RADIONUCLIDE MIGRATION; NUMERICAL METHODS; MODELS, MATHEMATICAL; THEORETICAL STUDIES

<197>
Hsieh, J.J.C., A.E. Reisenauer, and L.E. Brownell, Battelle-Pacific Northwest Laboratories, Water and Land Resources Department, Richland, WA.

A Study of Soil Water Potential and Temperature in Hanford Soils. (1)

BNWL-1712; 23 pp. (1973)

This document describes in detail the construction and installation of a string of thermocouple psychrometers and diode temperature transducers in the soil between the surface and the water table on the Hanford Reservation. The results of fifteen months of data gathering from these instruments indicate that moisture movement in the soil profile, if any, is extremely small. (Auth)

Field experiments using thermocouple psychrometers and diode temperature transducers. Useful and rare field data, contributes to the understanding of the unsaturated zone at BNWL. (DB/00)

Moisture Potential; Volumetric Water Content; Grain Size Distribution

UNSATURATED ZONE; CAPILLARY POTENTIAL; TEMPERATURE; FIELD STUDIES; HYDRAULIC FLOW; SOILS; INSTRUMENTS; MOISTURE

<198>
Humphrey, T.G., and F.H. Tingey, EG and G Idaho, Inc., Idaho Falls, ID.

The Subsurface Migration of Radionuclides at the Radioactive Waste Management Complex, 1976-1977. (2)

TREE-1171; 98 pp. (1978, October)

Forty-seven core samples were collected from 8 wells on the INEL Radioactive Waste Management Complex, along with samples of perched water from well 77-2 and subpit samples collected by drive-tube. Statistically significant amounts of radioactivity were initially indicated in 17 of 303 analyses. Reanalysis of material corresponding to 14 of the 17 positive results failed to confirm the original analyses; of the remaining three, one was confirmed, and insufficient material was available to repeat the other two. The inconsistency of the results suggests that some of the original samples may have been contaminated in preparation and/or analysis. Analyses were for Pu 238, Pu 239, Pu 240, Am 241, Sr 90, Ce 144, Cs 137, and Co 60. In all well samples, radionuclide concentrations were below 10 (E-8) uCi/g. Evaluation of the data does not indicate radionuclide migration. Most of the radionuclides have been contained within two feet of the buried waste, but trace amounts occur down to six feet. Pit 2, which provided most of the trench samples, was flooded in the spring of 1962 before the waste had been covered, and may have been the source of some of this migration. There is no conclusive evidence of radionuclide migration into the underlying Snake River Plain aquifer; the concentrations and locations of radionuclides detected do not constitute a hazard to the aquifer, and with current protective measures, further migration of radionuclides in sufficient quantities to be a future hazard is not expected. (Auth) (LKH)

Total Ion Concentration

Pu 238; Pu 239; Pu 240; Am 241; Sr 90; G 144; Cs 137; Co 60

PERCHED WATER; CORES; RADIONUCLIDES; CONTAMINATION; RADIONUCLIDE MIGRATION; AQUIFERS; SAMPLES; SAMPLING; STATISTICS; PITS; TRENCHES; WASTES, TRANSURANIC; WASTES, LOW-LEVEL; WASTES, SOLID; MONITORING; SITE SURVEILLANCE; FIELD STUDIES

<199>
Hussain, L., J.M. Matuszek, J. Hutchinson, and M. Wahlen, New York State Department of Health, Division of Laboratories and Research, Albany, NY.

Chemical and Radiochemical Character of a Low-Level Radioactive Waste Burial Site. (2)

CONF-770512; Management of Low-Level Radioactive Wastes, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 8, (pp. 883-900), 1214 pp. (CONF-770512). (1979)

The primary objectives of this study of the radioactive waste burial ground at West

<199> CONT.
Valley, NY were: (1) to identify quantitatively in burial trenches, surface and underground waters, and air the radionuclides that are of greatest significance to human health, and (2) to obtain chemical and radiochemical data essential for predictive modeling of radionuclide movement from the burial trenches to the onsite and offsite environment. Measurements were performed on trench-water samples for gross-alpha and gross-beta activity and for H 3, C 14, Sr 90 and 20 other radionuclides. Of these, H 3 and Sr 90 were the most abundant. Radionuclides concentrations in water pumped out of trench 5 in 1975 were (in uCi/ml): H(H3)O 1.56-2.20, Sr 90 1.37-1.89 X 10(E-4), Pu 238 5.1-51 X 10(E-7), Pu 239, 240 3.5-35.5 X 10(E-7), Cs 137 1.87-3.81 X 10(E-5), Fe 55 4.3-11.5 X 10(E-6), and Ni 63 5.0-9.1 X 10(E-5). Carbonate- or bicarbonate-C 14 reached levels as high as 7 X 10(E-5) uCi/ml. Concentrations in a given trench were fairly constant (to an order of magnitude), although isolated larger variations existed. Thus, the radionuclide concentrations in the trenches can be characterized sufficiently for mathematical simulation studies as a step toward model development. Determining the contribution of the radionuclide from the trenches to surface water is complicated by weapons fallout and the nearby presence of the fuel reprocessing plant, which have released much of the surface contamination present in the local environment. Samples of trench gas trapped under the soil caps were also collected from several well points. Radiochemical analysis yielded unexpectedly high levels of C 14, up to 9.6 X 10(E-5) uCi/cu cm. These samples also contained up to 68% CH4. Except for water overflow from the trenches, the largest uncontrolled release from the trenches to the environment may be from escaping gases. (Auth) (LKS)

Total Ion Concentration

H 3; Sr 90; Cs 137; C 14; Pu 238; Pu 239; Pu 240; Fe 99; Ni 63

DISPOSAL SITE; BURIAL, SHALLOW; TRENCHES; RADIONUCLIDE MIGRATION; WATER; RADIOACTIVITY; TRITIUM; CARBON 14; STRONTIUM 90; RADIONUCLIDES; CONCENTRATIONS; METHANE; PLUTONIUM 238; PLUTONIUM 239; PLUTONIUM 240; CESIUM 137; IRON 99; NICKEL 63; SURFACE WATERS; GASES; WELLS; FIELD STUDIES

<200>
Inoue, Y., Department of Sanitary Engineering, Kyoto, Japan.

Prediction of Radionuclide Migration in Ground Water at the Japan Atomic Energy Research Institute. (3)

CONF-670512; STI/PUB-156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 169-177), 666 pp. (1967, June)

The sorption and migration of the principal long-lived fission products in soil and rocks were studied under the conditions of a moving filtration stream. Laboratory investigations of the sorption properties of soils and rocks were performed on samples (of disturbed and natural structure) obtained by drilling. The accumulation of activity in the solid phase was found to proceed slowly, which led to considerable activity escaping in the filtrate. Field studies of radiostrontium migration indicated the possibility of applying the fundamental concepts of ion exchange theory to calculating the movement of the solution front. The possible relationship between laboratory microcomponent distribution coefficients and actual strata effective porosities and filtration coefficients were also brought out by the field studies. It was concluded that the most uniform distribution and migration of radionuclides (which is associated with contamination of the smallest unit volume) occurs through horizontal dispersion of the wastes. This can be brought about in porous water-bearing horizons. The most suitable water-bearing zones for disposal of radioactive solutions were thought to be deep-lying horizons of relic water and the local structures of static zones. (ET)

A study of the sorption and migration of dissolved, long-lived fission products in soil and rocks. It is applicable to site selection for disposal of radioactive solutions and to leakage problems. (DS/ET)

Depth to Water Table

Sr; Cs; Pu

RADIONUCLIDE MIGRATION;; SORPTION; SOILS; FILTRATION; ION EXCHANGE; STRONTIUM; CESIUM; SUSPENSION; ROCKS; FIELD STUDIES

<201>
Inoue, Y., Department of Sanitary Engineering, Kyoto, Japan.

Prediction of Radionuclide Migration in Ground Water at the Japan Atomic Energy Research Institute. (2)

CONF-670512; STI/PUB-156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 199-213), 666 pp. (1967, June)

Radionuclide migration in groundwater at the Japan Atomic Energy Research Institute in northwestern Japan was predicted from field groundwater measurements. The theory of the velocity of a radionuclide in groundwater being related to the groundwater velocity and the dispersion of radionuclides being predictable from the groundwater dispersion was applied. The surface sediments at the site are stratified sand and loam that slope about 10 degrees toward the Pacific Ocean. Groundwater flow was indirectly determined by Darcy's law (via permeability and equiwater-level field measurements) and directly measured by the point-dilution method. Values of the distribution coefficient of various radionuclides were obtained by measurement of the mass action constants of the sand and/or direct comparison of water and radionuclide travel (by passing a radionuclide in ground water through a soil column). Migration rates were obtained relative to groundwater by substituting values for the formation porosity, formation density, and nuclide distribution coefficients into a mathematical expression. Strontium was found to move at 1.13 m/day in the region of high groundwater

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<201> CONT.
flow. A possible location for a radioactive waste burial site for the laboratory was also suggested. (Auth)(ET)

The study can be used to print out the type of measurements necessary for predicting radionuclide migration in groundwater, which is important to waste site selection. (DE/ET)

Hydraulic Conductivity; Depth to Water Table; Porosity; Density; Distribution Coefficient; Ion Exchange Capacity

Sr 90; Cs 134; Co; I

RADIONUCLIDE MIGRATION; STRONTIUM; CESIUM; GROUND WATER; DISTRIBUTION COEFFICIENT; WATER TABLE; SEDIMENTS; WELLS; HYDRAULIC VELOCITY; FIELD STUDIES

<202>
Inoue, Y., S. Morisawa, and T. (Translator) Ohtani, Kyoto University, Faculty of Engineering, Kyoto, Japan.

Migration of Radioactive Nuclides in a Model Soil Tank. (3)

OLS-76-107; 2 pp.; 1976 Fall Divisional Meeting, Nihon Genshiryoku Gakki, (pp. 89).(1976)

A model soil bed composed of 306 kg of moistened sand (density 2.65 g/cu cm, average grain size 0.51 mm) collected at the Tokai Laboratory of the Japan Atomic Energy Research Institute was placed in a 105 x 40 x 55 cm vinyl chloride tank, to form a 50 cm deep layer with an average pore ratio of 35.6%. A cylinder of radionuclide/cement matrix containing 5 uCi Sr 90, 6 uCi Cs 137, 100 uCi Co 60, 0.01 uCi Fe 59, 2.5 uCi Mn 54, 5 uCi Zn 65, and 8 uCi Ag 110m was wet cured for 7 days and placed in the soil. After 229 days, results showed that Sr 90 and its Y 90 daughter were the only radionuclides leached; of the two, Y 90 migrated faster. The velocities of these nuclides are believed to be accelerated by the presence of other elements, such as calcium. It was concluded that the soil distribution of radionuclides can be estimated to a certain extent from their distribution coefficients. (LKH)

Density; Porosity

Sr 90; Y 90; Cs 137; Co 60; Fe 59; Mn 54; Zn 65; Ag 110m

MODELS; LABORATORY STUDIES; SANDS; CEMENTS; RADIONUCLIDE MIGRATION; DISTRIBUTION; STRONTIUM; YTTRIUM; SOILS; WATER; WASTE DISPOSAL; WASTE MANAGEMENT

<203>
Jeter, H.W., J.O. Martin, and D.F. Schutz, Teledyne Isotopes, Westwood, NJ.

The Migration of Gaseous Radionuclides through Soil Overlying A Uranium Ore Deposit: A Modeling Study. (3)

GJBX-67(77); IWL-0611-010; 88 pp.(1977, August 15)

This study presents several one-dimensional mathematical models to simulate the distribution of radionuclides in soil overlying uranium ore deposits, as an attempt to determine the feasibility of uranium ore detection by remote geochemical methods. The models assume a homogeneous, U- and Ra-free soil overlying a planar uranium deposit 1 m thick and of infinite horizontal extent, with 0.6% U308 and 20% emanation. Ground water effects are not considered. The steady-state diffusion model shows that Rn 222 (half-life 3.8 days) and some of its daughter products would be detectable several tens of meters from a uranium deposit; this range would actually be shortened by the masking effect of Rn generated within the overlying soil. Kr 85 would only be marginally detectable in the immediate vicinity of the ore, and in shallow deposits would be masked by diffusion of atmospheric Kr into the soil; Xe 133 would be detectable at half the range of Rn 222. Steady-state and transient models were used to evaluate the effect of soil gas motion as a transport mechanism. Long-term soil gas motions on the order of 1 x 10(E-8) cm/sec could increase gaseous radioactive isotope activities several orders of magnitude and greatly increase the detectability of U. This hypothesis should be explored further. A transient numerical model to simulate barometric influences on Rn 222 migration indicates that near-surface effects are plus or minus 15% for barometric fluctuations of 5-10 millibars amplitude, which would not affect the detectability of uranium. (LKH)

MATHEMATICAL; SOILS; RADIONUCLIDES; URANIUM; ORES; GEOCHEMISTRY; RADON; DAUGHTER PRODUCTS; GASES; KRYPTON; XENON; RADIONUCLIDE MIGRATION; DIFFUSION; THEORETICAL STUDIES

<204>
Kusuahiro, C., Y. Tanaka, T. Tamachi, and K. Takahashi, Kyoto University, Kyoto, Japan.

Tests for Behaviors of Radioactive Iodine Gas in Soils. Part 2. (3)

Bulletin of the Institute of Atomic Energy, Kyoto University, pp. 63; CRNL-tr-4553; 3 pp.(1973)

Tests of the transport properties of radioactive iodine gas in a soil column were conducted using samples of standard sand (from Toyoura), coarse river sand, fine river sand, and mountain soil (clay) packed in glass pipes. Air containing the iodine gas was fed through the pipes at a fixed flow rate and I 131 concentration at selected points was monitored using an NaI scintillation counter with lead collimator. The absolute quantity of iodine was determined by an iodinemetry method. The original data were interpolated to obtain the spatial distribution of iodine concentration at any given time. Test results are given. Results indicate there are 2 types of iodine adsorption: one easily desorbable (assumed for convenience to be of the Henry type), the other desorbable only with difficulty. The latter is considered to be a type in which adsorption probability is proportional to duration of contact with the gas, and an equation is given elaborating this relationship. According to this equation, adsorption increases as long as the supply of iodine gas lasts; however, in the actual test, a saturation effect was observed. In spite of this, the transport of iodine gas in soils can be well described by the equation. (LKH)

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<206> CONT.
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ABSORPTION; GASES; LABORATORY STUDIES; HALOGENS; RADIOCHEMISTRY; SANDS; CLAYS; SOILS; CONCENTRATIONS; DESORPTION; ISOTOPES; MODELS, MATHEMATICAL; EQUATIONS; RADIONUCLIDE MIGRATION; IODINE 131

<205>
Lacy, W.J., Oak Ridge National Laboratory, Oak Ridge, TN.

Radioactive Waste Disposal Report on Seepage Pit Liquid Waste - Shale Column Experiment. (2)

ORNL-2815; 21 pp.(1957, November)

The results of a laboratory column experiment utilizing Conasauga Shale and intermediate-level liquid wastes from the seepage pits at ORNL are presented in this report. The three primary objectives of this study were to develop methodology for prediction of breakthrough of radionuclides from the shale material, the order of appearance of the principal radionuclides in the breakthrough, and the leachability of sorbed radionuclides from the shale from infiltrating meteoric waters and flowing groundwater. It was established that breakthrough might be predicted by the monitoring of cesium 137 activity and the observance of significant rises in effluent cesium 137 activity. The order of breakthrough was shown to be ruthenium and rare earth elements, followed by strontium and cesium. Leaching of the saturated soil column by tapwater revealed the good retention capability of the Conasauga Shale. Fifty column volumes of freshwater was unable to remove more than one percent of the sorbed radionuclides. The capability of the shale was observed to be 7.7 x 10(E+8) dpm per gram. The poor retention of ruthenium was attributed to the formation of anionic complexes. (JC)

The results of this study represent an important source of ion exchange and description data relevant to the ORNL burial facility as well as to other sites with similar lithology. (DE/JC)

Ion Exchange Capacity; Total Ion Concentration

Ru 106; Cs 137; Sr 90; Rare Earths

ABSORPTION; SEEPAGE PITS; SHALES; CATION EXCHANGE CAPACITY; CATION CONCENTRATION; CESIUM; STRONTIUM; RUTHENIUM; CLAYS; EFFLUENTS; WASTES, RADIOACTIVE; LEACHING; WASTES, INTERMEDIATE-LEVEL; RADIONUCLIDE MIGRATION; LABORATORY STUDIES

<206>
Lands, E.P., L.N. Thorvig, and R.G. Gast, University of Minnesota, St. Paul, MN.

Effect of Selective Dissolution, Electrolytes, Aeration, and Sterilization on Technetium 99 Sorption by Soils. (2)

Journal of Environmental Quality 6(2):181-187,(1977, April-June)

The extent that Technetium 99 is sorbed from aqueous solution by 11 well-characterized Minnesota soils is determined. Also sorption mechanisms are elucidated. Technetium 99 is a persistent radionuclide with a half-life of 2.1 x 10(E+5) years and is produced at a rate of about 28 mg/day/MW. Technetium can potentially enter the environment from fuel meltdown, fuel cladding defects, coolant system leaks, nuclear medicine, and fallout from nuclear detonations. The physical and chemical properties of the soil samples were determined, but the mineralogy was left in a general format. The fine silt had mica, kaolinite, quartz, and feldspars. The fine clay was mainly montmorillonite with some mica and kaolinite. Only the Nicollet subsurface, Zimmerman surface, and Hegne did not sorb 98% of the Tc 99 (30 nCi/g) added to an aqueous solution at 25 degrees C over a 3 to 5 week period. Measurement of the pH before and after yielded no usable sorption vs pH trends. The soils that did not sorb 98% of the Tc 99 had a high organic content and by a dissolution treatment with H2O2 on one of the high organic soils the sorption reaction was stopped. By increasing the amount of Tc 99 to 3,000 nCi/g it was shown that the 30 nCi/g was below the sorption capacity of most of the soils because the 3,000 nCi/g was ultimately sorbed to the 98% level. The specific activity of Tc 99 is 17.2 mCi/g Tc. Anion exchange may also be a sorption mechanism when Tc 99 is added in small quantities as TcO_4^-. The slow kinetics of sorption suggests that the removal from solution may be related to microbial activity. This was substantiated when removal stopped after the soil was sterilized. The final study on aeration showed anaerobic conditions are not required for Tc 99 to be sorbed by soils. (SDW)

Grain Size Distribution; Cation Exchange Capacity; pH; Migration Rate

Tc 99

AIR; BETA PARTICLES; ANIONS; CATIONS; CHEMICAL PROPERTIES; CLADDING; ORGANIC COMPOUNDS; OXIDATION; pH; PHYSICAL PROPERTIES; HALF-LIFE, RADIOLOGICAL; SOILS, CLAYEY SAND; SOILS, SAND; SOILS, SANDY CLAY; TEMPERATURE; TIME FACTOR; KAOLINITE; MONTMORILLONITE; SPECIFIC ACTIVITY; SORPTION; LABORATORY STUDIES

<207>
Last, G.V., P.G. Easley, and D.G. Brown, Atlantic Richfield Hanford Company, Richland, WA.

Soil Moisture Transport During the 1974-1975 and 1975-1976 Water Years. (2)

ARH-ST-146; 133 pp.(1976, December)

The rate and direction of soil moisture movement in Hanford sediments was determined for the 1974-1975 and 1975-1976 water years. The data for these determinations were obtained from two large lysimeters located on the 200 Area plateau near the center of the Hanford Reservation. During the 1974-1975 water year, meteoric moisture percolated to a depth of 2.5 meters with a peak moisture content of 10.5 volume-percent. This percolation envelope was eliminated by evaporation during the hot dry summer of 1975. The 1975-1976 water year had only 70 percent of the normal precipitation; thus, the percolation envelope was small and penetrated to a depth of only two meters. However, in spite of this shallow depth and

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low volume of moisture, the percolation envelope was not eliminated by the end of the water year because of lower seasonal temperatures and higher humidity during the drying season. Moisture content of sediments in the 4-18 meter depth range showed no relative change throughout the two water years, and no moisture accumulated at the bottom of the lysimeters, which indicates there is no deep percolation of meteoric moisture at this site, and no recharge to the groundwater. (auth)

Information on the environmental characteristics of the Hanford shallow land, radioactive waste burial area is presented. (BB/TT)

Volumetric Water Content

SOILS; SEDIMENTS; MOISTURE; WATER; PERCOLATION; EVAPORATION; HYDROLOGY; GROUND WATER; PRECIPITATION, METEOROLOGICAL; FIELD STUDIES

<208>
Lebecka, J., and I. Touza, Glowny Instytut Gornictwa, Katowice, Poland.

Use of Liquid Scintillators for Determination of (In 114m) EDTA, Na2(S 35)O4, K(I 125) Utilized as Tracers in Studies of Mine Water Hazards. (3)

Revue de l'Institut d'Hygiene des Mines 32(2):76-83. (1977)

A new method of measuring radioactive tracers used in ground water studies is presented. The activity of the tracers (In 114m) EDTA, Na2(S 35)O4, and K(I 125) was measured by liquid scintillometry, allowing greater sensitivity than reported previously in the literature. Sensitivity of the method is 2.82 cps/pCi for In 114m) EDTA, 1.77 cps/pCi for Na2(S 35)O4, and 1.33 cps/pCi for K(I 125); minimum detectable concentrations are 1.53 X 10(E-13) Ci/cu dm, 3.12 X 10(E-13) Ci/cu dm, and 8.5 X 10(E-13) Ci/cu dm, respectively. (In 114m) EDTA was used in a practical test of the balance of waters drained to an underground coal slime settling tank; recovery of tracer in this case was 45%. Losses were attributed to leakage of water through pores and fissures in the rock and by some sorption. Estimated average flow time for water through the workings was 32 days. The method can be used for measurements of the migration and balance of waters used for hydraulic stowing, water balance in the case of utilizing mine workings left after coal extraction as underground settling tanks, or for any hydrologic studies requiring detection of tracers at very low concentrations. (LKB)

Total Ion Concentration

In 114m; S 35; I 125

TRACERS; GROUND WATER; HYDROLOGY; METHODS; SPECTROMETRY, SCINTILLATION; FIELD STUDIES

<209>
Leddicotte, G.W., W.A. Rodger, R.L. Prendberg, and W.W. Horton, Florida Power and Light Company, Miami, FL; Nuclear Safety Associates, Bethesda, MD.

Suggested Quantity and Concentration Limits to be Applied to Key Isotopes in Shallow Land Burial. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 10, (pp. 1073-1118), 1214 pp. (CONF-770512). (1979)

This paper introduces a methodology to develop isotopic limits, expressed both as quantities and concentrations, for the disposal of low-level radioactive wastes via shallow land burial. These limits were developed for two hypothetical sites, one in a humid region, the other in a dry area. In the calculations it has been assumed that 2.0 X 10(E+6) cu m of waste will be buried over 70 years; density of the waste is assumed to be 1200 kg/cu m and the concentration to be 1 nCi/gm, giving a total quantity of radioactivity of 2.4 X 10(E+3) Ci. The release pathways considered are: personal intrusion (excavation, inhalation, ingestion), natural intrusion (wind and water erosion of the burial site), abnormal events (earthquakes and meteor impacts), and site operational losses (spillage resulting in air or water contamination, and groundwater transport of radionuclide seepage to a watercourse). It is assumed that operational control of the site is lifted after 100 years. The limiting concentrations (in nCi/gm) for each isotope considered and the limiting pathway for each can be summarized as follows: H 3 = 5 X 10(E+9) by fractional spillage to water (dry site), 5 X 10(E+5) by site release to groundwater (humid site); Co 60 = 4 X 10(E+7) by fractional spillage to water (dry site), 4 X 10(E+8) by fractional spillage to water (humid site); Sr 90 = 3 X 10(E+5) by fractional spillage to water (dry site), 3 X 10(E+6) by fractional spillage of water (humid site); I 129 = 3 X 10(E-3) by site release to groundwater (dry site), 2 by site release to groundwater (humid site); Cs 137 = 2 X 10(E+7) by fractional spillage to water (dry site), 2 X 10(E+8) by fractional spillage to water (humid site); Pu 238 = 900 by wind erosion (dry site), 900 by wind erosion (humid site); Pu 239 = 500 by wind (or water) erosion (dry site), 500 by wind erosion (humid site); Pu 240 = same as Pu 239; Pu 241 = 9 X 10(E+7) by fractional spillage to air (dry site), 9 X 10(E+7) by fractional spillage to air (humid site); Pu 242 = same as Pu 239, 240; Am 241 = 400 by water erosion (dry site), 500 by food grown on site (humid site); Am 243 = 400 by food grown on site (dry site), 400 by food grown on site (humid site); Cm 242 = 6 X 10(E+5) by fractional spillage to air (dry site), 6 X 10(E+5) by fractional spillage to air (humid site); Cm 244 = 3 X 10(E+5) by fractional spillage to air (dry site), 3 X 10(E+5) by fractional spillage to air (humid site). The results of this study show that isotopic and concentration limitations, with one or two possible exceptions, do not limit the usability of existing or proposed shallow land burial sites. The limiting mode for operation of a site is more apt to be the annual spillage of materials as they are received and handled at the site rather than the escape of buried activity from the site. (LKM)

Extensive tabular data is provided in the text. See also G.W. Leddicotte, et al., "Suggested Concentration Limits for Shallow Land Burial of Radionuclides," Symposium Waste Management '78, Tucson, AZ, March, 1978.

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<209> CONT.
WASTES, LOW-LEVEL; BURIAL, SHALLOW; CONCENTRATIONS; RADIONUCLIDES; ENVIRONMENTAL EXPOSURE PATHWAY; RELEASE LIMITS; DISPOSAL SITE; INTRUSION; EXCAVATION; INHALATION; INGESTION; EROSION; EARTHQUAKES; METEORITES; ACCIDENTS; POLLUTION, WATER; POLLUTION, AIR; SEEPAGE; GROUND WATER; AGRICULTURE; THEORETICAL STUDIES; PREDICTIONS; RECOMMENDATIONS

<210>
Leddicotte, G.W., E.C. Yarnarzer, W.A. Rodger, R.L. Prendberg, and H.W. Horton, Florida Power and Light Company, Miami, FL; Yankee Atomic Electric Company; Nuclear Safety Associates, Bethesda, MD.

Suggested Concentration Limits for Shallow Land Burial of Radionuclides. (3)

Waste Management and Fuel Cycles '78, R.G. Post (Ed.), Proceedings of a Symposium, Tucson, AZ, March 6-8, 1978, (pp. 168-178), 661 pp. (1978)

An extention of work done for two hypothetical sites, one in a humid region, the other a dry region is reported on in this paper. In the first paper concentration of 14 key isotopes was suggested. The techniques used in the preparation of that paper were: to establish protection criteria for individuals and for populations; to evaluate a series of ways by which the buried radioactivity might come in contact with individuals or populations; and to calculate the limiting concentration for each pathway for each isotope which would meet the protection criteria. In the second paper the basic approach of the first was reviewed and reaffirmed. The protection criterion applied to individuals has been made more restrictive, and the study was extended to over 100 isotopes with practical significance. Included in the analysis was the effect of daughter products. Conclusions from this extended study are: subsurface migration of radioactivity into water is unimportant; the limiting pathways for all isotopes of importance are not site dependent; there is no need for NRC or EPA to key their programs for development of shallow land burial criteria or regulations to the completion of hydrogeological investigations in progress; no transuranic appears to require a limit lower than a few hundred nanocuries/gram; packaging and solidification of reactor wastes can only be justified for the possible mitigation of transport accidents; all routinely produced solid wastes at reactors should easily meet concentration limits acceptable for shallow land burial. (NDV)

Assumptions and data are compiled in extensive tables.

BURIAL; CONTAINMENT; DISPOSAL SITE; ENVIRONMENTAL EXPOSURE PATHWAY; GROUND WATER; GEOLOGY; HYDROLOGY; MODELS; RADIONUCLIDES; RADIONUCLIDE MIGRATION; SOILS; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, RADIOACTIVE; WASTES, SOLID; WASTES, LIQUID; THEORETICAL STUDIES; RECOMMENDATIONS

<211>
Lu, A.H., New York State Department of Health, Radiological Sciences Laboratory, Division of Laboratories and Research, Albany, NY.

Modeling of Radionuclide Migration from a Low-Level Radioactive Waste Burial Site. (3)

Health Physics 34:39-44. (1978, January)

A simplified mathematical model for analyzing the migration of leachate and radioactive material contained in radioactive waste burial trenches has been developed. The model is developed for application to the West Valley burial site or to sites with similar conditions. The soil in the burial area consists of a 28-m stratum of silty till, a very fine grained, heterogeneous mixture of clay and silt which contains minor amounts of sand and stone. It is dense, compact, and moist. A differential equation describing the distribution and movements of radioisotopes is analytically solved, assuming a constant flux of trench water infiltrating into a saturated porous medium which is not an aquifer. The calculated lateral migration for tritium as tritiated water agrees well with the field measurements, using a realistic value of the water velocity and an adjusted dispersion coefficient. For strontium, however, the results fit in an inordinately small distribution coefficient. Migration in silty till appears to be insignificant relative to the projected 1000-yr storage time, due primarily to low permeability and radioactive decay. (Auth) (PAF)

MODELS, MATHEMATICAL; WASTE STORAGE; RADIONUCLIDE MIGRATION; WASTES, LOW-LEVEL; THEORETICAL STUDIES; BURIAL; LEACHATES; TRENCHES; EQUATIONS; DISTRIBUTION; POROSITY; TRITIUM; GROUND WATER; DISPERSION COEFFICIENT; STRONTIUM; DISTRIBUTION COEFFICIENT; TILL; SILTS; PERMEABILITY; RADIOACTIVE DECAY

<212>
Marino, M.A.

Distribution of Contaminants in Porous Media Flow. (2)

Water Resources Research 10(5):1013-1018. (1974, October)

This paper presents a mathematical analysis of dispersion and adsorption of a radioactive contaminant in a homogeneous and isotonic porous half-space one dimensional medium with steady unidirectional flow. Boundary condition at origin is imposed on the concentration, and sources exponential in time are treated. A brief review of the analytical work done on contaminant transport up to 1974 is included. (00)

Good brief summary on analytical work on contaminant transport in half-space one-dimensional geometry. Uses concentration boundary conditions at origin. Treats exponential sources with equilibrium and non-equilibrium adsorption. (DM/00)

RADIATION SOURCES; DISPERSION; ADSORPTION; GROUND WATER; EQUATIONS; MODELS, MATHEMATICAL; REVIEWS; HYDRODYNAMICS; RADIONUCLIDE MIGRATION; THEORETICAL STUDIES

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Markham, O.D., K.W. Puphal, and T.D. Filer, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID; Los Alamos Scientific Laboratory, Los Alamos, NM.

Plutonium and Americium Contamination near a Transuranic Storage Area in Southeastern Idaho. (2)

Journal of Environmental Quality 7(3):422-428.(1978, July-September)

From 1954 through 1970, transuranic waste from the Rocky Flats facility near Golden, Colorado, was shipped to the Idaho National Engineering Laboratory and buried in the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex. Soil samples collected near the SDA indicate that ths storage has resulted in transuranic contamination outside the SDA perimeter. Maximum concentrations in surface soils (0-8 cm) occurred in the drainage depression near the perimeter of the SDA and were 2,088 nCi Am 241/sq m, 1,377 nCi Pu 239/sq m, and 32 nCi Pu 238/sq m. Contamination outside this drainage channel was lower and has primarily spread in the northeast-southwest directions. The maximum distances from the SDA perimeter that above background concentrations of Am 241, Pu 239, and Pu 238 could be detected were approximately 2,500, 2,400, and 1,000 m, respectively. Surface water runoff in 1962 and 1969 and wind transport appear to be the primary mechanisms which transported these nuclides out of the SDA. The vertical soil migration of Pu 238 from 0-4 cm to the 4-8 cm depth was significantly greater than that for Pu 239 (P=0.001). Hides and gastorintestinal tracts of deer mice (PEROMYSCUS MANICULATUS) had higher concentrations of transuranics than lungs or carcasses. Ingestion appeared to be a more important mechanism than inhalation in the intake of transuranics into the deer mice. The Am 241/Pu 239 ratio in the carcass was significantly (P=0.02) higher than the ratio in soil indicating a greater uptake of Am 241 into deer mice. The data indicate that Pu 238, Pu 239, and Am 241 may behave differently in the terrestrial environment. (Auth)

PLUTONIUM 238; PLUTONIUM 239; AMERICIUM 241; RODENTS; SITE SURVEILLANCE; FIELD STUDIES; SAMPLING; MEASUREMENTS; ISOTOPE RATIOS; WASTES, TRANSURANIC; WASTE STORAGE; BURIAL; RADIONUCLIDE MIGRATION; SOILS; SOIL TRANSPORT; RUNOFF; SURFACE WATERS; WINDS; BIOTA; INGESTION; INHALATION; DISPOSAL SITE

<213>
McFarlane, J.C., R.D. Rogers, and D.V. Bradley, Environmental Monitoring and Support Laboratory, Monitoring Systems Research and Development Division, Las Vegas, NV.

Environmental Tritium Oxidation in Surface Soil. (4)

Environmental Science and Technology 12(5):590-593.(1978, May)

The results of laboratory experiments to determine the reaction site, rate, and method of oxidation of elemental tritium (T2 or HT) to tritiated water (HTO) are presented. The investigation was initiated as a result of previously published data suggesting that rapid oxidation occurred in growth chambers containing lettuce plants. Prior to the lettuce plant experiments the oxidation of elemental tritium in natural systems was considered negligible. The site, rate and oxidation method was investigated by introduction of elemental tritium into closed systems containing attached leaves of living plants, detached leaves, water, aerated water, water on filter paper, hydrochloric acid, sodium hydroxide, humic material, sterilized soil, and natural soil. Conversion of elemental tritium to tritiated water was less than four percent in all systems except for the natural soil system where 100% oxidation was observed. Based on these results, a soil microbial oxidation was concluded to be the method. The soil profile data suggest the reaction to be a surface soil phenomenon. The conversion rates in natural soil were of the order of twenty percent per hour. (JC)

Although elemental tritium is rarely a component in burial trench contents, trench water evaporatory systems may introduce it into the surface environment. (DS/JC)

H 3

TRITIUM; SOILS; OXIDATION; PLANTS; MICROORGANISMS; FUEL REPROCESSING; EVAPORATION; UPTAKE; WASTES, GASEOUS; LABORATORY STUDIES

<213>
Means, J.L., D.A. Crerar, and J.O. Duguid, Princeton University, Department of Geological and Geophysical Sciences, Princeton, NJ; Battelle Columbus Laboratories, Energy and Environmental Systems Assessment Section, Columbus, OH.

Migration of Radioactive Wastes: Radionuclide Mobilization by Complexing Agents. (1)

Science 200:1477-1481.(1978, June 30)

Concentrations of Co 60 were recently found in the soil at Oak Ridge National Laboratory (ORNL) around seepage trench 7. The isotope has been found in concentrations up to 10(E+5) dpm/g in the soil and 10(E+3) dpm/ml in the water. Traces of I, Pu, Sr, In, and Ra have also been detected in water or soil from the area of trench 7. Cobalt 60 was found to be transported from the trench as an organic complexed ion and a portion of the migrating Co 60 was adsorbed by in sites. Experimentally measured distribution coefficients for Co 60 in weathered Conasauga shale were 7.0 x 10(E+4) and 1.12 x 10(E+4) at pH 6.7 and 12.0, respectively. In the presence of EDTA the values were reduced to 2.9 and 0.8. Analyses of filtered water from the Conasauga indicated that Co 60 did not readily exchange with cation-exchange resins. Only 5 to 10% of Co 60 is adsorbed by the resin. Other ion-exchange analyses showed the strength of Co 60 complexes with sulfate, nitrate, bicarbonate, carbonate, chloride, orthophosphate, pyrophosphate and metaphosphate was insufficient to produce the ion-exchange behavior of elution of Co 60 observed. Gel filtration chromatography was used to determine which of the synthetic chelates were responsible for mobilization. The profile produced indicated that the tetramethyl ester of EDTA was the mobilizing agent. This chelate is commonly used in decontamination operations at nuclear facilities. Other such weaker mobilizing agents detected were palmitic acid, phthalic acid and other mono- and dicarboxylic acids.

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EDTA is very persistent in the natural environment because it is resistant to radiation decomposition, thermally very stable, and slowly biodegradable. Significant concentrations of EDTA have already been detected. To lessen the effect of mobilization after treating low- and intermediate-level waste, the waste solution could be treated to remove the chelate. (NDV)

Distribution Coefficient; pH; Percent Absorption

Co 60

ACIDS; ACIDS, ORGANIC; ADSORPTION; BURIAL; CATIONS; COMPLEXES; CONTAMINATION; DISPOSAL SITE; DISTRIBUTION COEFFICIENT; ION EXCHANGE; LEACHING; pH; RADIONUCLIDE MIGRATION; RESINS; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; COBALT; SHALES; FIELD STUDIES

<216>
Means, J.L., D.A. Crerar, and J.O. Duguid, Princeton University, Department of Geological and Geophysical Sciences, Princeton, NJ; Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Chemical Mechanisms of Cobalt 60 Transport in Ground Water from Intermediate Level Liquid Waste Trench 7: Progress Report for Period Ending June 30, 1975. (1)

ORNL-TM-5349; Environmental Sciences Division Publication 980; 38 pp. (1976, November)

Cobalt 60 transport and absorption mechanisms, were investigated in a seep 50 meters east of trench 7 in the ORNL restricted area. Concentrations of Co 60 in the soil and water were 10(E+6) to 10(E+6) dpm/g and 10(E+3) dpm/ml. Transport occurred mainly by organic complexes which reduce the sediment adsorption capacity for the radionuclide. The ionic, weakly complexed Co 60 was absorbed by the manganese oxides in the Conasauga shale. Also the organic complexes were absorbed to a lesser extent by iron sesquioxides in both the shale and soil. When neither complexing agents are present, mobilization would be negligable because the sediment absorption capacity for inorganic forms of Co 60 is high. Calculations have shown that 85-98% of Co 60 is absorbed by MnO2 and 2-15% by Fe sesquioxides. In determining the transport and absorption mechanisms a computer program delineating the chemical equilibrium of the ground water was used. It calculated equilibrium activities and concentrations of 85 aqueous species and saturation state of a similar number of common minerals or amorphous solids. Since organic complexing characteristics of transition metals and transuranics are similar to those of Co 60, the study may be applied to plutonium and other alpha emitters. Traces of Sb 125 and various transuranics were detected in the soil around the seep. This method will provide insight into transport mechanisms and ultimately help control the movement of radionuclides in disposal area. (NDV)

Intensive tabular data are presented.

pH; Grain Size Distribution; Ion Exchange Capacity

Co 60; Sb 125; H 3

CONTAMINATION; GROUND WATER; ION EXCHANGE; pH; RADIONUCLIDE MIGRATION; TRENCHES; WASTES, INTERMEDIATE-LEVEL; WASTES, RADIOACTIVE; WASTES, LIQUID; WELLS; MANGANESE COMPOUNDS; PARTICLE SIZE; RESINS; ANIONS; SHALES; ORGANIC COMPOUNDS; ACIDS; CATIONS; CHELATES; IRON COMPOUNDS; COMPUTER PROGRAMS; SEPARATION PROCESSES; CHEMICAL ANALYSIS; SOILS; CLAYS; COMPLEXES; RADIOCHEMISTRY; GEOLOGY; HYDROLOGY; SEEPAGE; FIELD STUDIES

<217>
Miller, J.B., and E.F. Reitemeier, U.S. Department of Agriculture, Agricultural Research Service, Soil and Water Conservation Research Division, Beltsville, MD.

The Leaching of Radiostrontium and Radiocesium through Soils. (2)

Soil Science Society of America, Proceedings 27:141-146. (1963)

Sr 90 and Cs 137 are hazardous, long-lived, nuclear fission products. Experiments were conducted in the greenhouse to determine their downward movement in soils under intensive leaching. The five soils (Norfolk, Pacerstown, Miami, Port Collins, and Huntley series) selected for the investigation represented a wide range of soil properties, and the leaching treatments consisted of 30 inches and 300 inches of deionized water, 0.005N NaCl, and 0.005N CaCl2. Cation exchange capacity, pH calcium carbonate equivalent, and organic matter were parameters of interest for each soil. There was little downward movement of Cs 134 when the soils received the applications of deionized water, NaCl, or CaCl2. Radioactive assays of the soil columns showed that 96.6 to 100% of the Cs 134 was in the surface two layers of the soil columns (average depth 1.4 inches) after 300 inches of leaching. The slight movement of cesium in the test soils is due to the low exchange ability of absorbed Cs and fixation in a nonexchangeable form. In the leaching experiment with Sr, the CaCl2 produced the greatest movement of Sr 89 and deionized water the least. The maximum distance Sr 89 penetrated into the soils when leached with 30 inches of water was 1.3 inches, and with 300 inches of water the distance was 6.7 inches. In general, there was more movement of Sr 89 in the Norfolk soil and least in the Huntley, with the other soils being intermediate. The difference in movement between the two soils is the large difference in the exchange capacity. Other factors important in the movement of Sr are: pH, organic matter content, composition of the exchangeable cations, and predominate type of clay mineral. Possible factors affecting migration of Sr and Cs are: freezing and thawing, presence of macroscopic cracks, wetting and drying cycles, and the burrowing of earthworms and other small animals. (Auth) (NDV)

pH; Cation Exchange Capacity

Sr 89; Cs 134

BREAKTHROUGH DISTRIBUTION; ANIMALS, BURROWING; CATIONS; CALCIUM COMPOUNDS; FISSION PRODUCTS; ION EXCHANGE; ADSORPTION; LABORATORY STUDIES; LEACHING; pH; RADIONUCLIDE MIGRATION; SOILS, CLAY; UPTAKE; WASTES, RADIOACTIVE

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Motisawa, S., Y. Inoue, Y. Wadachi, and K. Kato, Kyoto University, Faculty of Engineering, Department of Sanitary Engineering, Kyoto, Japan; Japan Atomic Energy Research Institute, Tokai Establishment, Health Physics Section, Tokai, Japan.

Radiological Safety Assessment for a Low-Level Radioactive Solid Waste Storage Facility: Preliminary Risk Evaluation by Reliability Techniques. (2)

Health Physics 35(6):817-838.(1978, December)

The applicability of reliability techniques was examined to determine the quantitative risks which would be caused by a low-level radioactive solid waste storage facility. Fault trees and event trees were defined based on many relevant assumptions to achieve the average occurrence rate of rare accidents which could lead to potential hazards to the general public. The amount of radioactivity which would be transported into the environment from a storage facility was calculated using assumption and/or estimates of the magnitude of each accident, together with the estimates of probability of occurrence, and was used as an index for measuring the potential risks. Some valuable results were obtained in this study under the limits considered. These are as follows: (1) Reliability techniques are effective and promising for achieving the quantitative risks due to storing radioactive wastes in a waste package storage facility for long time periods; (2) The main failures associated with an accident are summarized and listed; (3) The advantages and disadvantages of two types of waste package storage rooms and the amounts of radioactivity which would be released accidentally from them are also summarized and listed; and (4) The improvements desired for a storage facilty are proposed from a radiological safety aspect. (Auth)

THEORETICAL STUDIES; SAFETY; EVALUATION; WASTES, LOW-LEVEL; WASTE STORAGE; WASTES, SOLID; ACCIDENTS; HAZARD ANALYSIS; RADIONUCLIDE MIGRATION; MODELS, MATHEMATICAL; PACKAGING; LEACHING; CESIUM 137

<219>
Hualem, Y., and G. Dagan, Colorado State University, Fort Collins, CO; Tel-Aviv University, Israel.

Hydraulic Conductivity of Soils: Unified Approach to the Statistical Models. (2)

Soil Science Society of America Journal 42:392-395. (1978)

Models for describing hydraulic conductivity of unsaturated porous media are derived systematically using some common statistical principles. Derivation of these models is presented in full theoretical detail with the mathematical detail. Formulas derived from these methods are classified into three categories: (1) universal formulas independent of the soil type which result from extremely simplifying assumptions; (2) formulas with one degree of freedom; and (3) formulas with two degrees of freedom. Empirical determination of parameters will be done. (NDV)

EQUATIONS; FLUID MECHANICS; HYDRODYNAMICS; MODELS, MATHEMATICAL; PREDICTIONS; THEORETICAL STUDIES; UNSATURATED ZONE; SOILS; HYDRAULIC CONDUCTIVITY; STATISTICS

<220>
Nelson, J.L., Hanford Laboratories Operation, Richland, WA.

Recent Studies at Hanford on Soil and Mineral Reactions in Waste Disposal. (1)

Ground Disposal of Radioactive Wastes, W.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959. University of California, Berkeley, CA, (pp. 70-92), 168 pp.(1961, July)

Results of studies on the reactions between Hanford soils and fission products are reported. The experiments were done in the laboratory and appropriate field studies were also done. Temperature was the first variable studied. Columns ranging from 19 degree C to 83 degree C were set up and it was found that as the hydration of the complementary ion decreases, increased temperature becomes beneficial to radionuclide uptake. In this case it could be predicted that Cs ion uptake would be maximum at the lower temperatures because it is the least hydrated of the common ions. From studying various Kd values at different temperatures it was found that Sr is likely to be adsorbed in quantities 25 times greater if Na rather than Ca is present. When Mg is increased by 10 times Sr sorption is decreased by 3.6 times. At high pH values there is no decrease of Sr sorption. However, when Ba is present the pH effect is less than it is when Na is present. The length and diameter of the columns used was investigated to see which is more important. By comparing breakthrough curves it was found that length was more important. A model waste crib was located in uniform fine sand 9.3 feet above the water table. Breakthrough at the 50% level of Sr 85 was achieved at 6710 gallons and 5% breakthrough was at 5170 gallons. The latter is higher than the theoretical indicating qualitative agreement with the column length data. It was noted in a mineral reactions study that calcite of 0.05 to 0.25 mm grain size removed 69.2% strontium. High pH favors such a removal rate as does a low flow rate. With rates of 10 ml/sq cm/hr the decontamination factor can be as high as 10(E+6). The mineral clinoptilolite was found to be useful at pH values as low as 1.0 and only loses 20% of its capacity from pH 12 to 1. (NDV)

Temperature; Distribution Coefficient; Depth to Water Table; pH; Grain Size Distribution

Sr 85

ADSORPTION; BREAKTHROUGH DISTRIBUTION; CLINOPTILOLITE; CONTAINMENT; DECONTAMINATION FACTORS; DISTRIBUTION COEFFICIENT; FIELD STUDIES; CALCITE; LABORATORY STUDIES; PIEZOMETRIC SURFACE; RADIONUCLIDE MIGRATION; TEMPERATURE; WASTE DISPOSAL; WASTES, LIQUID; pH; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; STRONTIUM; LABORATORY STUDIES; FIELD STUDIES

<221>
Nelson, R.W., and W.A. Haney, General Electric

<221> CONT.
Company, Hanford Atomic Products Operation, Richland, WA.

Analog Simulation of Hanford Ground Water Flow. (3)

Retention and Migration of Rad ioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962, (pp. 131-138).(1963)

The first phases of development of an electric analog for ground water flow at the Hanford Reservation are presented. Ultimately this analog will be used to answer questions about how and where radionuclides migrate in the soil. The analog method allows for solution of the flow problem using irregular boundaries and varying permeabilities. Partial differenial equations are used to solve the flow equations and to find the equivalent electric network equation coefficeints. One of the problems in using this method is accurate knowledge of the permeability in the area of study. To that end measurements are being developed and tested. Problems still exist but are being resolved. (NDV)

DISPOSAL SITE; EQUATIONS; GROUND WATER; HYDRODYNAMICS; MODELS, MATHEMATICAL; RADIONUCLIDE MIGRATION; THEORETICAL STUDIES; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, LOW-LEVEL

<222>
Nishita, H., P. Taylor, G.V. Alexander, and F.E. Larson, University of California, Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles, CA.

Influence of Stable Cesium and Potassium on the Reactions of Cesium 137 and Potassium 42 in Soils and Clay Minerals. (1)

Soil Science 94:187-197,(1962, July-December)

Experiments were conducted to study the influence of stable Cs and K on the reactions of tracer quantities of Cs 137 and K 42 in soils and clay minerals, using an equilibrium batch method. The cation exchange capacity at various pH values were listed for the clays. Tracer quantities of both Cs 137 and K 42 were strongly sorbed in soils and clay minerals. Cesium was more strongly sorbed than K. Since the initial trace quantities of carrier-free Cs 137 were very strongly sorbed, the sequence of the addition of the tracer radioisotope in relation to the addition of stable Cs and K determined the level at which equilibrium was attained. The absolute amount of Cs and K sorption depended on the kind of clay mineral and soil. Cesium sorption relative to K was greater in Ca-clay than in H-Al-clay. The concentration of the stable Cs and K present was also an important factor. When the tracer Cs 137 was diluted to a negligible fraction of the total Cs in solution, only a negligible fraction of Cs 137 was sorbed. In equimolar mixtures of Cs and K, the sorption of Cs relative to K decreased as the ionic concentration increased. As a corollary to this effect, under conditions of low ionic concentration, stable Cs was much more effective than K in releasing Cs 137 from soils. In high concentration, however, K may be in certain soils, as effective as stable Cs. (Auth) (NDV)

Cation Exchange Capacity; pH

Cs 137; K 42

SORPTION; BENTONITE; CATIONS; ION EXCHANGE CAPACITY; LEACHING; LABORATORY STUDIES; pH; RADIONUCLIDE MIGRATION; SOILS; WASTE DISPOSAL; WASTES, RADIOACTIVE

<223>
Orcutt, B.G., I. Nagy, G. Klein, and W.J. Kaufman, University of California, Division of Civil Engineering; and Irrigation, Berkeley, CA.

Hydraulic and Ion-Exchange Phenomena in the Underground Movement of Radiostrontium. (3)

TID-7517 (Part 1A): Sanitary Engineering Aspects of the Atomic Energy Industry, Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 191-211) (TID-7517, Part 1A).(1956, October)

Theory and experimental results are presented for flow of a two density liquid system in an aquifer and the related ion exchange. Factors considered to influence the movement of radioactive wastes are: difference in density between the injected and displaced liquids causing an intrusion wedge; fissures; solution cavities; and regions of high permeability. A detailed discussion is presented on various [illegible] nature of laminar flow through a complex system of interconnected capillaries and the dispersion of a liquid interface. It is found that the steeper breakthrough curves result from a homogenous media of relatively high permeability. These media would be more satisfactory for a disposal formation. The model used in the experiments is the Hele-Shaw model of Two-Fluid Flow. This model was used to determine the magnitude and relative significance of density tilting and to evaluate the applicability of the Hele-Shaw viscous flow model to the study of gross velocity variation created by the existence of a difference in densities between injected and displaced liquids. Since the position of the boundary between the two fluids is continually shifting, the flow pattern of the interfacial liquid was resolved into two independent motions, a "longitudinal translatory motion" and a "rotational tilting motion". These two were presumed linear and could be added by algebraic addition for a general solution. The density tilting is related to the formation parameters and can contribute significantly to the maximum rate of underground waste travel. The chemistry of ion exchange is considered in general theoretical terms. Considered to be important in controlling the property are: the degree of contamination of the medium, the presence of other cations, and particularly hydrogen ion. With a favorable equilibrium relatively steep breakthrough curves result. A flattening of a breakthrough curve due to either an unfavorable equilibrium constant or to a failure to achieve equilibrium between the liquid and solid phases, would cause an inefficient utilization of the ion-exchange component of the storage capacity of a formation. It was found that ion-exchange may increase the storage capacity of a medium by ten fold. The storage capacity of a formation will be determined by the breakthrough of the waste at the maximum permissible concentration. When the radwastes has a selective affinity for the

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exchange medium the concentration front may be sharp and a more complete utilization of exchange capacity made possible. When the radiocontaminant is not selectively sorbed the radwaste will travel further into formation. (MDV)

Good presentation of theoretical fluid mechanic and ion-exchange considerations is given.

BREAKTHROUGH DISTRIBUTION; CAPILLARY STRUCTURE; CONTAINMENT; DIFFUSION; DISPERSIVITY; DISTRIBUTION; HYDRODYNAMICS; INFILTRATION; ION EXCHANGE; LABORATORY STUDIES; MAXIMUM PERMISSIBLE CONCENTRATION; MODELS; PREDICTIONS; ROCK-FLUID INTERACTIONS; SOILS; THEORETICAL STUDIES; WASTE DISPOSAL; WASTES, LIQUID

<224>
Parsons, P.J., Atomic Energy of Canada Limited, Chalk River, Ontario, Canada.

Migration from a Disposal of Radioactive Liquid in Sands. (1)

Health Physics 9:333-342. (1963)

A migration study was done on radioactive wastes that were disposed of in a pit at the Chalk River Project. The pit is in a low lying area with many lakes and swamps. Sand and till cover bedrock terraces and the soils are sorted into bands oriented along the terrace with the coarser material lying over the inner regions and the finer material deposited near the outer limits of the terrace. In some places the sand is 50 ft thick. The soil has a low permeability of 2 cu ft/sq ft/day and the sand has a cation exchange capacity of 1 meq/100 mg. The total activity from all waste solution was estimated to be 1000 to 1500 Ci of mixed fission products, which contains 700 to 1000 Ci of Sr 90 and 200 to 300 Ci of Cs 137. To trace the migration of the radionuclides in soil and groundwater, samples were taken in an arc approximating a flow line of water with transverse lines to determine the cross section of the migration. Strontium 90 was found to vary from zero near the pit to 2.5% Ci/ft at 325 ft from the pit and it diminished to near zero again at 650 ft from the pit. Cesium 137 remained in the sand beneath the pit where the concentration was 0.05 mCi/g and diminished with depth to 1.0 uCi/g. At the water table the contamination dropped another 2 orders of magnitude. Sampling also showed that Ru 106 moved away from the pit rapidly with the groundwater. It is postulated that the Ru 106 moved close to the surface of the water table taking a more direct route across the terrace than the Sr 90. Ruthenium entered the surface water after a 3-yr underground migration. Strontium migrated 250 ft after the first year and in the five subsequent years only 160 ft. At this rate the maximum anticipated concentration of Sr 90 entering the stream is 6.5 x 10(E-7) uCi/ml. While the area is far from the ideal disposal area with the shallow water table and low cation capacity, it is noteworthy that 1000 Ci has migrated only 600 yards. (MDV)

Depth to Water Table; Permeability Coefficient; Stratigraphic Unit Thickness; Cation Exchange Capacity

Sr 90; Ru 106; Cs 137

BEDROCK; BURIAL; BREAKTHROUGH DISTRIBUTION; CATIONS; CONTAMINATION; CONTAINMENT; DIFFUSION; DILUTION; DISPERSIVITY; DRAINAGE BASINS; FIELD STUDIES; FISSION PRODUCTS; GEOLOGY; GROUND WATER; HYDRODYNAMICS; HYDROLOGY; ION EXCHANGE CAPACITY; LAKES; MAXIMUM PERMISSIBLE CONCENTRATION; PERCOLATION; PERMEABILITY; RADIONUCLIDE MIGRATION; RIVERS; SANDS; SOILS; SILTS; SORPTION; SEEPAGE PITS; UNSATURATED ZONE; WASTE DISPOSAL; WASTES, LIQUID; WASTES, RADIOACTIVE; FRESHWATER SYSTEMS

<225>
Phillips, S.J., Battelle-Pacific Northwest Laboratories, Richland, WA.

Monitoring and Physical Characterization of Unsaturated Zone Transport. (2)

BNWL-2377-2; Nuclear Waste Management Quarterly Progress Report, April through June, 1977, A.M. Platt (Comp.), (pp. 11.1 - 11.3), 51 pp. (BNWL-2377-2). (1977, November)

The project reported on is charged with developing monitoring instrumentation systems and burial media-waste characterization methods to evaluate low-level radwaste migration from burial sites. Evaluation of several specific transducer and monitoring systems capable of accessing fluid and vapor phase water and radwaste transport through burial media is one task. The system is to be used in an arid region under the subsurface is partially saturated conditions. Two systems being evaluated are: a heat dissipation ceramic block and a thermocouple psychrometer. Further studies on soil chemistry and soil physics are being done. Base lines have been determined for fluid retentivity, conductivity, pH moisture percentage, saturation paste chemical composition, cation exchange capacity, organic carbon content, calcium carbonate content, particle size distribution, and selectivity constants. An empirical selectivity constant with a correction term was derived. Tests using synthetic groundwaters were done to evaluate the distribution coefficients. Studies have also been started to solve one-space fluid flux and dispersivity in one-to-one models using transport in isotropic homogeneous materials. Field monitoring systems are being placed in an area next to a retired burial facility. Instruments to measure evapotranspiration and temperature flux are expected to aid in quantifying energy and mass balance of shallow land waste burial sites. (MDV)

CATION EXCHANGE CAPACITY; CONTAINMENT; CONTAMINATION; DISPOSAL SITE; EQUATIONS; FIELD STUDIES; GROUND WATER; CALCIUM CARBONATE; ISOTOPES; LABORATORY STUDIES; MONITORING; MODELS; PARTICLE SIZE; RADIONUCLIDE MIGRATION; ROCK-FLUID INTERACTIONS; SOILS; TRENCHES; UNSATURATED ZONE; WASTE MANAGEMENT; WASTES, LOW-LEVEL

<226>
Phillips, S.J. (Project Manager), Battelle-Pacific Northwest Laboratories, Richland, WA.

Monitoring and Physical Characterization of Unsaturated Zone Transport. (3)

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PNL-2377-3; Nuclear Waste Management Quarterly Progress Report, July through September 1977, A.M. Platt, (pp. 11.1-11.5). (1978, February)

The objective of this project is to develop monitoring instrumentation systems and burial media-waste characterization methods to evaluate the migration of contaminants from disposal sites for low-level solid waste. The project has been subdivided into 3 tasks: Laboratory Analysis, Physical Modeling, and Field Monitoring and Data Evaluation. Studies include, among others, X-ray diffraction analyses of 2 generic Hanford sediments and examination of Na, K, Ca, and Mg ion exchange reactions in the soil. Data has been obtained to evaluate the total diffusivity and contributions of vapor- and liquid-phase constituents. Physical models of contaminant transport have been constructed, and environmental and subterranean parameters of waste burial sites (including porous media flow, thermal inertia and flux, and evapotranspiration) are being monitored in situ. A draft document describing theoretical, numerical analysis, laboratory analysis, and in situ monitoring has been written and initially reviewed. (LKH)

BURIAL, SHALLOW; CATIONS; CLAYS; HEAT EXCHANGE; KAOLINITE; FIELD STUDIES; LABORATORY STUDIES; MODELS; MONITORING; SOILS; SATURATED ZONE; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, RADIOACTIVE; HYDROSICAS; EQUATIONS; ION EXCHANGE; SEDIMENTS; THEORETICAL STUDIES; REVIEWS

<227>
Prudic, D.E., and A.D. Randall, U.S. Geological Survey, Albany, NY.

Ground-Water Hydrology and Subsurface Migration of Radioisotopes at a Low-Level Solid Radioactive-Waste Disposal Site, West Valley, New York. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 8, (pp. 853-882), 1214 pp. (CONF-770512). (1979)

Burial trenches for disposal of solid radioactive waste at West Valley, NY, are excavated in till that has very low hydraulic conductivity (about 5 X 10(E-8) cm/sec). Fractures and root tubes with chemically oxidized and/or reduced soil in their walls extend 3 to 4.5 m below natural land surface. Preliminary simulations of pressure heads with a digital model suggest that hydraulic conductivity is an order of magnitude greater in the fractured till near land surface than at greater depth. Hydraulic gradients are predominantly downward, even beneath small valleys. The upper part of a body of underlying lacustrine silt is unsaturated; in the lower, saturated part, slow lateral flow may occur. It is estimated that over 400 years would be required for water moving downward and laterally from the trenches to reach Buttersilk Creek, the nearest stream. In the older trenches, water began to build up in 1971, overflowed briefly in 1975, and was pumped out in 1975-76. Water levels rose abruptly during major rainstorms in mid-1975, indicating rapid infiltration through cracks in the cover material. The new trenches have maintained low, stable water levels, perhaps because of thicker, more compact cover and less waste settlement; pressure heads near these trenches are low, locally approaching zero, perhaps because of slight infiltration and limited near-surface storage. Two hundred fifty cores from the 1975 test drilling, mostly from holes within 5 m of nominal trench boundaries, were analyzed for H 3. In nearly all holes, peak tritium concentrations (generally 10(E-5) to 10(E-3) uCi/ml were found within 3 m of land surface and are attributed to surface contamination. Concentrations declined rapidly with depth within the fractured till; secondary peaks found at about 9 m in three holes are attributed to lateral migration from trenches. Tritium concentrations were generally less than 10(E-6) uCi/ml in the unaltered till below the oxidized fractures. Other radioisotopes were detected only near land surface. Samples from the walls of shallow fractures revealed no accumulation of radioisotopes. Experience and data available through 1976 demonstrate that under the conditions existing at West Valley, radioisotopes are far less likely to reach the environment by subsurface seepage than by saturation and overflow of the trenches, which can occur when there is substantial recharge through cracks in the cover. (Auth) (LKH)

Hydraulic Conductivity; Total Ion Concentration

H 3

TRENCHES; BURIAL, SHALLOW; DISPOSAL SITE; TILL; HYDRAULIC CONDUCTIVITY; FRACTURES; ROOTS; HYDRAULIC HEAD; HYDRAULIC GRADIENT; SILTS; SEDIMENTS; HYDRAULIC FLOW; SEEPAGE; CORES; TRITIUM; SURFACE CONTAMINATION; RADIONUCLIDES; RADIONUCLIDE MIGRATION; OVERFLOWS; FIELD STUDIES

<226>
Purtyman, W.D., Los Alamos Scientific Laboratory, Los Alamos, NM.

Storm Runoff and Transport of Radionuclides in DP Canyon, Los Alamos County, New Mexico. (2)

LA-5748; 9 pp. (1974, October)

Effluents from the waste treatment plant at Los Alamos Scientific Laboratory's Technical Area 21 are released into DP Canyon. The radionuclides remaining in the effluents are bound to stream-channel sediments which are later carried out of the canyon by storm runoff. A study was made to determine the runoff volume, the suspended-sediment load, and the amount of radioactivity carried out of DP Canyon by storm runoff. During the summer of 1967, precipitation resulted in 23 runoff events that carried approximately 88,000 kg of suspended sediments out of the canyon in approximately 36,800 cu m of water. Less than 7% uCi of gross alpha emitter and approximately 40,100 uCi of gross beta were carried out of the canyon in solution. The suspended sediments carried out approximately 70 uCi of gross alpha emitters and approximately 11,300 uCi of gross beta emitters. About 31,000 uCi of Sr 90 left the canyon in solution, as did traces of Pu 238, Pu 239, and Am 241. (Auth)

Sr 90; Pu 238; Pu 239; Am 241

RUNOFF; WASTES, LIQUID; WASTES, LOW-LEVEL; RADIONUCLIDE MIGRATION; EFFLUENTS; WASTE TREATMENT; SEDIMENTS; STREAMS; ALPHA PARTICLES;

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BETA PARTICLES; PRECIPITATION, METEOROLOGICAL; STRONTIUM 90; PLUTONIUM 239; PLUTONIUM 238; AMERICIUM 241; IONS; ROCKS; PARTICLE SIZE; QUARTZ; SILTS; SANDS; GRAVELS; CLAYS; SOLUBILITY; FIELD STUDIES

<229>
Fortyune, W.D. J.R. Buchholz, and T.E. Hakonson, Los Alamos Scientific Laboratory, Los Alamos, NM.

Chemical Quality of Effluents and their Influence on Water Quality in a Shallow Aquifer. (4)

LA-6898-PR; Biomedical and Environmental Research Program for the LASL Health Division, January-December 1976, (pp. 88-91). (1977, July)

Industrial liquid effluents were discharged to a creek after treatment for removal of most of the radioactive constituents. The stream water and water in a shallow aquifer fed by the stream were studied from 1963 to 1976 to determine changes in water quality. It was found that the release of effluents into the stream has degraded the quality of water in the aquifer. A direct relationship between relative amounts of various ions in the effluents, such as calcium, magnesium, sodium chloride, nitrates, and dissolved solids, and the increases in occurrence of each of these ions in the aquifer water exists. Only a dilution factor from storm runoff alters concentrations. No build up of chemicals is occurring indicating that rapid turnover of water in stream limits total chemical concentrations. (CAB)

Indirectly related to shallow land burial. (DH/CAB)

pH

WASTES, LIQUID; AQUIFERS; GROUND WATER; CONTAMINANTS; EFFLUENTS, CHEMICAL; pH; STREAMS; RUNOFF; WASTES, INDUSTRIAL; FIELD STUDIES

<230>
Fortyune, W.D., R. Garde, and R. Peters, Los Alamos Scientific Laboratory, Los Alamos, NM.

Movement of Fluids and Plutonium from Shafts at Los Alamos, New Mexico. (2)

LA-7378-MS; 6 pp. (1978, June)

The movement of fluids and Pu from LASL Plutonium Processing Facility wastes disposed in shafts drilled into rhyolite tuff were studied under normal and test conditions. During normal operations of the waste treatment plant at LASL, a Fe(OH)3 sludge is mixed with cement and disposed as a paste into shafts. Under these conditions there was no indication of movement of fluids into the tuff; however, there was some movement of paste into open joints that intersected the shafts. As a special test, 2.9 X 10(E+3) L of Fe(OH)3 sludge (Pu content 1.3 X 10(E-4) Ci) without cement was put into an experimental shaft in two batches; 1.5 X 10(E+3) L were disposed on March 29, 1968, and 1.4 X 10(E+3) L on May 13, 1968. Cores were recovered from 3 surrounding test holes about 9 months after the study began to assess Pu movement from the sludge. The cores showed Pu 238 30 cm from the shaft at 4.6-5.5 m depth; Pu 239 was detectable out to 60 cm at 5-5.5 m. This difference is due to the large amount of Pu 239 in the sludge (90%), rather than to differences in migration behavior. Fluids in the sludge carried trace amounts (1.1 X 10(E-6) Ci) of Pu from the shaft, but an inventory indicated more than 7% remained absorbed or attached to the sludge in the shaft. The major mechanism for Pu transport from the sludge was fluid movement into the tuff. Test holes drilled adjacent to a cement-paste filled shaft indicated no loss of fluids into the tuff from hydration of the cement-paste mixture. Thus, movement or transport of contaminants is very unlikely because of the lack of fluids. (LKE)

Pu 238; Pu 239

TUFFS; RHYOLITES; IGNEOUS ROCKS; SLUDGES; CEMENTS; GROUTING; SHAFTS; DISPOSAL SITE; STORAGE, GEOLOGIC; BOREHOLES; CORES; JOINTS; PLUTONIUM 239; PLUTONIUM 238; RADIONUCLIDE MIGRATION; FIELD STUDIES; WASTE DISPOSAL; WASTE MANAGEMENT

<231>
Bascon, D., CEA, Center d'Etudes Nucleaires de Cadarache, France.

Mechanism of Radioactive Contamination in Consolidated Impermeable Rocks or Rocks of Very Low Permeability. (2)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29 - June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 179-198), 666 pp. (STI/PUB/156). (1967, June)

The geochemical studies of radioactive contamination carried out so far have been mainly concerned with granular rocks (clay and soil) in which, owing to the infiltration of water, the radioisotopes are retained by micrograins or microcrystals of clay. But a circulation of radioactive effluents can also affect consolidated rocks which are impermeable or of very low permeability. The retention phenomena are then different, since they occur mainly on the surface. In order to determine the capacity of a body to retain a given radioisotope, use is made of the distribution coefficient or Kd. This value, which is characteristic of granular rock for a given radioisotope, is not characteristic of a consolidated rock. We have, however, devised a law expressing the variation of this Kd measured as a function of the thickness of penetration (e) of the liquid and of the dimension of the rock, which was experimentally verified by measuring the Kd as a function of the diameter x of the grains in the rock. Similarly it has been found that this measured Kd increases linearly with the specific surface of the rock. Thus, the Kd does not represent a physico-chemical characteristic when applied to rocks of very low permeability, since it is dependent upon grain size and the specific surface. Accordingly, an alternative concept has been defined for uptake by rocks of this nature, i.e. the surface distribution coefficient, or Kd(S). Experience has shown that this value of Kd(S) was constant and characteristic of a rock and a radioisotope for a specific contact time. The author describes the methods used to ascertain the retention

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stability of the radioisotope on the rock and the kinetic study of its diffusion. (Auth)

Procedures for whole rock distribution coefficients are outlined. (DH/JC)

Distribution Coefficient

Cs 137; Sr 90

ADSORPTION; DISTRIBUTION COEFFICIENT; ROCKS; GEOCHEMISTRY; CLAYS; WASTES, RADIOACTIVE; PERMEABILITY; HYDROLOGY; GEOLOGY; RADIONUCLIDE MIGRATION; THEORETICAL STUDIES

<232>
Rhodes, D.W., General Electric Company, Hanford Atomic Products Operation, Richland, WA.

Waste Characteristics Governing Fixation in Soils. (U)

TID-7550; Fixation of Radioactivity in Stable, Solid Media, Proceedings of a Conference, Baltimore, MD, June 19-21, 1957, U.S. Atomic Energy Commission, Oak Ridge, TN, (pp. 1-3), 102 pp. (TID-7550). (1958, March)

Research conducted on the fixation of radioisotopes on soils at Hanford is detailed in this report. Wastes studied fall into the categories generally classed as low-level and intermediate-level waste solutions. The equilibrium uptake on soils of most of the isotopes studied was found to be greatly influenced by the pH of the system. The adsorption of cesium, strontium, yttrium, and cerium from distilled water solutions is much greater when the equilibrium system is alkaline than when it is in the acid range. Hanford waste solutions destined for ground discharge are neutralized to a pH of 9 to 11. The adsorption by soil of ruthenium, plutonium, and zirconium is less sensitive to pH changes over a wide range, although below a pH of 2, equilibrium exchange of these ions on soil also undergoes a marked decrease. The equilibrium exchange, Kd, (also known as the distribution coefficient) of strontium in distilled water for calcium on soil is 4 at pH 5.0 increasing to 130 at pH 11. Cesium shows a somewhat less marked effect having a Kd value of 90 at pH 5.0 and a Kd value of 240 at pH 11. The influence of pH on the equilibrium-exchange constants of yttrium and cerium is more complex, with Kd values reaching a maximum greater than 1000 between pH 6 to 8 and a second maximum at pH 12. These Kd values are all quoted for a cation concentration of 10(E-6) M. The influence of pH on the equilibrium exchange of other polyvalent ions such as plutonium, ruthenium, and zirconium is complicated by other reactions such as changes in oxidation state and polymer formation. These ions display a maximum equilibrium exchange in soils from distilled water solutions between pH 4 and pH 8 and a second maximum above pH 12. For systems in which the total amount of cations in the solution does not exceed 0.1 percent of the total exchange capacity of the soil, no influence of cation concentration on the equilibrium exchange is observed, but Kd values decrease when the total cation concentration in the solution exceeds the limit. For the cations studied, increases in the total concentration of dissolved salts decrease the equilibrium exchange constants with soils. The presence of other species of cations has no appreciable effect on Kd values obtained for a cation if the total amount of all cations present is less than 0.1% of the soil saturation capacity. The presence of aluminum compounds significantly effects the equilibrium exchange of certain isotopes, such as strontium. Data indicates the occurrence of an interaction between aluminum and the strontium ion, rather than any reaction of aluminum with ion-exchange sites. Phosphate has been found to increase the Kd values for strontium due to a shift in exchange reaction equilibrium as a result of a phosphate reaction with adsorbed strontium that either tends to hinder its replacement by other ions or permits the adsorption of additional strontium. (MRT)

pH; Distribution Coefficient

Cs; Y; Sr; Ru; Pu; Zr; Ce

pH; SALTS; ALUMINUM; ANIONS; CATIONS; ION EXCHANGE; DISTRIBUTION COEFFICIENT; FIXATION; SOILS; CHEMICAL PROPERTIES; ZIRCONIUM; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; FISSION PRODUCTS; LABORATORY STUDIES; RADIONUCLIDE MIGRATION

<233>
Rhodes, D.W., General Electric Company, Hanford Atomic Products Operation, Richland, WA.

The Effect of pH on the Uptake of Radioactive Isotopes from Solution by a Soil. (U)

Soil Science Society of America, Proceedings 21:389-392. (1957)

Experiments to define the effect of pH on the uptake of several important radionuclides by soils were performed and the results reported. Calcareous subsoils found at the Hanford Reservation were reacted with solutions containing less than 1 x 10(E-9) moles per liter of selected radionuclides. Particle size distribution reported as percent by weight was as follows: 6% greater than 2 mm diameter, 67% 2-0.2 mm, 10% 0.22-0.02 mm, 6% 0.02-0.002, and 2% less than 0.002 mm. The effect of high concentrations of competing ions was also investigated. Distribution coefficients for Cs, Sr, Pu, Ru, Y, Zr, Nb, and Ce are reported over the entire pH range. The adsorption (Kd greater than 200) of Cs was shown not to be appreciably affected by change in pH between 4 and 10. The optimal pH for strontium uptake was observed to be approximately 10, and a rapid drop in distribution coefficient was noted as the pH was lowered. The polyvalent radionuclides, Pu, Ce, Zr, Nb, Y, and Ru, were observed to have maximum distribution coefficients in the 4 to 8 pH range. Above pH 8, distribution coefficients were observed to be reduced. The addition of relatively large concentrations of competing ions such as sodium was seen to greatly inhibit the soil uptake of both strontium and cesium. In the case of strontium, nitrate ion was seen to reduce the interference of sodium with strontium. (Auth) (JC)

Very good information of distribution coefficient data for Hanford Reservation soils including values as a function of pH is presented. (DH/JC)

pH; Distribution Coefficient; Ion Exchange Capacity; Grain Size Distribution

Sr 90; Cs 137; Pu 239; Ru 106; Y 91; Ce 144; Zr

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95; Nb 95

ADSORPTION; DISTRIBUTION COEFFICIENT; SOILS; CATIONS; WASTE DISPOSAL; WASTES, RADIOACTIVE; GEOCHEMISTRY; CATION CONCENTRATION; ENVIRONMENT; RADIONUCLIDE MIGRATION; LABORATORY STUDIES

<234>
Robertson, J.B., U.S. Geological Survey, Water Resources Division, Menlo Park, CA.

Numerical Modeling of Subsurface Radioactive Solute Transport from Waste Seepage Ponds at the Idaho National Engineering Laboratory. (2)

IDO-22057; USGS Open File Report 76-717; 68 pp. (1977, January)

Aqueous chemical and low-level radioactive effluents have been disposed to seepage ponds at INEL. The solutions percolate down toward the Snake River Plain Aquifer (135 m below) through interlayered basalts and unconsolidated sediments and an extensive zone of perched water layer about 80 m beneath the ponds. A three-segment numerical model is developed to simulate the system, including effects of convection, dispersion, adsorption and radioactive decay. The first segment used a one dimensional (vertical) and analytic solution, the second segment was a two dimensional lateral numerical solution, and the third segment used a one dimensional numerical solution for independent discrete vertical column systems. Results agree adequately with the available field data. The flow of groundwater in the aquifer is about 5-25 ft per day. Infiltration from the Test Reactor Area (TRA) ponds has formed at least 2 perched water bodies beneath the TRA. A small one is perched on the basalt layer about 50 ft below the surface. The second, and much larger body occurs on a layer of clay and silt within the basalt about 180 ft below the surface. The effects of the perched water upon distribution of radionuclides is discussed. The subsurface system beneath the TRA ponds was divided into 3 segments. The first, primarily the surface layer of alluvial sediments from the Big Lost River, is composed of a heterogeneous mixture of clays, silts, sands, and gravels. Porosity ranges from 25-45% and permeabilities range from 1 to 10,000 gal/sq ft. The average vertical hydraulic conductivity appears to be about 1 ft/day. Segment 2 occupies a sequence of basalt layers between the surface alluvial sediments and the main perching layer at a depth of 180 ft. The size, shape, and transient behavior of perched water at TRA suggest that the hydraulic conductivity of these particular basalts might be relatively low, perhaps 10 ft/day. The effective porosity is probably 5 to 15%. The third segment is about 300 ft thick and is made up of approximately 75 ft of major sediment layers, 220 ft of basalt, and a minimum of 5 ft of minor sediment layers. (DO) (JTE)

An adequate simulation (of which there is almost none in the field) of vertical transport of radiocontaminants through layered unsaturated zone including the interaction of perched water table with the migratory process. Good summary of modelling parameters for INEL. (DA/DO) See also Robertson, J.B., IDO-12079 (1975).

Depth to Water Table; Hydraulic Conductivity; Porosity; Stratigraphic Unit Thickness; Permeability

Sr 90; H 3; Cs 137

ADVECTION; DISPERSIVITY; ADSORPTION; RADIOACTIVE DECAY; UNSATURATED ZONE; PERCHED WATER; COMPUTER CODES; FIELD STUDIES; SEEPAGE PITS; THEORETICAL STUDIES; GROUND WATER; WATER TABLE; HYDROLOGY; DISTRIBUTION; WASTE DISPOSAL; WASTES, LIQUID; WASTES, RADIOACTIVE; SOILS; CLAYS; SANDS; SILTS; GRAVELS; WASTES, LOW-LEVEL; RADIONUCLIDE MIGRATION

<235>
Robertson, J.B., U.S. Geological Survey, Water Resources Division, Idaho Falls, ID.

Digital Modeling of Radioactive and Chemical Waste Transport in the Snake River Plain Aquifer at the National Reactor Testing Station, Idaho. (1)

IDO-22056; 81 pp. (1974, May)

Digital (numerical) modeling is applied to the water and contaminant transport in the Snake River Plain Aquifer using finite difference methods. Simulation includes effects of convection, dispersion, adsorption, and radioactive decay. Dispersivities that give best fit to field data are calculated. Radiocontaminants considered are tritium and strontium 90. Chloride is also considered.

Simulation of hydraulic flow regime and radiocontaminant transport for the INEL using finite difference methods. Summary of hydrogeologic parameters applicable. Comprehensive and thorough reference, currently applicable. (DA/DO)

Dispersion Coefficient

H 3; Sr 90; Cl

RADIONUCLIDE MIGRATION; ADVECTION; DISPERSION; ADSORPTION; RADIOACTIVE DECAY; SATURATED ZONE; AQUIFERS; NUMERICAL METHODS; COMPUTER CODES; FIELD STUDIES; DISPERSION COEFFICIENT, LONGITUDINAL; RECHARGE; TRITIUM; STRONTIUM 90; MODELS, MATHEMATICAL; THEORETICAL STUDIES

<236>
Robertson, J.B., U.S. Geological Survey, Idaho Falls, ID.

Numerical Modeling of Subsurface Radioactive Solute Transport from Waste Seepage Ponds at the Idaho National Engineering Laboratory Site, Idaho. (2)

IDO-12079; Summaries of the Idaho National Engineering Laboratory Site Ecological Information Meeting, O.D. Markham (Ed.), (p. 13), 69 pp. (IDO-12079). (1975, July 10)

Aqueous chemical and low-level radioactive effluents have been disposed to seepage ponds since 1952 at the Idaho National Engineering Laboratory Site. The solutions percolate toward the Snake River Plain aquifer (135 m below) through inter-layered basalts and unconsolidated sediments and an extensive zone of ground water perched on a sedimentary layer about 80 m beneath the ponds. A three-segment numerical model was developed

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to simulate the system, including effects of convection, hydrodynamic dispersion, radioactive decay, and adsorption. The first segment uses an analytical solution to simulate transport from the ponds to the 25-m thick, perched water lens, assuming steady vertical flow through a 15-m long, saturated, homogeneous column. The second segment simulates two-dimensional horizontal transport in the perched water body using finite-difference methods, assuming complete vertical mixing with vertical leakage from the bottom. The third segment of the model simulates vertical solute transport from the perched water body toward the aquifer, by assuming unsaturated but steady water flow in a series of continuous nonhomogeneous, independent, vertical columns. The transport equation is solved by a "hop-scotch" finite-difference scheme for each column. Simulated hydraulics and solute migration patterns for all segments agree adequately with limited field data. The model can be used to project subsurface distributions of waste solutes under a variety of assumed conditions for the future. Although chloride and tritium reached the aquifer several years ago, the model analysis indicates that the more easily sorbed solutes, such as Cs 137 and Sr 90, would not reach the aquifer under present conditions in detectable concentrations within 150 years. (Complete Text)

See also Robertson, J.B., IDO-22057 (1977)

MODELS, MATHEMATICAL; WASTES, INDUSTRIAL; WASTES, LOW-LEVEL; SEEPAGE PITS; PONDS; AQUIFERS; BASALTS; SEDIMENTS; GROUND WATER; CONVECTION; DISPERSION; HYDRODYNAMICS; RADIOACTIVE DECAY; SORPTION; RADIONUCLIDE MIGRATION; LEAKAGE; HYDRAULICS; CHLORIDES; TRITIUM; CESIUM 137; STRONTIUM 90; THEORETICAL STUDIES

<237>
Bodier, J., F. Niezbocala, and H. Marichal, CEA, Plutonium Production Center, Marcoule, France.

Comparative Study of the Behavior in Soil Radioactive Waste Solidified by Various Processes. (3)

CONF-670512; STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 383-400), 666 pp. (CONF-670512, STI/PUB/156). (1967, May 29 - June 2)

The processing of radioactive waste has given rise to a certain number of intensive studies of industrial projects. Vitrification, encapsulation in bitumen, and solidification constitute three solutions to the problem of storing radioactive waste. A comparative study is made of the behavior of waste processed by these three methods in a specific soil and under particular atmospheric conditions. (Auth)

Sr 95; Ru 106; Ce 144; Cs 137; Sr 89; Sr 90

VITRIFICATION; BITUMENS; ENCAPSULATION; CEMENTS; SOILS; FIELD STUDIES; RADIONUCLIDE MIGRATION; WASTES, RADIOACTIVE

<238>
Rogers, J.A., and S. Wright, Fred C. Hart Associates, Inc., New York, NY.

Analysis of Water Contamination Incident in Gray, Maine. (3)

Report to USEPA for Contract No. 68-01-3897; 87 pp. (1978, March)

The local groundwater drinking supply in a town in Maine has been condemned because of the presence of several known carcinogens in significant concentrations. The ground water contamination is thought to be related to the migration of spilled or leaked cleaning solvents from a waste storage and processing facility located immediately upgradient of the contaminated wells. This report presents a summary of the contamination event and includes a list of the sources of information used in the evaluation, a profile of the waste facility, a description of the local hydrogeological and environmental conditions, a discussion of the contamination chronology, a description of the field investigations of the incident, and an evaluation of the incident with respect to its severity and damage to human health and the environment. The principal contaminants in this incident were 1,1,1 trichloroethane, trichloroethylene, and dimethyl sulfide. (JC)

The implications this incident poses with respect to hazardous waste disposal site selection and operational procedures are very appropriate to radioactive waste disposal sites. (DE/JC)

Depth to Water Table; Hydraulic Conductivity; pH; Hydraulic Velocity; Stratigraphic Unit Thickness

SOILS; TILL; AQUIFERS, UNCONFINED; ORGANIC COMPOUNDS; WASTES, NONRADIOACTIVE; METHYL CHLOROFORM; TRICHLOROETHANE; PLANTS, WASTE TREATMENT; DIMETHYL SULFIDE; CONTAMINATION; ACCIDENTS; TANKS; SOLVENTS; CONTAMINANT TRANSPORT; GROUND WATER; DRINKING WATER; MAINE

<239>
Rogers, V.C., Ford, Bacon and Davis Utah Inc., Salt Lake City, UT.

Migration of Radionuclide Chains in Groundwater. (3)

Nuclear Technology 40(3):315-320. (1978, October)

Expressions are developed for the maximum concentrations and discharge rates of radionuclide chains migrating through the ground via the ground water pathway. Expressions are presented for two-member chains that quantify the reconcentration effect in terms of dimensionless parameters. The dimensionless parameters are used to demonstrate the interrelationships between the basic nuclide and adsorbing medium parameters. The magnitude of the reconcentration effect for the third member of three-member chains is adequately described by the two-member expressions, except the range of reconcentration is extended. A waste inventory containing 1 X 10(E+6) Ci of Th 230 and Ra 226 is used as an example of radionuclide reconcentration. The chain U 238-Th 230-Ra 226 is listed as an example of a three-member decay chain.

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ENVIRONMENTAL TRANSPORT

<239> CONT.
(Both) (RAP)

RADIONUCLIDE MIGRATION; GROUND WATER; HALF-LIFE PRODUCTS; THEORETICAL STUDIES; EQUATIONS; DISPERSION COEFFICIENT, LONGITUDINAL; CONVECTION; SORPTION; RADIOACTIVE DECAY; URANIUM 234; THORIUM 230; RADIUM 226; LEACHING; CONCENTRATIONS; RECONCENTRATION

<240>
Bogoveki, A.S., and T. Tamura, Oak Ridge National Laboratory, Health Physics Division, Oak Ridge, TN.

Erosional Behavior of Cesium 137. (2)

Health Physics 10:667-677. (1970, May)

Cesium 137 movement by runoff, erosion, and infiltration from a silt-loam soil in Tennessee is studied, and a mathematical model for nuclide erosional loss is suggested. A 60% decrease in radiation dosage (as measured with a GM survey meter) from surface-deposited Cs 137 occurs during the first seven months following nuclide application. Most of the applied radiocesium is found in the upper 3 cm soil layer or has been eroded away. It is concluded that considerable erosional losses of Cs 137 could occur, particularly from exposed areas (i.e., base soil). Total erosion index value of 30.3 x 10(E-3) dynes/sec for the 2 yr experimentation period was higher than expected and somewhat different in distribution than normal for the area. It also appears that the specific loss of Cs 137 reflects the seasonal variation in the magnitude of the erosion index and the extent of vegetative cover for a particular location. An empirical parabolic equation adequately describes radionuclide loss over a two year period, although an exponential model based on the Cs 137 in the soil profile appears to give more general results. Infiltration rate for a two-year period for alluvial Captiva silt loam soil ranged from 96 cm to 205 cm. (Both) (HF) (CSF)

This study is useful for characterization of radionuclide behavior in surface seeps from shallow waste burial sites. (DR/HT)

Infiltration Rate; Erosion Rate

Cs 137

EROSION; SOILS; MODELS, MATHEMATICAL; INFILTRATION; CLAYS; EQUATIONS; RADIONUCLIDE MIGRATION; RUNOFF; PRECIPITATION, HYDROLOGICAL; THEORETICAL STUDIES

<241>
Rootsen, R.C., and R.J. Serne, Battelle-Pacific Northwest Laboratories, Water and Land Resources Department, Richland, WA.

Experimental Support Studies for the PERCOL and Transport Models. (T)

BNWL-1719; 66 pp. (1972)

A group of support studies conducted during development of a transport model for the Radionuclides in Soils program is described in this report. Sorption parameters using column and batch tests are compared. Chemical interaction of Ru is analyzed. Distribution coefficients for strontium are reported. (00)

Good field data on chemical characteristics of soils in Hanford area. Attempts at generalization of results are partially successful and instructive in the complexity of the modelling of chemical characteristics. (DR/00)

Distribution Coefficient

ABSORPTION; RADIONUCLIDE MIGRATION; EQUATIONS; CHEMICAL PROPERTIES; FIELD STUDIES; LABORATORY STUDIES; ACTIVATION ANALYSIS

<242>
Savannah River Laboratory, Aiken, SC.

Fixation of Cesium by Soils. (T)

DPST-75-125-3; Savannah River Laboratory Quarterly Report, Waste Management, July-September, 1975, (pp. 46), 48 pp. (DPST-75-125-3). (1975)

Laboratory studies using Savannah River Plant soil indicate effective retention of Cs 137 occurs in the plant's burial grounds. As an initial test nine soil columns containing 2 inches of Cs 137 soil and 10 inches of uncontaminated soils were flushed with uncontaminated groundwater. Other tests fed supernate with Cs 137 into soil columns. Preliminary results indicate that supernate reduces soil permeability by more than 99%. Leaching by groundwater moved the isotope only 4 inches in the soil column. When 36 inches of rain (equivalent), was used instead of 18 inches the isotope moved only 6 inches. Ruthenium was also used in the study; the soil retained little or no quantities of that isotope. (RBV)

Cs 137; Ru 106

SORPTION; CESIUM; CONTAINMENT; DISPOSAL SITE; LABORATORY STUDIES; PERMEABILITY; RADIONUCLIDE MIGRATION; SOILS; GROUND WATER; WASTE DISPOSAL; WASTES, RADIOACTIVE; WASTES, LIQUID

<243>
Savannah River Laboratory, Aiken, SC.

Interim Management of Plant Wastes: Environmental Effects. (T)

DPST-76-125-3; 58 pp. (1976)

A summary of the studies conducted at the Savannah River Plant to predict movement of radionuclides through the geohydrologic environment at this site. Studies include the sorption of Sr 90 by soils at the site and movement of mercury from the burial ground. Mathematical models are being developed to (1) estimate water flow and probable paths through aquifer and (2) predict transport of certain radionuclides. (Both) (JF)

Mathematical models developed for the prediction of radionuclide transport by surface and groundwater are based on release of liquids from high-level liquid waste tanks. Studies on the effects of ion exchange, viscosous simemls and

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clay may be applicable. Minimal data presented. (DE/JT)

Distribution Coefficient

Sr 90

RADIONUCLIDES; GROUND WATER; SORPTION; SOILS; MODELS, MATHEMATICAL; RADIONUCLIDE MIGRATION; DISPOSAL SITE; WASTES, HIGH-LEVEL; WASTES, LIQUID; TANKS; THEORETICAL STUDIES

<204>
Savannah River Laboratory, Aiken, SC.

Retention of Cesium 137 by Savannah River Plant Soils. (E)

DPST-76-125-2; Savannah River Laboratory Quarterly Report, Waste Management, April-June 1976, (pp. 41-46) (DPST-76-125-2). (1976, October)

A review of experimental techniques and results of a study on the retention of Cs 137 by Savannah River Plant (SRP) soils. Distribution coefficients determined for SRP soils were 10(E-5) for Cs 137, with 99% retention. Investigations showed that sodium ions tend to reduce the soil's distribution coefficient for Cs. Activity of supernate liquid used was 1.7 mCi/mL. (JT)

Emphasis is on high-level liquid wastes. However Kd's determined are still applicable to shallow land burial. (DE/JT)

Distribution Coefficient

Cs 137

SORPTION; RADIONUCLIDES; SOILS; DISTRIBUTION COEFFICIENT; SODIUM; CESIUM 137; GEOCHEMISTRY; VIRIATION; WASTES, HIGH-LEVEL; WASTES, LIQUID; LABORATORY STUDIES

<205>
Schmalz, B.L., and G.L. Polzer, U.S. Atomic Energy Commission, Idaho Falls, ID.

Tritiated Water Distribution in Unsaturated Soils. (J)

Soil Science 108(7):83-87. (1968, July)

A study of the movement of water in the unsaturated soil zone as evidenced by the distribution of tritium introduced by rainwater is presented. Study of soil samples taken at three localities indicated that 71 to 80% of the tritium present was found in the upper 100 cm soil below the ground surface. Only 3.5% of the amount of tritium estimated to have been introduced by rain over a 15 year period was found to be present in the soil. The regional water table is approximately 200 m below the land surface. Grain size distribution for the soil shows clay ranging from 10-42%, silt ranging from 51-70%, and sand ranging from 3-22%. Total porosity of the silt samples collected was from 44.8% to 48.3%. (CAB) (CSP)

This study can be helpful in that it discusses the movement of tritium in the soil as an indicator of water movement in the unsaturated zone resulting from rainfall. This can be related to the movement of tritiated water formed when rain water comes into contact with radioactive waste in shallow land burial sites. (DE/CAB)

Grain Size Distribution; Depth to Water Table; Porosity

H 3

UNSATURATED ZONE; GROUND WATER; SOILS; SAMPLING; PARTICLE SIZE; MODELS, MATHEMATICAL; RADIONUCLIDE MIGRATION; WATER TABLE; POROSITY; SOIL TRANSPORT; PRECIPITATION, METEOROLOGICAL; FIELD STUDIES

<206>
Schaille, P., H. Lippok, and D. Weisflog, Bundesanstalt fur Gewasserkunde, Koblenz, German Federal Republic.

Model Experiments on Fluid Flow in the Transition Zone from Unsaturated to Saturated Soil. (J)

CONF-670512; STI/PUB-156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 151-160), 666 pp. (1967, June)

Infiltration of water in the unsaturated soil zone and horizontal spreading in the saturated zone were analyzed with sand models scaled to resemble alluvial plain conditions. Special large glass lysimeters, experimental troughs with glass walls, and small diameter copper and glass sequent-tubes were used as models. The tracing of liquid fronts was accomplished via ultra-violet fluorescent dye. Infiltration through the aerated zone of apparently homogeneous media was found to be possibly dependent upon random inhomogeneities that were difficult to discern. Experiments accomplished in a glass-walled model trough filled with medium-fine sand revealed the possibility of horizontal flow in a simulated confined aquifer that consisted entirely of capillary zone with insufficient moisture for a saturated zone to accumulate. Variations in flow in stratified sands were observed as a result of permeability differences between the individual striations. The height of the capillary fringe and moisture distribution within it were found to be important parameters for the description of migration processes of liquids. It was concluded that analytical treatment of liquid flow in every case was not yet possible, even in homogeneous media. (Auth) (HT)

A scale model study of fluid flow in soil with possible relevance to subsurface radionuclide migration in alluvial plain sediments. No significant numerical data were presented. (DE/HT)

Volumetric Water Content

MODELS; CAPILLARY STRUCTURE; AQUIFERS; WATER TABLE; RADIONUCLIDE MIGRATION; INFILTRATION; PERCOLATION; SANDS; LABORATORY STUDIES

<207>
Serne, R.J., and R.C. Routson, Battelle-Pacific

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ENVIRONMENTAL TRANSPORT

<287> CONT.
Northwest Laboratories, Water and Land Resources Department, Richland, WA

PERCOL User's Manual. (2)

BNWL-1720; 50 pp.(1973)

The report describes the PERCOL program and procedures on how to use it. PERCOL is a one-dimensional contaminant transport model for evaluation of the chemical parameters required as input to the more general contaminant transport code. (00)

A working model to describe the chemical interactions of radioactive contaminants with soils under different pH and ionic content conditions. Good reference and introduction into the complexity of the subject. (DH/00)

ADVECTION; ABSORPTION; CHEMICAL PROPERTIES; EQUATIONS; COMPUTER CODES; NUMERICAL METHODS; THEORETICAL STUDIES; RADIONUCLIDE MIGRATION; MODELS

<288>
Serne, R.J., R.C. Routson, and B.A. Cochran, Battelle-Pacific Northwest Laboratories, Water and Land Resources Department, Richland, WA.

Experimental Methods for Obtaining PERCOL Model Input and Verification Data. (7)

BNWL-1721; 38 pp.(1973)

Experimental procedures to determine some of the chemical hydrogeological parameters affecting the contaminant interaction with soils are described. Among the parameters are cation exchange capacities, effective porosities, soil exchange selectivity constants. (00)

Relatively elaborate experimental procedures that are still applicable are described. Good references on techniques. (DH/00)

Ion Exchange Capacity; Selectivity Coefficient; Porosity

ABSORPTION; CHEMICAL PROPERTIES; LABORATORY STUDIES; SOILS; HYDROLOGY; GEOLOGY; RADIONUCLIDE MIGRATION; MODELS

<289>
Shaikh, A.U., Vanderbilt University, Department of Physics, Nashville, TN.

A Study on the Movement of Radionuclides Through Saturated Porous Media. (3)

M.S. Thesis; 105 pp.(1967, January)

The successfulness of the subsurface environment for disposal of radioactive waste requires that the geologic and hydrologic characters of the lithologic medium be clearly understood. Prediction of potential radionuclide migration requires knowledge of the flow pattern and rate of movement of the host fluid, the dispersivity of the host medium as well as its permeability and porosity. Movement of radionuclides through a medium is affected by the ion-exchange properties of the medium, the chemical composition of the transporting waters, and the radionuclide's physical and chemical properties. Radionuclide migration in sandstone was simulated using Berea sandstone and an inverted five-spot well array. Using the sorption data obtained, the times required for breakthrough of Sr 89 and Ca 45 were found to be 8.5 and 6.2 times that of water. Models reviewed for ground water flow included sand models, electrical models, viscous fluid models, and analytical models. (JT)

Distribution Coefficient; Grain Size Distribution; Porosity; Dispersion Coefficient

Sr 89; Ca 45; Ca 43

RADIONUCLIDE MIGRATION; ION EXCHANGE; BREAKTHROUGH DISTRIBUTION; DISPERSION; SANDSTONES; HYDRODYNAMICS; SATURATED ZONE; POROSITY; PARTICLE SIZE; MODELS; GEOCHEMISTRY; LABORATORY STUDIES

<250>
Simpson, E.S., U.S. Geological Survey, Washington, DC.

Investigations on the Movement of Radioactive Substances in the Ground. Part 1. Geohydrology and General Considerations. (3)

TID-7628; Ground Disposal of Radioactive Wastes, J.L. Borgese, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 105-154), 635 pp.(1962, March)

Investigations were conducted at two waste burial sites to determine to what degree an environment of low containment (a site underlain mostly by permeable sand) may be used for the disposal of relatively insoluble waste as opposed to a site with an environment of high containment for the disposal of untreated or relatively soluble waste. A method was developed to study the velocities and patterns of groundwater at each site. The method utilizes a metal tube encased well into which a radiation detector is lowered. The detector measures the amount of a tracer isotope which has been injected into the groundwater and is picked up by a chemically reactive coating on the surface of the well tube. The amount of tracer picked up in a given time interval is related to groundwater velocity. Alternatively the tube could be coated with a radioisotope and the amount lost to reaction with a known dissolved solid would indicate groundwater velocity. The land surface is nearly flat except for small areas occupied by sand dunes up to 10 ft high, now mostly covered with vegetation. The water table is everywhere 6 ft or less below land surface, except under the dunes. The water table slopes northeastward across the Borochoic site, and southward across the residential area of CRR to the inner canal. On the Borochoic and CRR sites, the water-table gradient reaches a maximum value of about 0.3%. This results in a ground water velocity of about 1 ft/day. Average aquifer ground water velocity in the Sol sand is about 5 cm or less. (CRR) (CSF)

Brief discussion of factors affecting subsurface migration of radiocontaminants. Proposes method for detecting groundwater flow velocities, directions, anisotropies, etc. (DH/CRR)

Depth to Water Table; Hydraulic Gradient

ISOTOPES; GROUND WATER; SANDS; CLAYS; SEDIMENTS;

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<250> CONT.
RADIONUCLIDE MIGRATION; WATER TABLE; PERMEABILITY; MEASUREMENTS; FIELD STUDIES

<251>
Staley, G.S., G.P. Turi, and D.L. Schreiber, U.S. Nuclear Regulatory Commission, Division of Site Safety and Environmental Analysis, Hydrologic Engineering Section, Washington, DC.

Radionuclide Migration from Low-Level Waste: A Generic Overview. (E)

CONF-771012; Management of Low-Level Radioactive Waste, R.G. Carter, A.A. Moghissi, and M. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 10, (pp. 1041-1072), 1210 pp. (CONF-770512).(1979)

The objective of this study was to evaluate generically the sensitivity of radionuclide migration to certain transport parameters, as related to shallow low-level radioactive waste burial sites. This study could form the basis for establishing site boundaries. Three homogeneous soil types were considered in the analyses: clay, silt, and sodium sand. In addition, evaluations are included for typical loess and till soils that might be found at existing or potential burial sites. Probable values of hydraulic conductivity, total porosity, effective porosity and bulk density were selected for each soil type. Hydraulic conductivity values (in ft/day) used were clay: 1.30 X 10(E-5), silt: 1.30 X 10 (E-2), sand: 100, loess: 5.48 X 10(E-2), and till: 7.94 X 10(E-3). Total porosities used were 53.0%, 48.0%, 42.0%, 45.1%, and 52.9%, respectively. Effective porosities were 5.0%, 15.0%, 30.0%, 16.7%, and 2.2%, respectively. Average bulk density values (in gm/cm cm) adopted were clay: 1.02, silt: 1.73, sand: 1.77, loess: 1.6, and till: 1.6. Soils were assumed to be completely saturated. For each soil type, the time-varying concentrations of specific radionuclides were determined at given distances from the source. Sensitivity analyses were performed for each soil type by varying the hydraulic gradient of the water table and the leach rate of the source. Distribution coefficient values and retardation factors were obtained for 19 radionuclides in the 3 main soil types. Kd's calculated for some of the isotopes in sand were: Cs 134 = 20, Co 60 = 100, Pu 241 = 200, Sr 90 = 2, Cs 137 = 20, Pu 239 = 200, Am 241 = 70, and Pu 239 = 200. Kd's for silt and clay were an order of magnitude larger than the sand values. Retardation factors in clay, silt, and sand, respectively, were 690, 720, and 85 for Cs 134; 3000, 3600, and 420 for Co 60; 6900, 7200, and 840 for Pu 241, Pu 238, and Pu 239; 70, 73, and 9 for Sr 90; 690, 720, and 85 for Cs 137; and 2000, 2500, and 300 for Am 241. The sensitivity of distribution coefficients to pH was investigated for only the silt soil and three radionuclides, because of limited available data. Conservative analyses were conducted by considering only time decay of radionuclides resulting from groundwater travel and holdup due to ion-exchange with soil particles. More realistic analyses were performed using a three-dimensional dispersion model. (Auth) (LKH)

Paper contains extensive tabular data, as well as an appendix defining limiting forms of the radionuclide transport model.

RADIONUCLIDE MIGRATION; BURIAL; SHALLOW; WASTES, LOW-LEVEL; SOILS; CLAYS; SILTS; SANDS; LOESS; TILL; HYDRAULIC CONDUCTIVITY; POROSITY; DENSITY; RADIONUCLIDES; CONCENTRATIONS; HYDRAULIC GRADIENT; LEACHING RATES; WATER TABLE; DISTRIBUTION COEFFICIENT; pH; GROUND WATER; ION EXCHANGE; RADIOACTIVE DECAY; MODELS; BOREHOLES, MATHEMATICAL; RETARDATION FACTOR; CESIUM 134; COBALT 60; PLUTONIUM 241; PLUTONIUM 238; PLUTONIUM 239; STRONTIUM 90; CESIUM 137; AMERICIUM 241; THEORETICAL STUDIES

<252>
Takahashi, K., and H. (Translator) Kobota, Kyoto University, Reactor Research Institute, Kyoto, Japan.

Behavior of Gaseous Iodine in Sand. (E)

ORNL-tr-0550; KURRI-tr-125; CONF-7310127; Radioiodine, K. Katsurayama and T. Tsujimoto (Eds.), Proceedings of a Research Reactor Institute Symposium, Kumatori, Osaka, Japan, October 24, 1973, (pp. 17-21).(1974)

Radioactive iodine gas was passed through 10 types of sand samples under various atmospheric temperatures and humidities, and the relationship between the amount of iodine loaded and the amount adsorbed was measured. The adsorbed iodine was then swept up with dry air or washed away with water to determine the desorption state. Adsorption decreased with increasing temperature, the decrease being even greater with increased humidity. The smaller the particle size, the greater is the adsorption. If the region in which more than 90% of the loaded iodine is adsorbed is designated as the proportional adsorption zone, its value is 30-350 ug/sq cm sand on a surface area basis and approximately 1-3 times the 0.2-0.3 ug/sq cm associated with monomolecular adsorption film. An experiment with iodine gas passed through a sand column demonstrated the presence of two types of iodine, readily desorbable and poorly desorbable. The former is considered to be Henry-type adsorption, and the latter is associated with a first order reaction on an adsorbed state. (LKH)

Distribution Coefficient; Moisture Content

I

IODINE; SANDS; ADSORPTION; TEMPERATURE; HUMIDITY; DESORPTION; PARTICLE SIZE; GASES; RADIONUCLIDE MIGRATION; LABORATORY STUDIES

<251>
Takahashi, K., T. Naajyo, T. Tanechi, and H. Tanaka, Kyoto University Institute of Atomic Energy, Gokasho Uji-shi, Kyoto, Japan.

Transportation-Related Characteristics of Iodine Gas in Earth Samples. (E)

ORNL-tr-0546; 15 pp.; Nukes Setsuri 9:211-217,(1974)

Some transport characteristics of iodine gas in earths are investigated. For the tests three temperature ranges (20-22 degree C, 50-60 degree C, and near 100 degree C) and three levels of humidity (less than 10%, 50-60%, and above 90%) were selected to

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create nine different conditions by combination on soils with ion-exchange capacity of 0.228 to 6.363 meq/g. The density of the sands ranged from 2.46 to 2.65 g/cu cm. Several conclusions from the sorption tests are: 1) the smaller the grain size, the greater the adsorption; 2) the greater the ion-exchange, the greater the adsorption; 3) as temperature rises, adsorption quantity decreases; 4) as humidity increases, adsorption decreases; 5) desorption fractions for air sweep and water leach decrease with lowering temperature and humidity. The mechanism of sorption at this time has yet to be determined. Transportation tests showed that the velocity of iodine is much smaller than the carrier gas, which indicates the soil used has a large iodine adsorption capacity. There is indication that iodine is classified into two types: one which is hardly desorbable and the other easily desorbable. Also, as the water content in the soil increases, the transportation velocity becomes greater. An equation is used to describe the iodine gas concentration in a polyporous medium and, when solved in the isotropic, planar, and one-dimensional mode at specified initial and boundary conditions, the molecular diffusion coefficient can be calculated. In this set of tests the diffusion coefficient is 0.03 sq cm/sec. The distribution coefficients ranged from 29 to 1900 cu cm/g. From these experiments the behaviors of low-density iodine gas in an unsaturated water bed can practically be expressed by the derived equation. (EDV)

Permeability Coefficient; Ion Exchange Capacity; Diffusion Coefficient; Distribution Coefficient

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ADSORPTION; DISTRIBUTION COEFFICIENT; EQUATIONS; HALOGENS; ION EXCHANGE CAPACITY; DIFFUSION; LABORATORY STUDIES; SANDS; ROCK-FLUID INTERACTIONS; UNSATURATED ZONE; WASTES, GASEOUS; WASTES, RADIOACTIVE; IODINE 131

<256>
Tanner, A.B., U.S. Geological Survey, Washington, DC.

Physical and Chemical Controls on Distribution of Radium-226 and Radon-222 in Ground Water near Great Salt Lake, Utah. (3)

International Symposium on the Natural Radiation Environment. Published for William Marsh Rice University by the University of Chicago Press, Chicago, IL, Ch. 18, (pp. 253-276), 1069 pp. (1963)

Two groups of irrigation and stock wells south and east of Great Salt Lake, Utah were studied in an effort to understand the physical and chemical controls on Ra 226 and Rn 222 distribution in groundwater. Measurements were made of hydraulic gradient, groundwater flow velocity, water temperature, pH, Eh, dissolved oxygen, bicarbonate, dissolved iron, and barometric pressure. Calcium, sulfide, sulfate, and chloride concentration values are available for some wells. Radon levels were 5 to 6 X 10(E-10) c/l for the Bernester area (south of Great Salt Lake) and 4 to 16 X 10(E-10) c/l for the Woods Cross area (east of the lake). Radium values were from less than 1 to 20 X 10(E-13) gm/l at Bernester and from less than 1 to 6 X 10(E-13) gm/l at Woods Cross. The conclusions of this study were that 1) Rn 222 concentration in well water is dependent on the concentration of Ra 226 in the immediately surrounding sediments. 2) Most of the Rn 226 results from in situ decay of Th 230. Less than 1/1000 of this Ra is mobile. Mobility may increase to 1/100 in the presence of water containing large amounts of cations and having little tendency to reprecipitate alkaline earth compounds or ferric hydroxide. 3) Additional Rn 226 may migrate with water from fault zones or upstream sources. The mobile fraction tends to be reduced simultaneously by coprecipitation with CaCO3 or ferric hydroxide; the latter is likely at interfaces between Fe-bearing, low-oxygen water of leeward or fault zones, and oxygen-rich waters from recharge areas upstream. Rn 222 anomalies associated with subsurface faults are due to migration of radium and its immobilization by chemical changes in the sediment, not to direct radon migration. A relation of radon anomalies to faults has not be demonstrated in the area of study, however. (Auth) (LKH)

pH; Eh; Hydraulic Gradient; Total Cation Concentration; Hydraulic Velocity; Porosity

Rn 222; Ra 226

RADON 222; RADIUM 226; GROUND WATER; AQUIFERS; FAULTS; FIELD STUDIES; LABORATORY STUDIES; INERT GASES; GASES; GEOCHEMISTRY; HYDROLOGY; RADIONUCLIDE MIGRATION

<255>
Tewhey, J.D., Lawrence Livermore Laboratory, Livermore, CA.

Preliminary Results of Experimental Work in the Radionuclide Migration Program. The Sorptive Character of Tuffaceous Rocks in a "Static" Versus "Dynamic" Mode of Testing. (T)

UCID-17064; 17 pp. (1976, February 24)

Experiments were done to examine the effect of "static" and "dynamic" conditions on the sorptive capacity of various exchange media for Sr(+2). The "static" conditions were produced by allowing the rock (media) and the fluid to sit undisturbed. In the "dynamic" case the fluid flowed through the rock. The rocks used were a number of different tuffs but most of the tests were done on the Trailridge Member of the Thusty Canyon Tuff. As a source of Sr(+2) a combination of (SrNO3)2 and SrO was used. For the static case the more zeolite in the tuff, the more sorption occurred. Also, in rocks with a finer grain size more sorption took place. In the "static" experiments, a steady state was reached after the first hour producing a characteristic flat top curve for Na and K ions. This was interpreted as the rate of dissolution equalling the rate of sorption. The attainment of equilibrium and/or sorptive capacity in the "dynamic" experiments was achieved gradually and was assumed to occur in the "static" experiments. Low pH, however, inhibited Sr(+2) sorption because the hydrogen ion is a competitor for sorption sites. In the dynamic mode, sorption of Sr(+2) was greater in each experiment described above than in the static mode. The reason for this is that in the static mode the ions dissolved or leached remain in the solution and compete with the ion of

<255> CONT.
interest. Whereas, in the dynamic case the dissolved or leached ions are flushed from the system and hence do not compete. (PDF)

Grain Size Distribution; pH

CATIONS; DISTRIBUTION COEFFICIENT; IGNEOUS ROCKS; IONS; ION EXCHANGE; ION EXCHANGE CAPACITY; LABORATORY STUDIES; MINERALS; pH; ROCK-FLUID INTERACTIONS; TUFFS; ZEOLITES; ZEOLITES; SORPTION

<256>
Theis, C.V., U.S. Geological Survey, Albuquerque, NM.

Notes on Dispersion in Fluid Flow by Geologic Features. (S)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 166-178), 635 pp.(1962, March)

Attempts to explain the difference between dispersion as measured in the laboratory and in the field. Greater dispersion in the field is attributed to sedimentary structures and other geologic inhomogeneities. These inhomogeneities enhance dispersion by causing water to move at different velocities at different points within a bed. Lateral dispersion will result from lenticularity in sedimentary deposits. Vertical dispersion tends to be inhibited by bedding in such deposits. Field tests of dispersion in glacio-fluviatile deposits at Hanford, Washington are cited. A concentrated solution of 100 lbs of uranine dye was dribbled through a period of about 20 hr into an unpumped well. It was first picked up in about 60 days in well 11,500 ft downgradient and the peak concentration passed in about 135 days. The dye was shortly dispersed longitudinally over the major part of the distance traversed by the fastest water. (CAB) (CSP)

Just skims the surface. (DH/CAB)

ANISOTROPY; SEDIMENTS; DISPERSION; PERMEABILITY; GROUND WATER; HYDRAULIC VELOCITY; FIELD STUDIES

<257>
Thomas, H.C., University of North Carolina, Chapel Hill, NC.

Problems in Sorption on Clay Minerals Illustrated with Data on the System Cs-Ba-Montmorillonite. (S)

TID-7628; Ground Disposal of Radioactive Wastes, J.H. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 179-197), 635 pp. (TID-7628).(1962, March)

Montmorillonite, A.P.I. sa. 23, was treated with KCl until all Ca was removed and then dried and heated for 24 hrs at 500 degrees C to partially collapse the lattice. Characteristics of exchange-sorption of Cs-Ba were studied on both the treated and untreated clay using the equilibrium column technique at 30 degrees C and 70 degrees C using Cs 134 and Ba 133 tracers. The columns were eluted and the elements analyzed by scintillation spectrometry for total cation exchange capacity and ion composition of the mineral. Unheated montmorillonite had a cation exchange capacity of 1.379 meq/g backbone for the Cs-Ba system; values for treated montmorillonite ranged from 0.73-1.07 meq/g at 30 degrees C and from 0.92-1.06 at 70 degrees C for C(Cs)/Co values of 0.70-0.0005, respectively. Study of enthalpy change versus clay composition indicate that after the heating process, sites remaining available for exchange tend to bind Cs more strongly. If small amounts of a Cs salt are added to the treated montmorillonite suspended in water, the sorbed Cs reduces the clay's capacity for Ba-K exchange; total exchange capacities for Ba ranged from 0.900-0.786 meq/g for 0-0.0992 meq Cs added/g clay. It is speculated that Cs replaces K at sites of molecular-scale "cracks" in the clay mass, making entry of Ba ions to the "cracks" impossible. Another observed effect is the apparent "fixation" of Cs on the heated clay in the column after elution was supposedly complete; at C/Co = 0.005, residual Cs equivalent to 0.0019 meq/g was found. It is not known whether this effect is due to actual fixation or merely to extremely slow exchange. (LKB)

Cation Exchange Capacity

Cs 134; Ba 133

MONTMORILLONITE; SORPTION; CESIUM; BARIUM; CALCIUM; FIXATION; RADIONUCLIDE MIGRATION; IMMOBILIZATION; ION EXCHANGE; IONIC PROCESSES; LABORATORY STUDIES

<258>
Tiffin, L.O., J.V. Lagerwerff, and A.W. Taylor, Agricultural Chemicals Management Laboratory, Agricultural Environmental Quality Institute, Beltsville Agricultural Research Center, Beltsville, MD.

Heavy Metal and Radionuclide Behavior in Soils and Plants: A Review. (S)

Report; 182 pp.(1973, December)

The results of an extensive literature review on radionuclide and heavy metal behavior in soil-plant systems is presented. Factors affecting the availability of trace elements and radionuclides such as chemical state, soil distribution, formation of organic complexes, adsorption onto mineral surfaces, pH dependence, solubility products of moderately to highly soluble compounds, redox potential, microbial processes, exudation of compounds from plant roots, and meteorological conditions are discussed at length. The general processes of cation exchange, diffusion, root uptake, and translocation are detailed. Discussions of root uptake include descriptions of both passive and active uptake and the influence of oxidation state on uptake. Losses of radionuclides or metal ions from plants by leaf shedding, gutation, and leaching and the forms of translocation in the xylem and phloem are given specific attention. (JC)

A comprehensive review of radionuclide behavior in plants and soils is presented in a somewhat confused fashion. (DH/JC)

Sr 90; Cs 137; Ce 144; Th 230; Ra 226; Pb 210; Po 210; Co 60; Mn 54

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ENVIRONMENTAL TRANSPORT

<258> CONT.
UPTAKE; CATION EXCHANGE CAPACITY; CHEMICAL PROPERTIES; PLANTS; DIFFUSION; BIOTA; LEACHING; CROPS; METALS; RADIONUCLIDE MIGRATION; REVIEWS; RADIONUCLIDES; REVIEWS

<259>
Travis, C.C., Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN.

Mathematical Description of Adsorption and Transport of Reactive Solutes in Soil: A Review of Selected Literature. (2)

ORNL-5403; 67 pp.(1978, October)

A review on the state-of-the-art of describing the movement of reactive solutes through the soil is presented. The paper is divided into a section for definitions of pertinent terms, a section on the differential equations describing convective-dispersive solute transport in porous media, a section containing the mathematical models, and a section with a review of selected literature. The terms defined are: bulk density, porosity, pore velocity, Darcy flow velocity, volumetric water content, soil-water potential, hydraulic head, soil moisture retention curve, and breakthrough curve. Models discussed are in two categories, equilibrium adsorption and first-order kinetic adsorption. Linear adsorption isotherm, Freundlich isotherm, Langmuir isotherm, and Langmuir two-surface isotherm models are those under the former category. Reversible linear, reversible nonlinear, kinetic product, bilinear adsorption, Elovich, Fava and Eyring, and combined equilibrium and kinetic models are of the latter type considered. Analytical solutions to the transport models are outlined. (NDV)

ADSORPTION; BREAKTHROUGH DISTRIBUTION; EQUATIONS; DENSITY; EQUILIBRIUM CONSTANT; HYDROLOGY; MODELS, MATHEMATICAL; MOISTURE; POROSITY; ISOTHERMS; RADIONUCLIDE MIGRATION; SOILS; REVIEWS

<260>
Tyagi, A.K., Battelle-Pacific Northwest Laboratories, Richland, WA.

Radionuclide Transport in Unsaturated Groundwater Systems. (3)

BNWL-2285; Nuclear Waste Management Quarterly Progress Report, October through December 1976, A.M. Platt (Comp.), (p. 7.3), 12 pp. (BNWL-2285).(1977, April)

A study of radionuclide movement and mixing in unsaturated zones of groundwater basins has been divided into three areas. The review of literature consists of papers dealing with radionuclide transport and unsaturated flow along with water flow and water quality in unsaturated porous media. The second task will be the study of mechanisms such as hydraulic convection and dispersion, decay, and sorption of radionuclides. For the final task a flow model and a dispersion model will be formulated for prediction purposes. (NDV)

RADIONUCLIDE MIGRATION; UNSATURATED ZONE; GROUND WATER; MODELS, MATHEMATICAL; REVIEWS; HYDROLOGY

<261>
U.S. Public Health Service.

Biological Aspects of Low Level Radioactivity in the Columbia River. (3)

WASH-275; U.S. Atomic Energy Commission Sanitary Engineering Conference, Proceedings, Baltimore, MD, April 15-16, 1958 (pp. 153-165).(1958)

The U.S. Public Health Service conducted a study of the Columbia River in the vicinity of AEC operations at Hanford, Washington between 1951 and 1953 to determine water quality characteristics of the stream prior to impoundment and to determine the effects of radioactivity on the physical, chemical, and biological characteristics of surface waters. Several regions were studied throughout the Columbia Basin, but the Priest Rapids to Paterson area was selected for detailed observation. Physical and chemical examinations included those for turbidity, temperature, dissolved oxygen, ammonia, nitrites, nitrates, phosphates, sulfates, chlorides, pH, and total alkalinity. Mineral analyses were conducted for elements necessary to biotic metabolism, as well as for those which may be toxic. As far as could be determined, Hanford Plant effluents had had no effects on the physical or chemical characteristics of the Columbia River. Relative abundance data for plankton, filamentous algae, bottom animals, and fish showed little or no effects as a result of Hanford effluents; where differences occurred, they could be attributed to seasonal variation or the influence of more turbid, warmer tributaries. Radioactivity measurements of river water showed concentrations of 6 X 10(E-6) to less than 10(E-6) uCi/g. The principal radioisotopes in the water due to Hanford effluent were the short-lived beta-emitters Cu 64, Mn 56, Na 24, As 76, and Si 31, along with the longer-lived P 32 (1-2% of the total activity near the plant). Biological samples were prepared for radiological measurement by digesting the organisms in nitric acid and ashing the digestate in a muffle furnace. The residue was placed on a 1 in planchet and counted for 5-15 min; the count was corrected for decay, geometry, scatter, and absorption. Results indicated that river organisms concentrate radionuclides to a great degree, up to almost 10,000 times the total beta activity in the water. Plankton and filamentous algae concentrate the most radioactivity [range of avg's= 2 X 10(E-2) to 1 X 10(E-5) uCi/g, max. 8 X 10(E-2) uCi/g]; followed by bottom animals [range of avg's from less than 1 X 10(E-6) to 6 X 10(E-3) uCi/g, max. 1 X 10(E-2) uCi/g], juvenile fish [range of avg's = 6 X 10(E-6) to 1 X 10(E-3) uCi/g, max. 8 X 10(E-3) uCi/g], and adult fish [range of avg's = 6 X 10(E-5) to 2 X 10(E-3) uCi/g, max. 7 X 10(E-3) uCi/g]. Activity levels in plankton and algae are directly dependent on the activity levels in the water, while those of most aquatic animals are dependent upon their metabolic rates. Values for bottom animals were highest at low-water stages and high water temperatures. There was a decrease with low water temperatures, even though activity in the water and plankton remained high. Apparently most aquatic animals in the Columbia concentrate radionuclides through

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feeding rather than by other processes such as absorption through the skin or gills. At Hanford Perry Crossing, most of the activity in plankton is from Na 24, Mn 56, and Si 31, with a small amount from P 32; on the other hand, activity in fish and other aquatic animals is primarily from P 32. There are no indications that radioactivity levels in the river have any effect on the aquatic organisms themselves; however, the fact that they concentrate radioactivity to levels many thousands of times that in water and are utilized to a considerable degree by humans may be significant. (Auth) (LKH)

pH; Temperature; Total Ion Concentration

Cu 64; Mn 56; Na 24; As 76; Si 31; P 32

RIVERS; PHYSICAL PROPERTIES; CHEMICAL PROPERTIES; TEMPERATURE; pH; ALKALINITY; NITRATES; NITRITES; PHOSPHATES; OXYGEN; PLANKTON; BIOTA; ALGAE; INVERTEBRATES; FISH; RADIOACTIVITY; RADIONUCLIDES; PHOSPHORUS 32; CONCENTRATIONS; CONCENTRATION FACTORS; FOOD CHAINS; ENVIRONMENTAL EXPOSURE PATHWAY; RADIATION HAZARDS; FIELD STUDIES; LABORATORY STUDIES; DISPOSAL SITE

<262>
Wallace, A., K. Schulz, E.M. Romney, and H. Nishita, University of California, Los Angeles, CA.

Biological Transport of Radionuclides at Low-Level Waste Storage Sites. (2)

NUREG/CR-0701; Annual Report October 1, 1977 - September 30, 1978; 121 pp. (1979, March)

The major objective of the years work was to provide background information on monitoring aspects of low-level waste storage facilities. Studies performed are as follows: 1) capability for assay of several transuranics in sequence was developed at two laboratories. 2) A frequency distribution study of radionuclides and stable elements in plants was developed under reasonably uniform conditions. 3) Reasons for a several-fold range in the concentrations ratios used to predict plant uptake of transuranics were demonstrated. 4) The objective of developing a more accurate multiple regression model of soil parameters on the concentration ratio of five different transuranium elements in plants involved in the food chain of man was vigorously pursued. 5) The objective of determining how much radionuclide can be mobilized by deep rooting of plants from depths in soil was put into an experimental test. 6) The relative importance of stable Sr vs Ca on radiostrontium transport and of stable Cs vs K on radiocesium transport under waste management conditions was studied. 7) Several waste management soils were characterized as preliminary steps to growing plants on those soils with spiked levels of radionuclides and with actual waste chemicals otherwise added. 8) Future studies planned include field work at Barey Flats, Kentucky, and a review and synthesis of information relating to models. (Auth) (RAF)

WASTE STORAGE; WASTES, LOW-LEVEL; RADIONUCLIDE MIGRATION; SOILS; CHEMICAL PROPERTIES; PHYSICAL PROPERTIES; MINERALOGY; SAMPLING; PLANTS; UPTAKE; ACTINIDES, AMERICIUM 241; CHELATES; GROWTH; PLUTONIUM 238; PLUTONIUM 239; PLUTONIUM 240; NEPTUNIUM 237; CURIUM 244; STRONTIUM 85; RADIOCHEMISTRY; STATISTICS; MODELS; ROOTS; CALCIUM; pH; CATION EXCHANGE CAPACITY; EXTRACTION; REVIEWS

<263>
Ward, D.S., and G.T. Yeh, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Mathematical Modelling in Low-Level Radioactive Waste Management. (3)

CONF-781121; Science Underlying Radioactive Waste Management, Proceedings of a Symposium, Boston, MA, November 28-December 1, 1978. (pp. 70-71), 77 pp. (CONF-781121).(1978)

The role of mathematical models in the management of shallowly buried wastes is presented. For humid regions the modelling of transport processes in the soil and in the groundwater regimes by equations is a tool for a waste management program. This model and others may be used in management decisions. Such decisions are exemplified by near surface seals to prevent precipitation infiltration. Existing two-dimensional finite element moisture and material transport models have been modified and applied to a combined saturated and unsaturated system. (MCW)

MODELS, MATHEMATICAL; WASTES, LOW-LEVEL; DISPOSAL SITE; TRENCHES; WASTE MANAGEMENT; RADIONUCLIDE MIGRATION; THEORETICAL STUDIES

<264>
Wheeler, M.L., W.J. Smith, and A.P. Gallegos, Los Alamos Scientific Laboratory, Los Alamos, NM.

A Preliminary Evaluation of the Potential for Plutonium Release from Burial Grounds at Los Alamos Scientific Laboratory. (3)

LA-6698-MS; 19 pp. (1977, February)

In this report an analysis is made of a number of natural phenomena which could result in the release of plutonium from radioactive wastes buried at the Los Alamos Scientific Laboratory (LASL). Background information concerning the history and practice of radioactive waste disposal at LASL is provided. The potential impact of burial of radioactive wastes on the environment is addressed through the mechanisms and rates by which the radionuclides can enter the environment. Only mechanisms independent of human activity are considered. They are divided into two classes, acute and chronic. The acute release mechanisms considered are earthquakes, meteorite impacts, and tornadoes. These have been typified by low occurrence probabilities [10(E-6) - 10(E-7)/yr]. The chronic mechanisms that have been considered are release through uptake by plant roots, exposure by soil erosion, and transport by soil water. The rates of these processes are low, but may result in radionuclide release over long time periods. The analysis of uptake by plant roots was made using an environmental model currently under development; the model is discussed in some detail. (Auth)

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ENVIRONMENTAL TRANSPORT

<268> CONT.
Applicable to shallow land burial is that the report addresses mechanisms through which radionuclides may enter the biosphere. (DS/JT)

Pu 238; Pu 239; Pu 240; Am 241; Sr 90

RADIONUCLIDE MIGRATION; PLUTONIUM; BURIAL; METEORITES; TORNADOES; EROSION; INFILTRATION; GROUND WATER; PLANTS; UPTAKE; EARTHQUAKES; MODELS; DISPOSAL SITE; SOIL TRANSPORT; EROSION; INTRUSION; ROOTS; REVIEWS

<265>
Wight, L.H., and B.G. Kniazewycz, TERA Corporation, Berkeley, CA.

A Radionuclide Transport Model for Shallow Land Burial Sites. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 10 (pp. 1161-1172), 1218 pp. (CONF-770512).(1979)

A state-of-the-art computer code has been developed by TERA under EPA sponsorship and review that calculates the transport of pollutants through soils. The computer code calculates the one-dimensional transient response of a soil column to infiltrating water carrying a pollutant that interacts with the soil. The soil can initially contain a specified amount of water (0-100% of pore volume), and the surface boundary conditions can reflect either a variable rainfall or a variable pond height. The interaction includes both adsorption and diffusion. These are the dominant interaction mechanisms for most heavy metals; however, the structure of the code is such that other mechanisms can be easily incorporated. Because of these capabilities the code is applicable to the evaluation of shallow land burial sites typically utilized for disposal of low-level radioactive wastes. The model calculates the concentration (in mg/cu cm) and the flux (rate of pollutant movement through a horizontal cross-sectional area, in mg/sq cm min) of pollutants in the soil column for different depths as a function of total elapsed time. The model is composed of two major sections. The GEOFLO section routes fluid down through the unsaturated zone using a finite difference solution of a nonlinear partial differential equation which governs flow in this region. Input requirements include soil hydraulic characteristics and appropriate boundary and conditions. Soil data required include soil density, particle surface area, initial saturation, and hydraulic conductivity vs. pressure head (permeability). With regard to surface boundary conditions, annual rainfall, evaporation, and transportation are needed. Finally, the soil-pollutant interactive mechanisms need to be defined and quantified. The values of these parameters and their possible ranges can be readily determined by field investigation. The model can then calculate fluid velocities and degrees of saturation (moisture content) as a function of depth in the soil column and of elapsed time. The second section of the model (GEOQAL) incorporates the output of GEOFLO into a finite difference solution of the convective transport equation. Allowance is made for dispersion and reaction (e.g., adsorption) of the pollutant flux and pollutant concentration as a function of time for various depths in the soil profile. (Auth) (LKH)

MODELS; MODELS, MATHEMATICAL; COMPUTER CODES; CONTAMINANT TRANSPORT; RADIONUCLIDE MIGRATION; SOIL TRANSPORT; ADSORPTION; DIFFUSION; CONCENTRATIONS; UNSATURATED ZONE; EQUATIONS; SATURATION; HYDRAULIC CONDUCTIVITY; PERMEABILITY; PRECIPITATION, METEOROLOGICAL; EVAPORATION; TRANSPIRATION; MOISTURE CONTENT; THEORETICAL STUDIES; SITE EVALUATION; WASTE DISPOSAL

<266>
Wilhite, E.L., Savannah River Laboratory, Aiken, SC.

Chemical Speciation of Plutonium in the Radioactive Waste Burial Ground at the Savannah River Plant. (3)

DP-1511; 16 pp.(1978, August)

Chemical species of Pu in water and sediment samples from a burial ground monitoring well and an alpha waste burial trench at SRP were identified to aid in predicting Pu distribution and migration. Filtration of water (pH 7) from Well C-17 through filters finer than 0.45 u had no significant effect on Pu content (32-23.6 p Ci/l); thus, soluble Pu in the well has a molecular diameter less than 12 A, and is not colloidal, polymeric Pu. Ion-exchange resin batch tests demonstrated that the soluble Pu is about 88% cationic. TTA extraction showed about 25% of the Pu is Pu(+4); hexone extraction showed 43% Pu(+6). Less than 2% of the Pu was soluble in xylene; the remainder (30%) may be Pu(III). Plutonium Kd calculated from Well C-17 water and sediment analyses is 10(E+4); however, Pu removal by uncontaminated burial ground soil indicates an equilibrium Kd of 60. Kd values for soil samples from an alpha waste burial trench were 360-16,000 (with one exception, all were over 1000). Acid leaching of Pu from the soil suggests that it may be present as a non-polymeric hydroxide or sorbed on an acid-soluble soil constituent. Leaching with ammonium acetate was from less than 1% to 4%, indicating that Pu is not ionically bound to the soil. Leaching by a 1 M ammonium carbonate, 0.01 M EDTA solution (28.4-78.6% Pu) implies that Pu is not sorbed on the soil as a polymeric hydrous oxide. Grain size distribution of Pu was 11% in sand, 10% in silt, and 76% in clay-size particles. Soil Pu from the trench was not cation-exchanged; 78% of the soil Pu was associated with metallic oxides in the soil. Approximately 9% of the Pu was contained in the crystalline soil matrix. Ion-exchangeable and organic acid forms of Pu amounted to only about 2.5% each. Thus, about 87% of the Pu in the soil was in a relatively immobile form and will remain so, except for movement of soil particles containing Pu. (LKH)

Grain Size Distribution; Distribution Coefficient

Pu

BURIAL; TRENCHES; WATER; WASTES, LOW-LEVEL; PLUTONIUM; SOILS; RADIONUCLIDE MIGRATION; CHEMICAL PROPERTIES; OXIDES; SORPTION; CLAYS; SANDS; SILTS; LABORATORY STUDIES; DISPOSAL SITE

<267>
Wilhite, E.L., Savannah River Laboratory, Aiken, SC.

A Model to Project Dose-to-Man from Buried Solid Waste. (3)

CONF-770512; Management of Low-Level Radioactive Waste, R.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 9, (pp. 1009-1018), 1214 pp. (1979)

To plan for the postoperational surveillance and control of the Savannah River Plant solid waste burial site, a model is being developed to simulate movement of radionuclides from buried solid waste through the environment to man. A preliminary study has been completed to define possible pathways for Sr 90 movement from buried solid waste to man and to estimate the potential dose-to-man. Possible Sr 90 routes, movement rates, and extents of movement through the environment are organized in a flow diagram, based on known or assumed parameters. Strontium 90 in buried waste may move to man through a set of aquatic pathways (ground water, creeks, and river) and through a set of terrestrial pathways (vegetation, animals, and dust). A direct-contact compartment represents postulated conditions that could occur only if minimal control of the burial site were to cease. By integrating over the entire burial ground, the average rate at which Sr would enter the water table is estimated to be about 0.8 Ci/yr. The maximum Sr concentration in ground water would be about 2 X 10(E+3) pCi/L (maximum permissable concentration (MPC) = 3 X 10(E+2) pCi/L). The projected dose to a single individual from drinking water, if farmstead supply wells were located in the burial region in the year 2000, would be about 1.4 rem/yr. At the Sr 90 flow rate of 0.3 m/yr, about 2400 yr is required for Sr 90 to reach Four Mile Creek, the surface stream nearest the burial ground. During this time, Sr 90 would decay by a factor of 10 (E+25) to a negligible level. The same holds true for nearby Three Runs Creek. Data from tests now in progress are not yet available, but transfer of Sr 90 to deeper aquifers and then to the Savannah River is not expected to be faster than to the creeks. To project dose-to-man for the terrestrial pathways, data from other locations were reviewed for possible application at Savannah River Plant. Projected Sr 90 values in selected food items, if they were grown on burial ground soil after the year 2000, are based on extrapolations of data in the literature by assuming that strontium at depths greater than 85 cm will give the same uptake as that at 85 cm. For a worst case condition, in which the burial ground is assumed to be used as a farm site, the 70-yr bone dose commitments to an individual consuming corn, beef, milk, and water grown or obtained onsite would be 1.4 rem from water, 0.5 rem each from milk and beef, and 4 rem from corn. However, the effect of increased depth of placement of Sr on the reduction of plant uptake may have been underestimated, making consumption of shallow ground water the critical path for dose-to-man. To refine these projections, a detailed conceptual model of radionuclide transport has been formulated, and a computer program written to calculate nuclide transport among the compartments of the model. Several current and planned experimental programs are designed to refine estimates of model parameters, including exhumation tests, lysimeter tests, and soil tests. (Auth) (LWH)

MODELS; MODELS, MATHEMATICAL; WASTES, SOLID; DISPOSAL SITE; RADIONUCLIDE MIGRATION; BURIAL, SHALLOW; STRONTIUM 90; RADIATION DOSE; ENVIRONMENTAL EXPOSURE PATHWAY; GROUND WATER; SURFACE WATERS; MIGRATION RATE; UPTAKE; CROPS; ANIMALS; COMPUTER PROGRAMS; THEORETICAL STUDIES; STREAMS; CREEKS; RIVERS; FIELD STUDIES; ECOLOGICAL STUDIES

GENERAL STUDIES AND REVIEWS

<268>
Adams, A.S. (Ed.), and W.H. (Ed.) Lowder.

The Natural Radiation Environment. (2)

University of Chicago Press, Chicago, IL. (1964)

Sixty papers on environmental radiation sources and environmental monitoring are presented. An address entitled "Radiation and Other Environmental Factors in Human Biology" by R. Lowery Cobbon is also included. The appendices include sections on an intercalibration experiment on instrumentation used in environmental radiation measurements, properties of the uranium and thorium series, and abbreviations used in the text. (RT)

Information pertinent to Rn emanation from buried wastes and environmental monitoring of waste sites are presented. (DE/RT)

ENVIRONMENT; MONITORING; INSTRUMENTS; RADON; ROCKS; SOILS; PLANTS; BACKGROUND RADIATION; COSMIC RADIATION; URANIUM; THORIUM; BIOSPHERE; REVIEWS

<269>
Auerbach, S.I., D.E. Reichle, and E.G. Struxness, Oak Ridge National Laboratory, Oak Ridge, TN.

Environmental Sciences Division Annual Progress Report for Period Ending September 30, 1978. (3)

ORNL-5508; 197 pp. (1979, April)

This report describes progress of research conducted at the Oak Ridge National Laboratory Environmental Sciences Division (ESD) during FY 1978. Areas of research suitable for inclusion in this data base include actinide elements in aquatic and terrestrial environments, burial ground technology, and earth sciences studies. Actinide element research at ESD has emphasized abiotic and biotic studies of Waste Settling Pond 3513, prediction of Pu uptake by human bone, and comparative plant uptake of actinides from contaminated soil. Burial ground technology efforts have been directed at investigation of Sr 90 in White Oak Creek, evaluation of intermediate-level waste pits and trenches, evaluation of the effectiveness of preventive and corrective measures in ORNL Solid Waste Disposal Areas (bentonite seals and rainwater accumulations), mechanisms of radionuclide-sediment association, use of halocarbons as groundwater tracers, and development of hydrologic models. Activities of the Earth Sciences Section in FY 1978 included: laboratory and field leaching studies and laboratory characterization of ash/slags and feed coals for the purpose of generating information to be used in the land disposal of wastes produced by the coal industry (the Stored Solids Study); development of a simple and rapid assay technique to estimate biological activity in a denitrification reactor; development of mathematical models relating to impacts of nuclear and coal technologies; and experimental comparison of batch and chromatographic techniques for determination of distribution coefficients (Kd). (LKH)

ACTINIDES; ECOSYSTEMS, AQUATIC; ECOSYSTEMS, TERRESTRIAL; DISPOSAL SITE; PONDS; SETTLING PONDS; MAN; UPTAKE; RADIONUCLIDES; PLUTONIUM; PLANTS; SOILS, RADIONUCLIDE MIGRATION; SOIL TRANSPORT; CRE[illegible]; STRONTIUM 90; DRAINAGE BASINS; WASTES, INTERMEDIATE-LEVEL; PITS; TRENCHES; WASTES, SOLID; BENTONITE; SEAL MATERIALS; WATER TABLE; GROUND WATER; SEDIMENTS; TRACERS; HALOCARBONS; MODELS; MODELS, MATHEMATICAL; HYDROLOGY; NUCLEAR POWER; ENVIRONMENTAL IMPACTS; DISTRIBUTION COEFFICIENT; METHODS; WASTE MANAGEMENT; WASTE DISPOSAL; WASTE STORAGE; SITE SELECTION; SITE SURVEILLANCE; FIELD STUDIES; LABORATORY STUDIES; THEORETICAL STUDIES; REVIEWS

<270>
Bonhote, P.A., International Atomic Energy Agency, Vienna, Austria.

Environmental Problems Posed by Wastes from the Uranium Milling Industry. (8)

IAEA-AG/33-14; Uranium Ore Processing, Proceedings of an Advisory Group Meeting, Washington, DC, November 24-26, 1975. International Atomic Energy Agency, Vienna, (pp. 119-128), 238 pp. (IAEA-AG/33-14). (1976, December)

The environmental problems posed by wastes from the uranium milling industry are receiving attention by the industry and by national authorities. Air pollution from mills is not a serious problem. Various airborne radionuclide releases estimated for a mill producing 960t U/a are 500 uCi/d U, 270 uCi/d Th 230, 270 uCi/d Ra 226, and 13 x 10 (E+5) uCi/d Rn 222. Water pollution is potentially a greater problem, but methods are available to treat liquid effluents released from operational mills so that their impact need not be significant. The problems posed by the disposal of tailings in engineered surface waste retention systems are not completely resolved at the present time. Some of these problems, such as contaminated seepage, revegetation, and stabilization, are common to other mineral extraction operations. The unique problems arise from the long half-life of the radionuclides (notably, Th 230 and Ra 226) present in the tailings, which have the potential to lead to radiation exposure of both present and future populations. The actual significance of these potential radiation exposures has not yet been convincingly demonstrated. Bearing in mind the fact that these exposures are caused by natural radioactivity to which mankind has always been exposed, it is believed that the total radiation detriment caused by the extraction of uranium from ores can be shown not to be unjustifiable in relation to the benefits from such extraction. (Both) (LKH)

URANIUM; MILLING; MINING; POLLUTION, AIR; POLLUTION, WATER; TAILINGS; THORIUM; RADON; ENVIRONMENT; WASTE DISPOSAL; WASTE MANAGEMENT; WASTE STORAGE;WASTES, RADIOACTIVE; WASTES, SOLID; WASTES, LIQUID; WASTES, ORGANIC; REVIEWS

<271>
Bishop, W.P., M.J. Bell, K.S. Dragonette, and J. Adan, U.S. Nuclear Regulatory Commission, Waste Management Program, Washington, DC.

Overview of the Nuclear Regulatory Commission Low-Level Waste Management Program. (2)

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GENERAL STUDIES AND REVIEWS

<271> CONT.
CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 1, (pp. 31-45) 1218 pp. (CONF-770512). (1979)

In November, 1972, a document entitled "Environmental Survey of the Nuclear Fuel Cycle" (WASH-1248) was published by the AEC. Its purpose was to establish a technical basis for informed consideration of environmental effects of the uranium fuel cycle and environmental impact statements for individual light water reactors (LWR's). In the survey, the uranium fuel cycle was treated generically. Environmental impacts were tabulated and promulgated as a final rule for referencing (Table S-3) on April 22, 1974 (39 FR 14188). In response to a U.S. Circuit Court of Appeals finding of inadequate documentation to support Table S-3, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle" (NUREG-0116) and "Public Comments and Task Force Responses Regarding Environmental Survey of the Reprocessing and Waste Portions of the LWR Fuel Cycle" (NUREG-0216) were published. As a result of these in-house studies, an interim rule revising Table S-3 has been published. These documents include discussions of shallow land burial of low-level waste, past experiences and sensitivity calculations estimating potential dose commitments from the ground water migration of the wastes. An NRC task force report (NUREG-0217) examining the Federal and Agreement State programs for regulating commercial low-level waste disposal recommends increasing the federal role in low-level waste disposal. The need to investigate alternatives to shallow land burial is identified. The NRC is developing a radioactive waste management program which includes a plan for the implementation of the task force recommendations, the development of environmental impacts for low-level waste disposal, development of standards and criteria, and the establishment of a regulatory framework and licensing procedures for the disposal of low-level radioactive waste. Specific programs and timetables are being formulated and should be available for comments soon. Input from all sectors is solicited. To date hydrogeological modeling and operational experience indicate no health and safety problems in the near term from the operation of shallow land burial facilities, but analyses continue. The environmental impacts from shallow land burial are small and, when properly done, shallow land burial is an acceptable method of disposal. (Auth) (LKM)

ENVIRONMENTAL IMPACT STATEMENTS; ENVIRONMENTAL IMPACTS; REACTORS, LIGHT-WATER; BURIAL, SHALLOW; WASTES, LOW-LEVEL; DOSE COMMITMENTS; REGULATIONS, FEDERAL; WASTE MANAGEMENT; WASTE DISPOSAL; LICENSING; REVIEWS

<272>
Blackburn, J.A., and D.D. Ed, Illinois Department of Public Health, Division of Nuclear Safety, Springfield, IL.

Illinois Experience with Low-Level Waste Management. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 8, (pp. 837-841), 1218 pp. (CONF-770512). (1979)

This paper discusses the operating experience of the Sheffield Nuclear Waste Disposal Site in Illinois and makes recommendations concerning the perceived major problems with site operations. Among the things learned from this experience have been the importance of adequate site criteria; the interactions between the State as the owner and the Federal Government as the licensing agency; the need for extensive environmental surveillance data; and the necessity for maintaining an impartial and unbiased relationship between the contractor and the general public. The criteria for the site, which were established in 1965, require that only solid waste be buried at the site. Although liquid may be received, it must be solidified prior to burial. Further, excluded from burial are all wastes containing more than 1 Ci/cu. ft. In a few instances, shipments exceeding this limit have been accepted by the State Department of Health for burial, where the shipments contained relatively short-lived radionuclides. Several requests for exemption to the limitation have been denied. Environmental surveillance by the State originally consisted of several wells around the site boundary, monitoring water for migrating radionuclides. In the past year, several wells have been drilled with the assistance of the U.S. Geological Survey to expand this effort. Several recommendations are made to improve the effectiveness of this and future waste management operations. State ownership of the buffer zone around the site as well as the site itself is felt to be necessary in order to avoid the awkward situation of having radwaste buried next to private land, should the present buffer zone be sold. A more orderly approach to site monitoring is suggested, with a predetermined monitoring well plan based on the site criteria. At present, users of the site do not totally pay for all services connected with its operation; in fact, spending on monitoring alone almost equals this funding. It is recommended that site operations be funded entirely from charges on the waste buried. Possible solutions are discussed for the problem of misclassification, improper packaging, and incomplete documentation of radwastes being transported from nuclear facilities to Sheffield for disposal. Since federal regulations in these areas are not being adequately enforced, the State of Illinois is preparing to do so. Increased charges for disposal, fines, and formal citations are among the options under consideration to deal with violators. (Auth) (LKM)

DISPOSAL SITE; SITE SURVEILLANCE; MONITORING; BURIAL, SHALLOW; REGULATIONS, FEDERAL; REGULATIONS, STATE; WASTES, LOW-LEVEL; WASTES, SOLID; WELLS; WASTE MANAGEMENT; COSTS; ECONOMICS; PACKAGING; TRANSPORTATION; RECOMMENDATIONS; WASTE DISPOSAL; REVIEWS

<273>
Blaylock, B.G., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Radioactive Waste. (2)

Journal of the Water Pollution Control

SEVERAL STUDIES AND REVIEWS

<272> COST.
Federation 50(6), 16 pp.(1978, June)

Management of high-level and low-level wastes in the environment are reviewed. High-level wastes fall into two categories: fission products of intermediate atomic weights (Cs 137 or Sr 90) with half-lives of about 30 yr; and actinides (Pu 239) with long half-lives of around 20,000 yr. To isolate this waste and render it harmless to man, 500,000 to 1 million yrs are required. If the actinides are extracted and recycled in reactors at reduced efficiencies, storage time would be cut to 700 to 1000 yr. Geologic disposal seems to be best for these wastes, but it is the consensus of several investigators that international cooperation is vital for such a waste management system. The project at Lyons, Kansas was mentioned as well as the full-scale hunt for six waste-terminal storage repositories. Ice sheet disposal of high-level radioactive wastes has been considered. The hot canisters would be allowed to melt their way to the ice-rock interface 1000 to 3000 m below the surface. Cables could be used to tether the canister for eventual recovery. Technical problems exist with ice sheet flow, and political problems exists because an international agreement forbids radioactive wastes disposal in Antarctica. Ocean disposal is complicated by the need for agreement on the international political and legal problems as well as the scientific ones. A number of studies on circulation models and dose rate models are briefly discussed. Marine pathways are evaluated for intermittent releases of low-level wastes. The radionuclides of interest are Zn 65, Cs 137, Co 60, Mn 54. It is their concentration in edible marine organisms that are of concern. The concentrations of the above radionuclides are also discussed with respect to bottom sediments. Various methods of treating wastes with strontium, plutonium, and ruthenium are briefly considered. Leach rates were compared by three methods of mathematical analysis. The present and past land burial and storage techniques have until now been adequate; however, such practices may not be sufficient in the future. Computer analysis of a one-dimensional transient response of a soil column to infiltrating water is mentioned. Assessments of power plant impacts are now including one- and two- dimensional mathematical models for the transport of dissolved radionuclides. Effects of sediment-radionuclide interaction, routine and accidental discharges and aquatic and atmospheric dispersion, deposition, and resuspension are included. The aquatic and terrestrial food chain transport and the calculation of doses resulting from internal and external modes of exposure are considered as well. When comparing the behavior of plutonium and americium in marine and freshwater environments, there is no preference of uptake between the two transuranics. The major reservoirs of plutonium and americium are the sediments in both environments. Several studies were briefly included on the uptake by organisms of transuranics. (MDV)

ACCIDENTS; BEDROCK; BIOSPHERE; BURIAL; CHELATES; COMPUTERS; CONTAINMENT; CONTAMINATION; DISPERSIVITY; DISPOSAL SITE; DOSE RATE; ENVIRONMENT; EXPOSURE, EXTERNAL; EXPOSURE, INTERNAL; FISSION PRODUCTS; FOOD CHAINS; FRESHWATER SYSTEMS; GROUND WATER; INGESTION; LEACHING; MAN; MODELS, MATHEMATICAL; NUCLEAR POWER; UPTAKE; WASTE MANAGEMENT; WASTE DISPOSAL; WASTES, HIGH-LEVEL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, TRANSURANIC; ACTINIDES; MARINE SYSTEMS; REVIEWS; CONTAINMENT TRANSPORT

<273>
Duckworth, J.P., T.J. Jump, and B.E. Knight, Nuclear Fuel Services, Inc., West Valley, NY.

Final Report on the Radioactive Waste Management Project. (2)

Final Report; 59 pp.(1976, August)

The results of a waste management research project funded by the New York State Atomic and Space Development Authority are presented in this report. The major tasks in the research project were a literature survey of waste characterization and immobilization alternatives, a description of the burial ground characteristics, and the development of disposal operation standards. The discussion on waste characteristics includes a summary of U.S. commercial low-level waste burial history, the historical use of the NFS burial site, and volume, activity and compositional data for spent resins and evaporator bottoms. A discussion of the results of a program of boring holes around the burial trenches is presented. Elevated tritium levels were detected in the soil zone above twenty feet, however, the extent of tritium migration at the time of this investigation was limited to within ten feet of the trenches. A comparison of immobilization methodologies is included with information on cement, urea formaldehyde, microcell, vermiculite and asphalt. Observations and suggestions for disposal criteria are also presented. (JC)

The comparison of the advantages and disadvantages of cement and urea formaldehyde is useful. The waste characterization data are limited. (DH/JC)

Stratigraphic Unit Thickness; Distribution Coefficient; Volumetric Water Content

H 3; Sr 90; I 129; I 125; Cs 137; Cs 134

BURIAL; WASTES, RADIOACTIVE; TRENCHES; SOLIDIFICATION; IMMOBILIZATION; ABSORBENTS; CEMENTS; UREA FORMALDEHYDE; EVAPORATORS; FILTERS; SLUDGES; RESINS;; SATURATION; BOREHOLES; RADIONUCLIDE MIGRATION; ASPHALTS; REVIEWS; WASTES, LOW-LEVEL; WASTE VOLUME; WASTE DISPOSAL; DISPOSAL SITE; ENCAPSULATION; BETA PARTICLES; ALPHA PARTICLES

<275>
Duguid, J.O., F.S. Brinkley, D.A. Crerar, S.J. Draggan, E.R. Eastwood, D.E. Edgar, C.F. Francis, J.H. Hayes, D.R. Jackson, T.L. Levin, J.L. Means, H. Reeves, O.H. Sealand, H.P. Stooksbery, T. Tamura, and G.M. Thompson, Oak Ridge National Laboratory, Oak Ridge, TN.

Environmental Sciences Division Annual Progress Report, Period Ending September 30, 1976. (2)

ORNL-5257; 31 pp.(1976, September)

This report summarizes research findings at the Environmental Sciences Division of ORNL during FY 1976. After installation of a near surface seal of polyvinyl chloride over waste trenches 105, 83, and 72 in Burial Ground 5 at ORNL, monitoring of water levels downslope

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<275> CONT.
showed water well below the top of the trenches and elimination of radionuclide contaminated seepage. Also constructed was a surface runoff diversion system for Burial Ground 6, using paved ditches. Sampling data from White Oak Creek, into which the burial ground discharges, was inadequate for evaluation because of malfunction of Sampling Station 3. At least one year's data will be needed to measure the effects of diversion. Burial Ground 6 has had near surface seals of bentonite/shale 15% bentonite installed over trenches. No instrumentation has yet been installed to determine the effectiveness of this seal. Gel filtration chromatography has been used to investigate organic complexes as mobilizers of Co 60. Two Co-carrying weight fractions have been separated using this technique. One, greater than 700 MW, carries ~10% of Co 60 and probably represents natural organics such as fulvic or humic acid. The less than 700 MW fraction carries 90-95% of the Co, and is believed to represent synthetic compounds introduced into the waste during decontamination. A two-dimensional mathematical model of saturated-unsaturated transport in ground water has been developed and applied to radionuclide movement from ILW-Trench 7. Data is still being collected for evaluation. Channel-layer chromatography was used to assess the mobility of Pu 237 in the Pequay Sand from Barnwell, S.C., near a proposed nuclear fuel reprocessing plant. Experiments using Pu(IV), Pu(V), and Pu(VI) produced similar results - less than 3% of the Pu migrated farther than 2.5 cm. Movement in limed soil was greater than in unlimed. A higher proportion of Pu reached the ends of the chromatographs than Sr 85 when water was the elutant. The fact that water eluted Pu farther than 0.01 M calcium nitrate implies movement as a carbonate or as an organic complex. Kd's derived by batch technique and column chromatography for Pu 237 and Sr 85 from the Pequay Sand and Kd's for Pu under different pH's and salt solutions were compared. It was determined that Pu 237 in solution was associated with an organic complex. Preliminary gel-filtration chromatography results appear to indicate an organic substance of between 700 and 100,000 MW. The role of microorganisms and plants in the uptake and transfer through the soil of Cs 137, Co 58, Na 58, and Na 22 was studied under simulated natural conditions. Cs and Co were leached more under winter conditions than in summer, due to reduced water movement and microbial immobilization. Na leaching increased in summer conditions, caused by rapid decomposition of the organic litter and leaching. Plant roots decreased losses of Co, Na, and Ba, but had little effect on Cs. Investigation of fungal and bacterial transfer of tritium indicated that concentration ratios for HTO are greater than for organically bound H 3 in these organisms. (LKH)

Distribution Coefficient; Leaching Rate

Co 60; Co 58; Pu 237; Sr 85; Cs 137; Na 58; Na 22; H 3; Ru 106; U 233; Np 237

TRENCHES; BURIAL; RUNOFF; BENTONITE; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTE MANAGEMENT; ORGANIC COMPOUNDS; TRITIUM; PLUTONIUM; STRONTIUM; CESIUM; MICROORGANISMS; PLANTS; UPTAKE; MONITORING; SOILS; BENTONITE; MODELS, MATHEMATICAL; SHALES; FIELD STUDIES; ECOLOGICAL STUDIES; REVIEWS

<276>
Park, D., and S. Ward, U.S. Environmental Protection Agency, Washington, DC.

Information about Hazardous Waste Management Facilities. (3)

EPA/530/SW-145; 130 pp.(1975, February)

This compilation includes information concerning 68 known hazardous waste management facilities. Data are presented in a standard resume form under general categories of toxic chemical, flammable, radioactive, explosive, and biological wastes. Information supplied in resumes includes general background, waste streams, waste handling, and economics, as well as comments and description of sources of information. (CAB)

Useful information for hazardous waste generators. (DE/CAB)

HAZARD ANALYSIS; WASTE MANAGEMENT; WASTE DISPOSAL; ECONOMICS; REVIEWS; WASTES, NONRADIOACTIVE; WASTES, RADIOACTIVE

<277>
Rosser, R.L., C.F. Holoway, and D.G. Hadewell, Oak Ridge National Laboratory, Oak Ridge, TN.

Guide to Radioactive Waste Management Literature. (2)

ORNL-5226; 382 pp.(1977, October)

This guide has been compiled to serve scientists, engineers, administrators, legislators, and private citizens by directing them to sources of information on various aspects of radioactive waste management. References have been selected from about 6000 documents on waste management contained in the computerized information centers in Oak Ridge, TN. These documents were selected, examined, indexed, and abstracted between 1966-1976 by several knowledgeable indexers, principally at the Nuclear Safety Information Center. The selected references have been further indexed and classified into 12 categories. These categories and the number of documents included under each are as follows: Management - General, 879; Treatment, 265; Storage, 104; Disposal, 311; Transportation and Handling, 27; Alternative 11; High-Level Waste, 125; Intermediate-Level Waste, 38; Low-Level Waste, 62; Fuel Reprocessing, 85; Tritium, 38; and Bibliographies, 26. The bibliographic part of this guide exists in computerized form in the Health Physics Information System and is available through the Oak Ridge Information Center Complex for searching from remote terminals. (Auth) (LKH)

WASTE MANAGEMENT; WASTE DISPOSAL; WASTE STORAGE; WASTE TREATMENT; WASTES, HIGH-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; TRITIUM; BIBLIOGRAPHIES; REVIEWS; TRANSPORTATION; WASTES, RADIOACTIVE; FUEL REPROCESSING

<278>
International Atomic Energy Agency, Vienna,

GENERAL STUDIES AND REVIEWS

<276> CONT.
Austria.

Disposal of Radioactive Wastes into the Ground. (2)

STI/PUB/156; Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967; 666 pp.(1967, June)

The proceedings covered a comprehensive range of methods employed, and demonstrated the effort expended by national authorities and researchers alike to achieve an economical solution to the waste disposal problem that is compatible with exacting standards of safety. Topics included: operational experience (10 papers); uptake and migration (11 papers); site selection (5 papers); buried solidified wastes (5 papers); salt disposal and disposal into deep or porous formations (12 papers). (Auth)(MT)

Studies on shallow burial disposal site practices, environmental characteristics, radionuclide transport mechanisms, and environmental monitoring are presented. (DH/MT)

WASTES, RADIOACTIVE; WASTE DISPOSAL; SITE EVALUATION; SITE SELECTION; PLANTS, WASTE TREATMENT; WASTE MANAGEMENT; GEOLOGY; HYDROLOGY; BURIAL; WASTE STORAGE; ENVIRONMENT; FIELD STUDIES

<279>
International Atomic Energy Agency, Vienna, Austria.

Management of Radioactive Wastes at Nuclear Power Plants. (8)

STI/PUB/208; 225 pp.(1968)

Factors to be considered in the design and operation of waste management programs are presented. Included in the discussion are sections on the source and character of the wastes, standards and criteria for the control of wastes, environmental considerations (both on and off-site), waste processing capabilities, and verification of waste management performance and monitoring. A section on future trends and perspectives on waste management is also included. The four appendices describe radioactive waste management at Canadian, French, British, and American nuclear power reactors. (MT)

Information pertinent to the types of wastes to be buried and pre-burial waste processing are presented. (DH/MT)

WASTE MANAGEMENT; REACTORS; WASTE DISPOSAL; WASTE STORAGE; WASTE TREATMENT; WASTES, RADIOACTIVE; HAZARD ANALYSIS; CONTAMINATION; MONITORING; STANDARDS, FEDERAL; REVIEWS

<280>
Jones, D.F., L.R. Cowder, and K.P. Martin Los Alamos Scientific Laboratory, Los Alamos, NM.

Computerized Low-Level Waste Assay System Operation Manual. (2)

LA-6282-M; 80 pp.(1976, February)

An operation and maintenance manual for the computerized low-level waste Nal counter is presented. Routine assay techniques are described and theory of operation is treated in sufficient depth so that an experienced assayist can make nonroutine assays. Complete system schematics are included, along with a complete circuit description to facilitate not only maintenance and troubleshooting, but also reproduction of the instrument if desired. Complete software system descriptions are included so far as calculational algorithms are concerned, although detailed instruction listings would have to be obtained from Group N-1 at Los Alamos Scientific Laboratory in order to make machine-language code changes. (Auth)

RADIATION DETECTORS; COMPUTERS; DESIGN; MEASUREMENTS; WASTES, RADIOACTIVE; MAINTENANCE; WASTES, LOW-LEVEL; REVIEWS

<281>
Kaufman, W.J. (Ed.), University of California, College of Engineering, Sanitary Engineering Research Laboratory, Berkeley, CA.

Ground Disposal of Radioactive Wastes. (1)

Proceedings of a Conference, Berkeley, CA, August 25-27, 1959; 168 pp.(1961, July)

This proceedings volume was compiled from papers submitted by those attending an unclassified conference on ground disposal of radioactive waste and from tape recordings of discussions at the conference. Major subjects included are: 1) operating practices, experiences, and problems at Hanford; Oak Ridge; National Reactor Testing Station; the Savannah River Plant; Chalk River, Ontario, Canada; Scalay, France; and Mol, Belgium; 2) research on ion exchange and adsorption in natural media; and 3) current investigations of hydrodynamic problems in flow through porous media. Each chapter in the book has been abstracted separately. (Auth)(MT)

ADSORPTION; DISPOSAL SITE; FIELD STUDIES; FISSION PRODUCTS; HYDRODYNAMICS; ION EXCHANGE; LABORATORY STUDIES; MONITORING; HYDROLOGY; GEOLOGY; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, SOLID; BURIAL; RADIONUCLIDE MIGRATION; SOILS; WASTE DISPOSAL

<282>
Lenneman, W.L., U.S. Atomic Energy Commission, Washington, DC.

U.S. Atomic Energy Commission Interim Radioactive Waste Burial Program. (3)

STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 261-300), 666 pp. (STI/PUB/156).(1967, June)

Early in 1960, the U.S. Atomic Energy Commission (AEC) provided industry with radioactive waste disposal service in strategic locations within the United States. It announced that radioactive waste burial grounds at Oak Ridge, Tennessee, and the National Reactor Testing Station, Idaho, would be made available to AEC licensees for the disposal of solid radioactive wastes. For the next three years, the AEC had an

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GENERAL STUDIES AND REVIEWS

<202> CONT.
interim radioactive waste burial program which was terminated when privately operated grounds, serving regional areas of the country, became available. The paper does not go into detail concerning the physical handling, treatment, or preparation of solid radioactive waste, per se, or the actual operations of a waste burial ground, but principally covers the administrative processes, treatment, and procedures of a national radioactive waste burial program. All AEC radioactive waste burial grounds and operations were coordinated and a common reporting system and administrative controls were established for radioactive waste burials. Procedures were established for handling off-site and licensee waste shipments and deliveries to the interim burial grounds. Complete records were maintained of the disposition of the 7.2 million cu ft (203 thousand cu m) of AEC and licensee generated waste which was buried during the three-year period. Radioactive waste classification, handling procedures, reporting forms and system, administrative controls, and numerous problems and their resolutions are presented and discussed. Waste burial data and burial costs for the program are given. Post-1963 United States radioactive waste burial data and information through 1966 also are included. (Auth)

A general description of the waste management services including burial practices, costs, and packaging following the announcement that INEL and ORNL would accept waste from AEC licenses. (DE/JC)

WASTES, RADIOACTIVE; BURIAL; TRANSPORTATION; ECONOMICS; CONTAMINATION; WASTES, SOLID; WASTES, LOW-LEVEL; WASTES, HIGH-LEVEL; WASTES, INTERMEDIATE-LEVEL; PACKAGING; SOLIDIFICATION; REVIEWS

<283>
Markham, O.D. (Ed.), Idaho National Engineering Laboratory, Idaho Falls, ID.

Summaries of the Idaho National Engineering Laboratory Site Ecological Information Meeting. (3)

IDO-12079; 68 pp.(1975, July 10)

The report presents the various ecological studies currently being conducted at the Idaho National Engineering Laboratory Site (INEL). In addition to strictly ecological studies at the site, the following radioecological studies are summarized: concentrations of radionuclides in tissues of antelope and doves on and near the INEL site; area studies of the test reactor leaching ponds; numerical modeling of subsurface radioactive solute transport from waste seepage ponds; current distributions of liquid radioactive and chemical wastes in the Snake River Plain aquifer; I 127 and I 129 relations; environmental monitoring; radioactivity in the soil near INEL; radioactive contamination near the radioactive waste management complex; effect of wind speed on the retention of radioactive particles on vegetation; and relationship between secondary succession, wind erosion, and radionuclide resuspension on a buried area. Four of the summaries have been abstracted separately for input into the data base. (HAP)

ECOLOGY; ECOSYSTEMS, TERRESTRIAL; ECOSYSTEMS, AQUATIC; RADIONUCLIDE MIGRATION; RADIOECOLOGY; TISSUES; ANIMALS; BIRDS; LEACHING; PONDS; MODELS, MATHEMATICAL; SEEPAGE PITS; DISTRIBUTION; WASTES, LIQUID; WASTES, INDUSTRIAL; AQUIFERS; IODINE 127; IODINE 129; MONITORING; SOILS; PLANTS; WINDS; PARTICLES; RETENTION; EROSION; RESUSPENSION; REVIEWS; ECOLOGICAL STUDIES

<284>
Markham, O.D. (Ed.), and W.J. (Ed.) Arthur, Radiological and Environmental Sciences Laboratory, Idaho Falls, ID.

Proceedings of the Symposium on the Idaho National Engineering Laboratory Ecology Program, Jackson Lake Lodge, Grand Teton National Park, September 10-12, 1978. (3)

IDO-12080; 72 pp.(1979, April)

A symposium on ecological research being conducted at the Idaho National Engineering Laboratory Site in southeastern Idaho was presented at Jackson Lake Lodge in Grand Teton National Park on September 10-12, 1978. The work presented was funded by the Office of Health and Environmental Research, U.S. Department of Energy, the Idaho Department of Fish and Game, the Office of Waste Management-DOE, and the U.S. Fish and Wildlife Service. Thirty-six papers were presented at this symposium; those which relate to radioactive waste management aspects have been abstracted separately for this data base. (LKH)

See also IDO-12087.

ECOSYSTEMS, TERRESTRIAL; ECOSYSTEMS, AQUATIC; DISPOSAL SITE; PONDS; PITS; TRENCHES; RADIONUCLIDE MIGRATION; UPTAKE; ENVIRONMENT; BIOTA; ECOLOGY; REVIEWS; ECOLOGICAL STUDIES

<285>
McKinney, J.D., EG and G Idaho, Inc., Idaho Falls, ID.

Long-Term Management Plan Idaho National Engineering Laboratory Radioactive Waste. (3)

TREE-1284; 182 pp.(1978, December)

The Idaho National Engineering Laboratory stores large quantities of transuranic-contaminated waste at its Radioactive Waste Management Complex. This report presents a 10-year plan for management of this transuranic waste and includes descriptions of projects involving nuclear waste storage, retrieval, processing, systems analysis, and environmental science. Detailed project schedules and work breakdown charts are provided. Cost estimates and schedules for completing each major task and work package are presented, along with a discussion of the reasoning behind the schedule and interrelationship of the task. (Auth) (HAP)

WASTES, TRANSURANIC; WASTE MANAGEMENT; WASTE STORAGE; BURIAL; RETRIEVABILITY; WASTE PROCESSING; ENVIRONMENTAL EXPOSURE PATHWAY; COSTS; DESIGN; CONTAINERS; REVIEWS

GENERAL STUDIES AND REVIEWS

<206>
Nuclear Waste Disposal. (3)

Editorial Research Reports 2?(17):
885-906. (1976, December 3)

One of the most unsettling problems to confront the nuclear industry is the handling of radioactive wastes from weapons programs and from commercial nuclear reactors. Proponents of nuclear power are convinced that the technology exists, while opponents are not as certain of these conditions. Wastes are piling up at the 69 nuclear power plants and at present there is no policy for handling them. A number of reports are cited expressing concern that disposal of wastes has been poorly managed by the government and in some cases leaks have developed which could have been potentially harmful to the environment. One example of this condition is a leak at Hanford which allowed so much plutonium into the soil that the concentration could have caused a chain reaction in the soil. Also, there is a concern that storage requiring long intervals of time may not be practical due to necessity of extremely high levels of dedication and perseverance which is somewhat foreign to human nature. The report emphasizes all the problems that have occurred with storage facilities already in operation. Land burial of low-level radwastes was started to supplement ocean burial which was used from 1946 to 1970, dumping 62,000 drums of waste. Subsequent studies of radionuclide migration has indicated leaks off both coasts from the sites. Problems of leakage also exist at the land burial sites where 42 million cu ft of military low-level wastes and 9 million cu ft of commercial low-level wastes are buried. The lack of uniformly good performance of these sites gives cause for concern. Also addressed is the real necessity of waste recycling and the growing backlog of spent fuel assemblies. (ERV)

ACCIDENTS; BIOSPHERE; BURIAL; CONTAINMENT; CONTAMINATION; DECOMMISSIONING; DISPOSAL SITE; ENVIRONMENT; FUEL CYCLES; FUEL REPROCESSING; HAZARD ANALYSIS; LEACHING; LEAKAGE; MONITORING; RADIONUCLIDE MIGRATION; REVIEWS; REPROCESSING; SEEPAGE PITS; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, HIGH-LEVEL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE

<207>
Platt, A.M., Battelle-Pacific Northwest Laboratories, Richland, WA.

Nuclear Waste Management Quarterly Progress Report - October through December 1976. (3)

BNWL-2205; 60 pp. (1977, April)

This document is one of a series of technical progress reports designed to report on commercial radioactive waste management programs at Battelle-Pacific Northwest Laboratories. Progress during the last quarter of 1976 is reported on decontamination and densification of chop-leach cladding, monitoring methods for particulate and gaseous effluent from waste solidification processes, transuranic waste fixation studies, krypton solidification, C 14 and I 129 fixation, international program coordination, waste management system studies, waste management safety assessment, U.S. Nuclear Regulatory Commission studies, detection and characterization of mobile organic complexes of fission products, characterization of 300 area burial grounds, electropolishing as a decontamination technique, and decommissioning of retired contaminated facilities at Hanford. (ER)

Information on probable waste processing migration of radionuclides from burial sites, environmental monitoring of burial sites and the environmental characteristics of the Hanford "300" Area burial grounds is presented. (DB/TT)

RADIONUCLIDE MIGRATION; CONTAINMENT; DECOMMISSIONING; ENVIRONMENT; MONITORING; DECONTAMINATION; WASTE MANAGEMENT; SOLIDIFICATION; WASTES, RADIOACTIVE; SAFETY; WASTE TREATMENT; REVIEWS

<208>
Raymond, J.R., Battelle-Pacific Northwest Laboratories, Richland, WA.

Use of a Neutron Well Probe. (2)

BNWL-36 (Part 4); Hanford Radiological Sciences Research and Development Annual Report for 1968, D.E. Pearce and J.K. Green (Eds.), (pp. 436-439), 571 pp. (BNWL-36, Part 4). (1965, January)

The neutron well probe is used to describe subsurface stratigraphic breaks. The probe works on the basis of the more soil moisture present the higher the reading. Siltstone and shales give the higher readings because the small pore size allows more water to be held than do the coarse-grained sediments, such as sandstones. The probe also aids in studying the subsurface moisture in the aeration zone above the water table and is determining the degree of saturation in the capillary fringe. The probe will determine the total porosity so an estimate can be made of ground water flow rates. Examples are given of the ability to determine position of the Palouse Formation, which is a fine sandy-silt zone. In one of the logs a perched water zone is noted. The water table on both logs is clearly evident. The neutron probe was originally designed for measuring moisture content of the soil adjacent to buried high-level, radioactive waste storage tanks. (ERV)

GEOLOGIC STRATA; PERCHED WATER; POROSITY; WATER TABLE; LOGGING, WELL; SILTSTONES; SANDSTONES; SHALES; NEUTRONS; MONITORING; REVIEWS

<209>
Steger, J., E. Albenesius, J.O. Bequid, C. Hanson, and L. Johnson, U.S. Energy Research and Development Administration, Steering Committee on Land Burial.

The ERDA Plan to Develop a Technology for the Shallow Land Burial of Solid Low-Level Radioactive Waste. (2)

29 pp. (1976, June)

The U.S. Energy Research and Development Administration's Steering Committee on Land Burial presents in this report its initial plan which establishes program goals, outlines the procedures which will be followed during the program, guides the organization of activities, and coordinates

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the activities with other responsible agencies. The goal of the program is to define what technical information is presently available, identify data needs, initiate the appropriate need investigations, to assemble and evaluate all relevant information into a technology including cost/benefit considerations, to construct a demonstration facility to field test the developed technology, and to disseminate the appropriate information to site operators, environmental scientists, and policy/decision makers. The chief areas of concern for the steering committee are data acquisition, burial site selection, waste criteria, site engineering, operational assessment, and validation/demonstration. The existing state of knowledge on these topics is reviewed and a schedule of the program through 1982 is presented. (JC)

Data not contained within but strategy for attaining it is. (DE/JC)

BURIAL; WASTES, LOW-LEVEL; SITE SELECTION; WASTE MANAGEMENT; RADIONUCLIDES; GEOLOGY; HYDROLOGY; DECOMMISSIONING; SORPTION; WASTE DISPOSAL; DESIGN; BURIAL, SHALLOW; WASTES, SOLID; REVIEWS

<290>
Tamura, T., J.P. Eastwood, and O.H. Sealand, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN.

Applied Soils and Waste Management Studies. (E)

ORNL-4848; Environmental Sciences Division Publication 880; Environmental Sciences Division Annual Progress Report for Period Ending September 30, 1972, (pp. 49-51), 127 pp. (ORNL-4848). (1973, February)

Progress report on characterization of plutonium contaminated soil from the Nevada Test Site and in the development of plugs to be used as sealants in the salt mine repository. Use of plutonium 236 as an internal spike permits determining plutonium in the sample. Samples collected at NTS permit determination of plutonium on different size fractions and minerals. Results of analyses show that about 75% of the plutonium is extractable with nitric acid (H_2O_2-HF-HCl technique). Investigations into borehole sealants indicates that type S cement exhibits a reduced permeability when compared with standard cement. Type III cement was found to be the most impermeable. All tests were run under short curing time for the cement and relatively short test periods. (TNH) (JT)

Progress report on the characteristics of plutonium contaminated soil at the Nevada Test Site and the development of borehole sealants. (DE/JT)

pH; Flow Rate; Permeability

P, 236

PLUTONIUM; CONTAMINATION; SEPARATION PROCESSES; WASTE DISPOSAL; REPOSITORY; BOREHOLES; CEMENTS; MONTMORILLONITE; SOILS; ANIONS; ION EXCHANGE; PARTICLE SIZE; SALT DEPOSITS; SEAL MATERIALS; PERMEABILITY; MINERALS; WASTES, HIGH-LEVEL; REVIEWS

<291>
U.S. Congress, House of Representatives, Washington, DC.

Low-Level Radioactive Wastes-Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, February 23, March 12, and April 6, 1976. (E)

Low-Level Radioactive Waste Disposal, Hearings before a Subcommittee on Government Operations, House of Representatives. U.S. Government Printing Office, Washington, DC. (1976)

Verbal testimony presented to the House Subcommittee on Government Operations concerning low-level radioactive waste disposal is recorded of individuals representing the Illinois Dept. of Public Health, U.S. Nuclear Regulatory Commission, U.S. Geological Survey, U.S. General Accounting Office, U.S. Energy Research and Development Administration, U.S. Environmental Protection Agency, South Carolina Dept. of Health and Environmental Control, Nevada Dept. of Human Resources, and Nuclear Engineering Co., Incorporated. Also included are letter statements, and other written material submitted to the Congressional Record by these representatives. The appendix consists of (1) a report on improvements needed in the land disposal of radioactive wastes (GAO Report RED-76-54) with comment by the U.S. Energy Research and Development Administration and the U.S. Nuclear Regulatory Commission, (2) an April 9, 1976, a letter from Mr. Henry Eschange (Director, Resources and Economic Development Division, U.S. General Accounting Office) to Mr. Robert Seamans, Jr. (Administrator, U.S. Energy Research and Development Administration) concerning funding of a proposal ERDA radiological safety study on some early decommissioned nuclear facility sites, and (3) a statement submitted for the hearing record from a private citizen residing near the Maxey Flats disposal site in Kentucky. (NT)

The technical, legal, and problematic aspects of shallow waste burial are reviewed. The rules of the various government agencies involved in shallow waste burial are also discussed. (DE/NT)

WASTE DISPOSAL; WASTE MANAGEMENT; GEOLOGY; HYDROLOGY; LEGISLATION; BURIAL; RADIONUCLIDE MIGRATION; ENVIRONMENT; WASTES, RADIOACTIVE; WASTE TREATMENT; DISPOSAL SITE; WASTES, LOW-LEVEL; REVIEWS

<292>
Untersuyer, S., L.E. Brass, and A.S. Klein, National Nuclear; Rockwell International, Rockwell Hanford Operations, Richland, WA; Nuclear Equipment.

Measuring Low Concentrations of Plutonium and Americium in Earth Samples. (E)

Transactions of the American Nuclear Society 27:116-117, (1977)

A series of tests was made to determine the suitability of high-resolution x-ray detectors for measuring both the Pu and Am content of waste materials. Since the L x-rays emission rate of Pu 239 is so much lower than that of Am 241, it is essential to

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distinguish between Pu and Am when counting x-rays to establish alpha emission rates. Tests show the L x-ray assay can detect Pu in levels down to 40 pCi/g. The units are rugged and do not require nitrogen when not in use. The units are also precise. (VDV)

AMERICIUM 241; PLUTONIUM 239; INSTRUMENTS; X-RAY; WASTE MANAGEMENT; ALPHA PARTICLES; LABORATORY STUDIES

<293>
Arnett, R.C., and P.A. Deju, Atlantic Richfield Hanford Company, Richland, WA.

Hydrologic Impact Analysis of New Water Uses in Section 7, T.10 N., R.28 EWN., of the Hanford Reservation. (3)

ARH-LD-121; 29 pp. (1976, January)

An investigation was made into the hydrologic effects of removing 1.7 million gal of water per day from the unconfined aquifer in the northern half of Section 7, T. 10 N., R. 28 EWN., with recharge in the same areas of 1.0 million gal/day. For the purposes of the analysis, the following assumptions were made: the aquifer is homogeneous and of essentially infinite area; no radiocontamination of the water will occur as a result of the proposed water use; the aquifer is isotropic and of uniform thickness; pumping is at a steady rate of 6.4 X 10 (E+6) 1/day; the well receives water from the entire thickness of the aquifer by horizontal flow; and discharged water eventually infiltrates the aquifer at a point or in an area no closer than the sum of the radii of influence of the pumped and discharge wells. A well hydraulic analysis based on data from wells near the study area indicated that one well would be sufficient to deliver the volume of water required from the aquifer. An equation was generated that indicated minimal impact on the water table (maximum water buildup at the recharge face is less than 2.5 ft). Disposal pond area based upon a previously calculated infiltration rate of 5.3 X 10(E-3) gal/min/sq.ft. (1.0 ft./day) should be 3.1 acres; if the infiltration rate is 0.5 ft/day, the surface area should be 6.1 acres. It was recommended that one step-drawdown and one pump test be carried out on the withdrawal well to verify the calculations, and if the water to be recharged is chemically or radiologically contaminated, additional impact studies should be made. (LKH)

Infiltration Rate; Hydraulic Conductivity; Depth to Water Table

HYDROLOGY; WELLS; WITHDRAWAL; RECHARGE; WATER TABLE; HYDRAULICS; AQUIFERS, UNCONFINED; HYDRAULIC FLOW; EQUATIONS; DRAWDOWN; FIELD STUDIES

<294>
Barete, M.V., and E.B. Suarez, National Nuclear Energy Commission, Office of Radiological Security, Mexico.

Assessment of the Various Factors Governing the Siting of a Radioactive Waste Burial Ground for the Mexican National Nuclear Energy Commission. (3)

CONF-670512; STI/PUB/156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 367-382), 666 pp. (CONF-670512, STI/PUB/156). (1967)

The authors studied various regions in the neighborhood of Mexico City with a view to finding suitable sites for the installation of a radioactive waste burial ground. Each region was assessed from the viewpoints of lines of communication, rainfall, proximity to population centres, prevailing winds and their velocity, liability to earthquakes, sub-soil structure, fertility, and in general all the factors which might make it desirable or undesirable for habitation in the near future. Other important factors studied were the possibility of acquiring the sites, their size and proximity to common land which might be considered as affected, and certain legal aspects which might affect the land in the planning stage, such as rights of way, restrictions on use, and possible expressway construction. After assessment of the various technical, economic, administrative and legal aspects and consideration of the possible dispersal of radioactive elements into various media (atmosphere, water, soil, etc.), the sites most suitable for the radioactive waste burial ground are proposed, the conservation of natural resources and above all public safety being borne in mind. (Auth)

CLIMATE; SOILS; BURIAL; TOPOGRAPHY; GEOLOGY; SITE SELECTION; EARTHQUAKES; ENVIRONMENT; FIELD STUDIES

<295>
Barraclough, J.T., J.B. Robertson, and W.J. Janzer, U.S. Geological Survey, Idaho Falls, ID.

Geohydrologic Study of a Burial Site for Solid Low-Level Radioactive Wastes at the Idaho National Engineering Laboratory. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 8, (pp. 795-824), 1214 pp. (CONF-770512). (1979)

This paper describes a study of the geohydrologic and geochemical conditions which may control subsurface migration of radionuclides from a semiarid shallow burial site for solid radioactive wastes. Field investigation involved drilling 10 observation wells around and within the 88-acre Radioactive Waste Management Complex at the Idaho National Engineering Laboratory; 1700 sediment, rock, and water samples were collected for mineralogic, chemical, physical, and radioactive analysis. The subsurface rocks are chiefly basalt with two principal sedimentary beds occurring at depths of about 110 and 240 ft (34 and 73 m). The water table in the underlying Snake River Plain aquifer (basalt) is at a depth of 580 ft (177 m) at the site. Statistically significant trace amounts of radioactivity were found in about one-half of the 88 sediment samples from 6 shallow core holes down to depths of 240 ft (73 m), and in water samples from a small perched zone beneath the burial site. Detectable values (in pCi/kg) from sediment samples were: Co 60, less than 3 to 250 +/- 30; Sr 90, less than 200 +/- 50 to less than 8200; Cs 137, less than 20 to 550 +/- 80; Ba/La 140, 88 +/- 12 (detected in only one sample); Pu 238, 0.2 +/- 0.3 to 15.0 +/- 3.0; Pu 239, 240, less than 0.5 to 560.0 +/- 12.0; and Am 241, 1.0 +/- 1.5 to 230.0 +/- 20.0. Values for water samples (in pCi/L) were: H 3, less than 1000 to less than 2000; Co 60, less than 10 to 90 +/- 10; Sr 90, less than 2 to less than 5; Cs 137, less than 20 to 200 +/- 10; Pu 238, 0.025 +/- 0.008 to less than 0.010; and Pu 239, 240, 0.023 +/- 0.008 to less than 1.00. The levels of radioactivity detected were generally less

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than the amounts resulting from world-wide fallout found in surface soils in this region. The observed trace amounts of radioactivity may have been derived from the downward migration of radionuclides from the buried wastes, from artificial contamination of the cores during drilling and sample handling, or from a combination of these processes. Available data indicate that waste radionuclides have not migrated from this site into the Snake River Plain aquifer in detectable concentrations. Such downward migration appears unlikely, provided that water can be prevented from coming in contact with the buried waste. (Auth) (LEH)

Total Ion Concentration

Co 60; Cs 137; Ba 140; La 140; Pu 238; Pu 239; Pu 240; Am 241

DISPOSAL SITE; BURIAL, SHALLOW; GEOLOGY; HYDROLOGY; RADIONUCLIDE MIGRATION; WASTES, SOLID; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; SAMPLES; SAMPLING; CORES; SEDIMENTS; SURFACE WATERS; GEOCHEMISTRY; DESERTS; BASALTS; IGNEOUS ROCKS; SEDIMENTARY ROCKS; AQUIFERS; WATER TABLE; CORES; PERCHED WATER; RADIOACTIVITY; REVIEWS; FIELD STUDIES

<296>
Bouma, J., D.J. Van Booyen, and F.D. Hole, University of Wisconsin, Madison, WI.

Estimation of Comparative Water Transmission in Two Pairs of Adjacent Virgin and Cultivated Pedons in Wisconsin. (3)

Geoderma 13:73-88. (1975)

Hydraulic properties and soil morphology of virgin and cultivated pedons were studied in Wisconsin. The tests were on the A slopes (0-2%) of the Tama silt loam and Oshkosh clay. Hydraulic conductivity was calculated by the Green and Corey computation pore-interaction model. Results showed the conductivity of the virgin soil to be 160 cm/day and the cultivated pedon to be 20 cm/day. The capacity of the two cultivated soils to transmit water under saturated conditions was less than in virgin soils. However, unsaturated soil capacity of cultivated soils increased at corresponding moisture tensions. For example, 1 cm/day and 1 mm/day can be maintained in the A12 horizon at 60 cm of tension in the cultivated soil. Compacted layers below the Ap had a drying effect on the overlapping Ap, whereas a wetting effect resulted in the A1 horizon of virgin pedons at unsaturated flow rates. More research is needed in using the standard soil descriptions and estimating hydraulic conductivities from those descriptions. (HDV)

Hydraulic Conductivity; Moisture Potential

HYDROLOGY; PERCOLATION; SOILS; LOAM; CLAYS; WASTE DISPOSAL; WASTES, LIQUID; WASTES, LOW-LEVEL; A ZONE; HYDRAULIC CONDUCTIVITY; GROUND WATER; SATURATION; FIELD STUDIES

<297>
Bradley, E.F., and J.C. Corey, Savannah River Laboratory, Aiken, SC.

Concepteal Design of the Savannah River Plant Bedrock Waste Storage System. (2)

DP-1438; Technical Assessment of Bedrock Waste Storage at the Savannah River Plant, (pp. III-1 - III-99), 287 pp. (1976, November)

The conceptual design for a waste storage system in crystalline rock differs significantly from a waste storage system in Triassic rock. The relatively higher permeability and lower porosity of the crystalline rock coupled with its more inhomogeneous nature makes this system more susceptible to penetration by liquid waste than a system designed for Triassic rock. Rock penetration requires that the waste charged to crystalline caverns be altered significantly. This alteration includes separation of the inert chemical constituents (such as nitrate, nitrite, etc.) from the radionuclides in order to eliminate density gradients and radiolytic gassing. If these modifications are made, a total cavern volume in crystalline rock of approximately 100 million gallons would be acceptable, assuming that the total volume of modified waste is still approximately 80 million gallons. The technical feasibility and cost of these modifications are beyond the scope of this analysis; however, it should be emphasized that these modifications represent a major alteration of the waste. Alteration of the waste does not appear to be necessary for storage in the Triassic formation. A total cavern volume of ca. 130 million gallons should be sufficient for a Triassic cavern located in rock equivalent to that found near the center of the Triassic basin; i.e., 80 million gallons of waste, 30 million gallons for water inleakage and radiolytic gas, and 10 million gallons for cavern volume reduction from long-term creep of the rock. The Triassic conglomerate rock at the edge of the basin is not acceptable for bedrock storage because of excessive long term reduction of the cavern volume from the rock creep phenomenon. The remaining bedrock areas appear to possess adequate strength and structural properties; they offer no particular or unusual mechanical difficulties to cavern construction. Although alteration of the waste for storage in the Triassic formation does not appear to be necessary, it would be feasible to mix the waste with cement to form a grout that would set up in the cavern. This concept would provide some additional safety and should be considered as an alternative. The potential for the waste to destroy grouting materials plus the extended time periods involved in bedrock storage are such that, based on existing information, no credit can be taken for engineered reduction of the permeability of the rock surrounding the caverns by grouting, although extensive grouting would still be carried out as an added measure of safety. Effects of heat generation from decaying radionuclides in the waste should be considered in the final detailed design and arrangement of the caverns, but temperatures apparently can be kept to an acceptable level by proper sludge distribution and proper cavern size and arrangement. Shaft sealing should be secure to afford no significant path for waste migration. Preliminary analysis indicates that such a seal can be obtained. (Auth)

The information is directly related to disposal of high-level waste. However, it can also be considered to pertain to shallow land burial except that requirements for deep burial of high-level waste are more stringent than requirements for shallow land burial. (DM/JW)

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BEDROCK; RADIOACTIVITY; MONITORING; GROUTING; PIEZOMETERS; CORROSION; DISTRIBUTION COEFFICIENT; SANDSTONES; PERMEABILITY; HYDRAULIC GRADIENT; HYDROLOGY; RADIONUCLIDES; WASTE VOLUME; WASTE STORAGE; STORAGE, GEOLOGIC; DESIGN; THEORETICAL STUDIES

<298>
Crowe, B.M., G.W. Linn, G. Markes, and M.L. Revier, Los Alamos Scientific Laboratory, Los Alamos, NM.

Stratigraphy of the Bandelier Tuff in the Pajarito Plateau: Applications to Waste Management. (3)

LA-7225-MS; 57 pp.(1978, April)

The stratigraphic, petrologic, and hydrologic characteristics of the Bandelier Tuff (Plio-Pleistocene) in the Pajarito Plateau surrounding Los Alamos Scientific Laboratory have been studied to provide background information on its suitability as a medium for radioactive waste disposal. Of significance for waste management studies are the effects of lateral variations in lithology (welded vs. unwelded units), porosity, localization of joints, differences in physical properties of deposits within textural zones of a flow unit, and geochemical considerations. Results of geochemical analyses of altered and unaltered tuff are included as appendices, but the data are not evaluated in this report. Hydrologic characteristics of the Bandelier Tuff are controlled mainly by secondary features (cooling zones) which vary with emplacement temperature and transport distance. Primary depositional features provide second-order controls in distal portions of the flow. The recommendations of this report are: (1) a systematic hydrologic field-testing program be undertaken, (2) the general stratigraphic procedures used for this report be applied to specific waste disposal sites, (3) hydrologic data for tuffs on the Nevada Test Site be applied to studies of the Bandelier Formation, (4) the stratigraphic subdivisions used in LASL reports be revised to improve understanding of lithogenesis and credibility of geologic information at waste disposal sites, and (5) geochemical studies concerning radionuclide migration, rock-waste interactions and effects of lateral rock-alteration processes be continued. (LKH)

ASHFLOWS; FIELD STUDIES; GEOLOGIC FORMATIONS; GEOLOGIC STRATA; GEOLOGY; IGNEOUS ROCKS; TUFFS; SITE EVALUATION; GEOCHEMISTRY; DISPOSAL SITE

<299>
Giannotti, G.P., H. Hittenperghar, and G. Sidoti, Laboratorio Geominerario del CNEN, Geological Section, CSN Della Casaccia, Rome, Italy.

Selection Criteria for Ground Disposal Sites for Solid Radioactive Waste in Highly Populated Areas. (3)

CONF-670512; STI/PUB-156; Disposal of Radioactive Wastes into the Ground, Proceedings of a Symposium, Vienna, Austria, May 29-June 2, 1967. International Atomic Energy Agency, Vienna, Austria, (pp. 319-328), 666 pp.(1967, June)

In examining Italy for potential shallow, radioactive, solid waste burial sites, various criteria are studied and priority alloted to certain of these criteria. The six most important criteria for consideration are thought to be geology, hydrology, volcanology, seismicity, climatic details, and the population density associated with a proposal site. Economy, pedology, soil utilization, bathymetry, ecology, and ground organizaiton need also be considered. In choosing such disposal areas, those characterized by (1) seismic activities at the VII or higher grades of the "Mercalli scale", (2) active volcanism, (3) hydrology characterized by shallow aquifers circulating through karstic formations and fractures, (4) population densities greater than 500 inhabitants/sq km, (5) elevation in excess of 1000 m above sea level, and (6) national parks were ruled out. The favorable areas initially selected in accordance with these criteria cover a surface area slightly less than 1/8 of Italy. This area is reduced to about 1/30 with exclusion of interior areas whose hydrology, directly or indirectly, is likely to interfere with that of surrounding unfavorable areas. A second survey was conducted on the remaining favorable areas. (Auth) (RT)

This study is applicable to choosing and evaluating criteria for shallow land burial site selection. (DM/RT)

WASTE DISPOSAL; ECONOMICS; POPULATIONS; SEISMOLOGY; GEOLOGY; HYDROLOGY; CLIMATE; GEOGRAPHY; METEOROLOGY; SITE SELECTION; WASTES, RADIOACTIVE; WASTES, SOLID; BURIAL; DISPOSAL SITE; SITE EVALUATION; VOLCANOES; FIELD STUDIES

<300>
Morgan, J.M., Jr., Johns Hopkins University, Baltimore, MD.

Considerations in Evaluating a Burial Ground for Solid Wastes. (2)

TID-7517 (Part 1A); Sanitary Engineering Aspects of the Atomic Energy Industry, Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 283-289) (TID-7517, Part 1A).(1955, December)

At present, radwastes are buried at five different sites. It is suggested that a national land burial area be used to sequester radioactively contaminated materials. The life of such burial areas should be at least one hundred years. One square mile of burial area with a buffer zone of one-half mile should be acquired in an "empty" section of the country. Topography, geology, surface and ground water hydrology, meterology, soil conditions, and transportation facilities are the physical factors affecting the desirability of any particular site. The general geology should show an absence of faults and folds. The area should not have limestone or dolomite formations in addition to having no previous seissological history. The topography should be flat or gently rolling for ease of burial equipment operation and covered with vegetation. Streams in and near the proposed area should be observed with respect to hydraulic and hydrology factors, silt load, bed scour, variations in flow, vertical mixing and stratification. Lakes would be

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included in the study. Exhaustive information on the ground water conditions with special emphasis on shallow aquifers will be necessary. In the study attention should be paid to movements, natural recharge, discharge, depth to water table, permeability, and transmissibility of the aquifer and the velocity of flow. Any incineration ought to be practiced when there is a wind velocity of at least 10 mph and the prevailing direction away from site headquarters and nearby communities. A low rainfall area is preferable. Also areas where known inversions occur are to be avoided. The area should be chosen with a tight clay soil to inhibit ground water movement and maximize adsorption. The proposed site should be within 3 miles of a major highway and should have all-weather access road and railroad siding. Also the area should have an interlacing network of dirt and semi-improved roads for easy local transportation. The site should be located in the geographic center of the major waste producers. The cost of land burial may range from $1.52 to 9.40/cu yd. (MDV)

BURIAL; COST BENEFIT ANALYSIS; ENVIRONMENT; GEOLOGY; GROUND WATER; HYDRAULICS; HYDROLOGY; INCINERATION; METEOROLOGY; SITE EVALUATION; SOILS; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, SOLID; FIELD STUDIES

<301>
Purtymun, W.D., M.L. Wheeler, and M.A. Rogers, Los Alamos Scientific Laboratory, Los Alamos, NM.

Geologic Description of Cores from Holes P-3 MH-1 through P-3 MH-5, Area G, Technical Area 54. (2)

LA-7308-MS; 13 pp. (1978, May)

Five horizontal holes were cored beneath Pit 3 near the southeast edge of Mesita del Buey at Area G. Cores were obtained at depths ranging from 0 to 7.2 m beneath the pit, from two units of a rhyolite tuff. The pit, filled and covered by 1966, contains solid radioactive wastes. The holes were cored to obtain samples of the tuff underlying the pit to determine if there has been any migration of radionuclides by infiltration of water in the past 10 yr. The five holes were collared in Unit 2b of the Tshirege Member of the Bandelier Tuff; three of the holes plunged downward into Unit 2a. This report describes the rock units penetrated by core holes and the joint characteristics observed. The locations of core samples selected for analyses are related to the floor of the pit. Core recovery from the five holes ranged from 52% to 75%, with joint frequencies ranging from 0.9 to 1.7 m of core recovered. The largest percentage of the joints were filled or plated with brown clay. The remainder were open with joint faces slightly weathered or plated with caliche. Joint orientations on the mesa and in the pit indicate that the joints formed as the ashflows cooled. (RAP)

CORES; PITS; WASTES, SOLID; BOREHOLES; SAMPLES; TUFFS; WATER; RADIONUCLIDE MIGRATION; ROCKS; JOINTS; ROCK MECHANICS; CLAYS; CALICHE; ASHFLOWS; SITE SURVEILLANCE; FIELD STUDIES

<302>
Richardson, B.L., U.S. Geological Survey, Water Resources Division.

Significance of Climate in Relation to the Disposal of Radioactive Waste at Shallow Depth Below Ground. (2)

Retention and Migration of Radioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962, (pp. 207-211). (1963)

Climate is important when considering a site for the disposal of radioactive waste at shallow depths. Climate controls: depth to ground water in the upper zone of rapid water circulation; distance between drainage divides of perennial surface streams or the distance between points of recharge and discharge; physical and chemical characteristics of the soil; abundance and types of vegetation. A line extending north and south across the United States near the 97th meridian is an area in which evaporation and transpiration rates are about equal to the average annual precipitation. East of this line is the humid portion of the United States and west of the line is the arid part. In the humid regions the density of surface stream is high and the water tables are shallow. This means the detention time of precipitation reaching the water table is short, usually tens of days. Such rapid circulation is not conducive for near surface disposal of isotopes if the philosophy is "delay and decay". Arid soils with a deep water table, carbonates, and other inorganic salts are highly conducive to the philosophy of "delay and decay". However, with such a low flow of water through the arid soils, there is a very real possibility of contaminating the surface water sources. This possibility is much reduced in humid areas. The contamination of surface water sources in arid regions is also controlled by the sorptive properties of the ground and the location of the disposal facility with respect to the nearest perennial surface stream down gradient as well as depth to the water table. Hence, an accidental release of high-level liquid radwastes may not be as serious as once considered. Solid, packaged radwaste burial provides only a slight possibility of contaminating either ground or surface water, provided the site is in an area of substantial depth to the water table and is removed from areas subject to floods. Arid sites are preferable to those in humid regions. (MDV)

BURIAL; CONTAMINATION; DISPOSAL SITE; DRAINAGE BASINS; EVALUATION; FIELD STUDIES; GROUND WATER; HYDROLOGY; METEOROLOGY; PERCHED WATER; pH; PRECIPITATION, METEOROLOGICAL; RADIONUCLIDE MIGRATION; SOILS; SURFACE WATERS; SURFACE CONTAMINATION; WASTE DISPOSAL; WASTES, LIQUID; WASTES, RADIOACTIVE; SORPTION

<303>
Robertson, J.B., U.S. Geological Survey, Water Resources Division, Idaho Falls, ID.

Behavior of Xenon 133 Gas After Injection Underground: Molecular Diffusion, Materials Balance, Barometer Pressure Effects. (4)

IDO-22051; USGS Open File Report; 37 pp. (1969)

<303> CONT.
The results of a large scale field test conducted by the USAEC in 1967 to evaluate the use of radioactive gas injection as a disposal technique are presented. Nine hundred eighty seven curies of Xenon 133 were injected into the layered basalts of the Snake River Group which underly the INEL site. The test was conducted in the northern section of the site below the Birch Creek Playa which is underlain by as much as sixty feet of fine-ground lacustrine "playa" sediments as well as the layered basalt flows and interbedded sediments. The 987 curies of Xenon 133 were introduced with one million cu ft of air (STP) at a rate of 1,000 cfm with a 1.5 and 1.65 psig well head pressure. The lacustrine sediments were expected to perform as a low permeability confining membrane to restrict atmosphere release of the injected Xenon 133. The subsurface activity of Xenon 133 was monitored by Geiger-Muller detectors and from air samples collected in the array of 14 observation wells with isolated inspection ports around the injection well. A materials balance was formulated from the construction of numerous subsurface Xenon activity contour cross sections. The mass balance calculations revealed that the detection system employed recorded only about ten percent of total Xenon activity expected. The observed disparity was initially believed to be the result of five possible causes: 1) the effective porosity of the basalts was not approximately five percent but rather fifty percent, 2) the grid system used for the finite element mass balance calculations was too coarse, 3) 90% of the Xenon 133 was either dissolved into the ground water or sorbed onto mineral surfaces and 4) the monitor systems detection equipment or the reduced data was in error by an order of magnitude. The first three explanations are discounted in the text and the order of magnitude error in the detection system or data reduction is offered as the most plausible explanation. The effects of molecular diffusion and barometer pressure changes were analyzed and the results are presented. The estimated rates of diffusion indicated that the total diffusion loss was on the order of 0.4 curies and that neither diffusion nor barometric pressure drop responses would appreciably affect the atmosphere release of the Xenon 133. The overall conclusion of this study is that nearly all of the injected Xenon 133 remained underground and decayed and that application of this disposal technique might be useful in certain geographical regions where favorable subsurface conditions exist. (Auth) (JC)

The discussion as it applies to Xenon is not applicable to shallow land burial of radioactive wastes, but the hydrogeologic discussions of diffusion and effective porosity are useful to the site specific discussion of the INEL solid waste burial facility. (DH/JC)

Porosity; Stratigraphic Unit Thickness; Initial Injection Pressure

Xe 133

ADSORPTION; XENON; WELLS, INJECTION; ATMOSPHERE; DIFFUSION; MATERIAL BALANCE; MASS BALANCE; GASES; WASTES, GASEOUS; GEOLOGY; HYDROLOGY; BASALTS; SEDIMENTS; RADIONUCLIDE MIGRATION; FIELD STUDIES

<304>
Smith, D.D., Union Carbide Corporation, Y-12 Plant, Oak Ridge, TN.

Thermophysical Properties of Conasauga Shale. (3)

Y-2161; 27 pp. (1978, December)

Thermophysical characteristics of five Conasauga Shale cores were determined at temperatures between 298 and 673 degrees K. The cores were selected to be typical of the lithologies present at the Oak Ridge reservation. Methods of specimen fabrication for various tests were evaluated. Fabrication of samples for thermal conductivity tests was found to be best using a low-speed diamond saw and hand lapping and polishing. Specimens for linear thermal expansion tests were cut from the cores transverse and longitudinal to the core axes using a low-speed diamond saw; the ends were planned off with a diamond cut-off wheel. Physical properties measured for unheated and heated cores included bulk density (2.68-2.72 g/cu cm unheated, 2.60-2.71 g/cu cm heated), porosity (0.38-3.0%), real density, and average pore diameter. Thermal conductivities ranged from 2.8 to 1.0 W/m-K, and exhibited a small negative temperature dependence. Thermal expansions were 0.2-0.5% at 673 degrees K relative to 298 degrees K. Localized swelling and contractions were evident, mainly in the longitudinal-core orientations. Heat capacity varied with composition; three cores gave essentially identical results (0.21 cal/g-degree K at 298 degrees K to 0.28 cal/g-degree K at 673 degrees F), while the other two cores gave lower values, indicating compositional variations. (LKM)

Porosity; Density; Thermal Conductivity; Thermal Expansion; Heat Capacity

CORES; FABRICATION; THERMAL PROPERTIES; PHYSICAL PROPERTIES; ROCKS; SEDIMENTARY ROCKS; SHALES; LIMESTONES; LABORATORY STUDIES

<305>
Spitsyn, E.Ya.

Burial of Radioactive Wastes. (3)

Treatment and Disposal of Radioactive Wastes. Israel Program for Scientific Translations, Ltd., Jerusalem, (1965)

Selection of potential burial ground requires investigation of geologic, hydrologic, biologic, demographic, and meteorologic conditions. The burial grounds utilized in the USSR for the disposal of radioactive wastes are classified according to annual capacity: Type I, II and III. General recommendations for selection of a potential disposal area include (a) the site be located at least 20 km from the nearest town, (b) the soil be high in clay content, (c) the boundary of the site not be less than 0.5 km from the nearest open-water body and (d) ground water be non-existent or at least deep enough to minimize potential contamination. Burial areas are arbitrarily divided into "dirty" and "clean" zones. "Dirty" zones refer to areas containing buried radioactive wastes while "clean" zones refer to areas not utilized. Both liquid and solid radioactive wastes are routinely buried. Liquid wastes with specific activities greater than

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GEOLOGY, HYDROLOGY AND SITE RESOURCES

<305> CONT.
10(E-4)Ci/l are accepted for burial in unlimited quantities. (JT)

Reviews, in general terms, the disposal methods used in the USSR. (DE/JT)

WASTES, RADIOACTIVE; WASTE DISPOSAL; WASTES, SOLID; WASTES, LIQUID; WASTE MANAGEMENT; DECONTAMINATION; TRANSPORTATION; MONITORING; RECOMMENDATIONS; BURIAL; FIELD STUDIES

<306>
Wolff, R.G., J.D. Bredehoeft, W.S. Keys, and E. Shuter, U.S. Geological Survey, Water Resources Division, Reston, VA; U.S. Geological Survey, Lakewood, CO.

Stress Determination by Hydraulic Fracturing. (3)

American Water Works Association Journal 67(9):519-523. (1975, September)

The injection of liquid wastes into subsurface formations has caused fracturing and even earthquakes. Rocks are elastic solids and when the injection force exceeds the sum of the compression force and the rock's tensile strength the rock will fracture. In tectonically relaxed areas the fracture could easily be vertical. Such a fracture could lead to contamination of a potable aquifer. Fracture experiments were done in such a region in northwest Colorado in boreholes 200 to 1500 ft deep. A vertical compression load of 1 psi/ft was assumed. As expected, when fracturing occurred at pressures below the vertical load the fracture was vertical. State of stress experiments should be conducted whenever the injection pressure is expected to exceed one half of the overburden pressure. (PTS)

A report on possible vertical fracturing of rock by liquid waste injection at less than overburden pressures. (DE/PTS)

WELLS, INJECTION; WASTES, LIQUID; FRACTURES; AQUIFERS; ROCK MECHANICS; HYDRAULIC FRACTURING; CONTAMINATION; FIELD STUDIES

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<307>
Andrews, J.P., R.T. Cupp, and T.L. Snyder, Catalytic, Inc., Philadelphia, PA

A Systems Approach to Decontamination of Nuclear Power Plants. (3)

CONF-770512; Management of Low-Level Radioactive Waste, R.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-25, 1977. Pergamon Press, New York, NY, Ch. 2, (pp. 137-150), 1218 pp. (1979)

Is this paper a management approach to decontamination of nuclear power plants is covered in broad terms. Concern is expressed over the need for large-scale decontamination of nuclear power plants. The basis for the need of plant decontamination is established, and simple flow diagrams are developed to detail decisions for different aspects of decontamination. The overall management decision system for a decontamination project may be broken into four broad categories: 1) Project Study Phase, 2) Program Planning Phase, 3) Plan Implementation Phase, and 4) Process Operation Phase. Most management decisions occur during the early stages of planning. A systematic approach leads to sound management decisions with attention to the ultimate goals at each step of the project. Management becomes familiar with these goals during both the project study and planning phases which are the foundation of plan implementation, and finally, process operation. It is crucial that these goals be generally and widely accepted during these last two phases of the program. The use of a simple mathematical decision-making model, such as a decision-tree or the matrix method, provides a decision based on rational evaluation and lowers the risk of a decision based on advocacy. Also discussed are certain of the engineering details which make large-scale decontamination projects unique. These involve the areas of 1) selection of decontamination agent, 2) storage of radwaste, 3) radwaste concentration process, 4) solidification agent, and 5) transport and burial ground selection. (Auth) (LKH)

DECONTAMINATION; REACTORS; NUCLEAR FACILITIES; WASTE MANAGEMENT; METHODS; MODELS; EVALUATION; WASTE PROCESSING; WASTE STORAGE; TRANSPORTATION; WASTE DISPOSAL; SITE SELECTION; CONCENTRATIONS; SOLIDIFICATION; WASTE TREATMENT; WASTES, RADIOACTIVE; REVIEWS

<308>
Battelle-Pacific Northwest Laboratories, Richland, WA.

Summary of Technology, Safety and Costs of Decommissioning a Reference Low-Level Waste Burial Ground. (3)

NUREG/CR-0570(Draft); 38 pp. (1979, August 1)

This summary describes the results of a study to conceptually decommission commercial Low-Level waste (LLW) burial grounds. The purpose of the study is to provide information on the available technology, safety considerations, and probable costs of decommissioning the burial grounds after termination of waste emplacement operations. This information is intended for use as background data in the development of regulations pertaining to decommissioning activities. It is also intended for use by regulatory agencies and site operators in developing improved waste burial and site maintenance procedures at operating burial ground. Generic LLW burial facilities based on real characteristics of the 6 commercial burial grounds that have operated in the U.S. are used as the reference facilities for the study. These generic burial grounds are assumed to be located on two reference sites, an arid western site and a humid eastern site, for which representative parameters are chosen. Decommissioning options and estimated costs (in millions of 1978 dollars) are as follows: Minimal Stabilization Plus Long-Term Care = 17.7 (stabilization 0.4, long-term care 17.3) for the arid site, 25.0 (stabilization 0.5, long-term care 24.5) for the humid site; Modest Stabilization Plus Long-Term Care = 19.8 (stabilization 2.5, long-term care 17.3) arid site, 28.3 (stabilization 3.0, long-term care 24.5) humid site; Complex Stabilization Plus Long-Term Care = 24.0 (stabilization 7.7, long-term care 16.3) arid site, 31.3 (stabilization 5.3, long-term care 26.0) humid site; and Waste Relocation = 1402 arid site, 1810 humid site. The results of safety analysis for decommissioning the reference burial grounds are divided into public safety concerns (radiation exposure) and occupational safety concerns (radiation exposure, serious lost-time injuries, and fatalities). Public radiation exposures from decommissioning the arid site can be summarized as 0-100 man-rem for decommissioning operations and 0-3 man-rem for transportation (removal option only), depending on the decommissioning option. For the humid site, values are: decommissioning operations = 0-100 man-rem, transportation = 0-10 man-rem. Occupational exposures at both sites are estimated as 2.0-240 man-rem for decommissioning operations, 0-99 man-rem for transportation, and 0-0.21 man-rem for long-term care. Total lost-time injuries are estimated at 1.58 X 10(E-2) to 2.76/yr, and fatalities at 2.27 X 10(E-4) to 0.15/yr, depending on the option. (LKH)

DECOMMISSIONING; DECONTAMINATION; DISPOSAL FACILITIES; BURIAL, SHALLOW; WASTES, LOW-LEVEL; SAFETY; COSTS; COST ESTIMATES; REGULATIONS; STABILIZATION, PHYSICAL; EXPOSURE, OCCUPATIONAL; EXPOSURE, POPULATION; ACCIDENTS; TRANSPORTATION; WASTE MANAGEMENT; WASTE RETRIEVAL, THEORETICAL STUDIES

<309>
Bradley, R.F., and J.C. Corey, Savannah River Laboratory, Aiken, SC.

Evaluation Guidelines. (3)

DP-1438; Technical Assessment of Bedrock Waste Storage at the Savannah River Plant, (pp. II-3 - II-27), 287 pp. (1976, November)

The two basic criteria to be met for assessing the feasibility of bedrock storage are that radioactive and stable constituents entering the biosphere should: 1) have a negligible effect on a single individual and 2) produce a minimum effect on the entire population over extended time periods. Drinking water is the principal means of ingesting toxic waste. In order to satisfy the first criterion the net concentration of all toxic species, both radioactive and stable, must be well below (less than 1% of) presently accepted MPC values in public water. The second criterion requires that the total quantities of activity released

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should not exceed certain limits. Proper evaluation of bedrock storage necessitates a comparison with alternate means of storing waste on a risk-cost-benefit basis which, in turn, is dependent upon an evaluation of the risk of long-lived radionuclides. However, at present, there is no acceptable method for risk evaluation. Once this is achieved, potential biomedical costs resulting from radionuclide release to the environment can be readily calculated and equated with costs of relecing these releases by alternative waste storage methods. Biomedical cost estimates of various radionuclide releases are given in terms of: 1) uptake of nuclides of 1% MPC, 2) ingestion of I-129, Cs-135, and Pu-239, 3) failure of waste tanks assuming the same drinking water pathway and 4) alternative pathways to drinking water. Besides radionuclides, toxic stable chemical species also occur in the waste and it is assumed that they will all be released into the biosphere over a period of millions of years. Relaxation of the two criteria required for assessing feasibility of bedrock storage may be necessary when considering toxic stable compounds although relaxation is not confined. This preliminary cost-benefit-risk analysis indicates that: (1) The potential net biomedical cost of abandoning unaltered Savannah River radioactive waste in existing tanks is estimated to be about $300,000,000. The expected $100,000,000 cost of a bedrock storage facility for unaltered waste appears justified on this basis. (2) The potential biomedical cost (at $100/man-rem) of a bedrock storage facility that releases all of the I-129 and Cs-135 but essentially none of the Pu-239 may be only a few million dollars distributed over many centuries (ca. $130,000 for I-129 and ca. $2,200,000 for Cs-135 for the drinking water pathway); however, other potential pathways should be investigated. (3) Additional bedrock facility costs to prevent the entry of most of the Pu-239 into the biosphere are justified, if necessary, based on the estimated potential biomedical cost of 266,000,000 for releasing all of the Pu-239 from a bedrock cavern. The final assessment of bedrock storage will require identification and analysis of all potential exposure pathways for all of the isotopes, with special emphasis on the extremely long-lived isotopes such as I-239, Cs-135, and Pu-239 as well as the stable toxic chemical constituents such as mercury, and comparison on a cost-benefit-risk basis with alternative waste management techniques. (Auth) (JW)

Assessment of bedrock storage and a preliminary cost-benefit-risk analysis are the main themes of this section. Although the section deals with high-level waste the principals would seem to apply as well to low-level waste. (DH/JW)

BEDROCK; STORAGE, GEOLOGIC; ISOTOPES; UPTAKE; BIOSPHERE; COST BENEFIT ANALYSIS; DISPOSAL SITE; DOSE COMMITMENTS; ENVIRONMENTAL EXPOSURE PATHWAY; DRINKING WATER; WASTE STORAGE; WASTES, RADIOACTIVE; HAZARD ANALYSIS; THEORETICAL STUDIES

<310>

Diekhoner, J.E., U.S. Energy Research and Development Administration, Division of Waste Management, Production and Reprocessing, Washington, DC.

Sources, Production Rates and Characteristics of ERDA Low-Level Wastes. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 103-125), 1214 pp. (1979)

This paper presents data concerning the sources and characteristics of waste generated by U.S. Energy Research and Development Administration (ERDA) facilities. Information on the cumulative status of ERDA's waste is presented, along with a comparison of the types of data collected under the old information system and the new system. Data obtained from the "ERDA Solid Waste Management Questionnaire" on solid radioactive waste retrievably stored or buried at ERDA sites as of October 1, 1976, is summarized as follows: 1) ORNL - 182,000 cu m buried, activity at burial 190 kCi, activity with decay 65 kCi, 980 kg U buried, 13 kg TRU buried, 1200 cu m stored, 1 kg Pu stored, 15 kg other TRU stored; 2) Hanford - 174,000 cu m buried, activity at burial 2000 kCi, activity with decay 835 kCi, 600,000 kg U buried, 364 kg TRU buried, 6600 cu m stored, 53 kg Pu stored; 3) SRP - 261,000 cu m buried, activity at burial 9200 kCi, activity with decay 4030 kCi, 90,000 kg U buried, 7 kg TRU buried, 1800 cu m stored, 60 kg Pu stored, 5 kg other TRU stored; 4) INEL - 109,000 cu m buried, activity at burial 6100 kCi, activity with decay 3630 kCi, 310,000 kg U buried, 361 kg TRU buried, 21,600 cu m stored, 167 kg Pu stored, 64 kg other TRU stored; 5) LASL - 202,000 cu m buried, activity at burial 300 kCi, activity with decay 220 kCi, 260,000 kg U buried, 13 kg TRU buried, 1200 cu m stored, 17 kg Pu stored, 5 kg other TRU stored; 6) other sites - 427,000 cu m buried, activity at burial 20 kCi, activity with decay 20 kCi, 5,900,000 kg U buried, 60 cu m stored, 3 kg Pu stored. The current estimate of annual additions to the existing inventory is: 35,000 cu m buried volume, 400 kCi buried activity, 250,000 kg buried U, 6 kg buried TRU, 7100 cu m stored volume, 50 kg stored Pu, and 6 kg stored other TRU. This estimate is based on what sites expect to receive over the next three years, and reflect what has been received in recent years. After only a short period of operation with the questionnaire system it became apparent to ERDA headquarters personnel that an improved, possibly computerized, data management system was needed in view of the large number of burial and storage sites. As a result, in FY 1976 an improved system, SWINS (Solid Waste Information Management System) was developed to replace the earlier system and accept more detailed information from all ERDA solid, non-high-level radioactive waste generation, retrievable storage, and shallow land burial activities. In FY 1977, SWINS, is in a trial phase in which modifications and clarifications are being made. In FY 1978, it will be fully operational. (Auth) (LKH)

Waste Volume

INFORMATION; WASTE VOLUME; WASTE STORAGE; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES, RADIOACTIVE; WASTES, TRANSURANIC; PLUTONIUM; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; BURIAL, SHALLOW; DISPOSAL FACILITIES; STORAGE FACILITIES; RADIOACTIVITY; WASTES, SOLID; REVIEWS

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<311>
Hodson, C.E., Oak Ridge National Laboratory, Oak Ridge, TN.

Nuclear Shipping and Waste Disposal Cost Estimates. (T)

ORNL-TM-5976; 22 pp. (1977, November)

Cost estimates for the shipping of spent fuel from the reactor, wastes from the reprocessing plant, and disposition of the reprocessing plant waste have been performed for five reactor types, and the results are presented within this report. The reactors considered are the light-water reactor (LWR), the mixed-oxide-fuel light-water reactor (MOX), the fast breeder reactor (FBR), the high-temperature gas-cooled reactor (HTGR), and the Canadian deuterium-uranium reactor (CANDU). The assumptions used to develop the cost estimates are presented such that standardized methodology might be encouraged. The transportation and disposal costs for reprocessing wastes include data for high-level wastes, cladding wastes, intermediate-level transuranic waste, and low-level transuranic and nontransuranic wastes. (Auth) (JC)

The only data directly applicable to shallow land burial are the low-level waste generation rates for the five different types of reprocessing facilities. (DH/JC)

TRANSPORTATION; BURIAL; CLADDING; DRUMS; WASTES, LOW-LEVEL; COST BENEFIT ANALYSIS; WASTES, TRANSURANIC; REACTORS, LIGHT-WATER; SHIELDED CONTAINERS; DISPOSAL SITE; WASTES, HIGH-LEVEL; WASTES, RADIOACTIVE; FUEL REPROCESSING; SPENT FUELS; COSTS; REVIEWS

<312>
Jacobs, D.G., Oak Ridge National Laboratory, Office of Environmental Policy Analysis, Oak Ridge TN.

Cost-Benefit Analysis for Management of Low-Level Radioactive Waste. (2)

CONF-770512; Management of Low-Level Radioactive Waste, T.M. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 3, (pp. 227-232), 1218 pp. (CONF-770512). (1979)

There are several types of cost-benefit analysis that can be used in evaluating a technical activity such as low-level waste management. A direct comparison can be made of the benefits to be gained versus the costs to be accrued. If the balance is favorable the activity is considered to be acceptable. In many cases, however, a number of alternatives may be available requiring a comparative cost-benefit analysis so that the most favorable option is chosen. After the basic option is chosen, a further analysis is required in which additional control technologies can be considered to further reduce specific types of impact; this represents a differential cost-benefit analysis or, perhaps more properly, a study of cost-effectiveness. Also, because of the wide variety of parameters that go into a cost-benefit analysis and the range of value judgements that may be applied by different interest groups, it is likely that each additional increment of technology will have a slightly different balance point. The major concern associated with management of radioactive waste is the potential health impact that may occur. Complications arise in the use of dose limits as proxies for health effects in the comparison of radiation health risks associated with the various sources of radiation exposure. Further complications arise in selection of a suitable proxy when the relative importance of the various radionuclides changes with time, the modes of exposure change, and different critical organs are considered. Another complication that may occur with management of low-level radioactive wastes is that movement of radionuclides through the ground is retarded compared to the movement of water. This provides a considerable measure of safety by providing a barrier to off-site migration. However, in several situations there have been leakages of small amounts of radionuclides from waste burial facilities into surface waters. Current levels of activity are not considered to pose a health hazard, but it remains to be determined whether the leakage will continue at the current rate or whether current rates reflect the leading edge of a chromatographic breakthrough. The costs of monitoring and exploratory measurements would have to be considered in a cost-benefit analysis. More importantly, if remedial actions were required they would be complicated by the fact that a part of the radionuclide inventory had moved from the original location and the point where surface waters emerge. Removal of material from the disposal trenches, therefore, would not necessarily be sufficient. While health effects are the factor of most immediate concern in cost-benefit analyses of waste management systems, there are other factors that need to be considered in a holistic treatment. Social needs, environmental effects, ethical considerations, provisions for long-term control and periodic surveillance, contingencies for possible future remedial actions, resource and land commitments, and the costs of institutional arrangements also need to be considered. (Auth) (LKM)

COST BENEFIT ANALYSIS; WASTE MANAGEMENT; METHODS; RADIATION HAZARDS; RADIATION DOSE; EXPOSURE RATE; RADIONUCLIDE MIGRATION; SURFACE WATERS; CONTAMINATION; MONITORING; WASTES, LOW-LEVEL; BURIAL, SHALLOW; SOCIAL ASPECTS; ENVIRONMENTAL IMPACTS; REVIEWS

<313>
Kenny, A.W., World Health Organization, Geneva, Switzerland.

The Degree of Treatment Required for Low- and Intermediate-Level Radioactive Waste to Prevent the Hazardous Pollution of the Environment. (3)

CONF-651202; IAEA-SM-71/64; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 83-90) 948 pp. (CONF-651202, IAEA-SM-71/64). (1966)

The recommendations of the International Commission on Radiological Protection are taken as a basis for a general discussion of permissible levels for the disposal of liquid and solid radioactive wastes to the environment. For the relatively small number of major radioactive disposals, an

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experimental approach based on the measurement of environmental pollution, which results from preliminary disposals at lower levels than those ultimately envisaged, is recommended. Final levels are ultimately set in the light of calculated values of irradiation of the public. For smaller disposals where so elaborate an approach cannot be justified, permissible levels can be calculated from broad general considerations of the disposal of the waste and the habits of the public. Tentative conservative levels are suggested for the disposal of liquid radioactive waste to sewers and rivers, and for disposal of solid radioactive waste by tipping. The broad discussion of these methods of the disposal of liquid radioactive wastes to the ground and of incineration of solid radioactive wastes gives some guidance on how these levels may be relaxed in less restrictive conditions. Conversely, where the radioactive content of waste may ultimately appear in articles handled by the public, as when radioactive waste is salvaged, a more restrictive approach is considered essential. It is emphasized that the strict approach to radioactive health hazards and the painstaking evaluation of irradiation of the public constitute a degree of control not remotely approached with other industrial hazards; and that our knowledge of the effects of ionizing radiation, limited though it may be, enables us to assess the hazards with an accuracy not generally attainable in other fields. Permissible levels and potential hazards for ground disposal, salvage, incineration, and sea disposal are also considered. (Auth) (MDV)

ACCIDENTS; BURIAL; ENVIRONMENT; GROUND WATER; HAZARD ANALYSIS; MAXIMUM PERMISSIBLE CONCENTRATION; MONITORING; RETRIEVABILITY; INCINERATION; SEA DISPOSAL; STANDARDS, INTERNATIONAL; WASTE MANAGEMENT; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; THEORETICAL STUDIES

<314>
Konzek, G.J., and C.B. Sample, Battelle-Pacific Northwest Laboratories, Richland, WA.

Decommissioning of Nuclear Facilities - An Annotated Bibliography. (3)

BNWL/CR-0131; 525 pp.(1978, October)

The purpose of this bibliography is to compile pertinent, unclassified references relating to the decommissioning, including decontamination and disposal, of nuclear equipment and nuclear fuel cycle facilities. It contains the results of a literature review sponsored by the U.S. Nuclear Regulatory Commission (NRC) to establish an information source to aid researchers, scientists, and engineers currently engaged in decommissioning studies. This bibliography is intended for primary use by organizations in their planning and implementation of the eventual decommissioning of their own nuclear facilities. Abstracts are presented from 726 references from U.S. literature or from world-wide literature, along with identification numbers (1. through 726.) that are cross-referenced to author, report number, and subject (keyword) indexes. Also, keywords follow each abstract in the text as a further aid to reader applicability to that specific reference. To further facilitate use of this bibliography, each document has been classified into one of 9 categories: Mining and Milling (29 references); Reactors (183 references); Nonreactor Fuel Cycle Facilities (84 references); Environment/Exposure Pathways/Health Physics/Radioactive Maintenance (52 references); Chemical, Electro-, Mechanical Decontamination Devices, Equipment, and Methods (192 references); Calculations/Decontamination Chemistry/Decontamination Studies/Radiation Damage Studies (89 references); Packaging/Storage Sites/Transportation Wastes (71 references); Design/Facilitation (32 references); and Other Pertinent Literature (26 references). Also included is a glossary of decommissioning terminology. (Auth) (LHE)

BIBLIOGRAPHIES; DECOMMISSIONING; DECONTAMINATION; EQUIPMENT; FUEL CYCLES; NUCLEAR FACILITIES; REACTORS; REVIEWS; SIZING; MILLING; ENVIRONMENTAL EXPOSURE PATHWAY; METHODS; PACKAGING; TRANSPORTATION; DESIGN; DISPOSAL SITE; WASTE STORAGE; WASTE TREATMENT; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, LIQUID; WASTES, INDUSTRIAL; RADIATION HAZARDS

<315>
Ohnishi, S., Radioactive Waste Management Center, Tokyo, Japan.

Research and Planning on Low-Level Radioactive Waste Disposal in Japan. (3)

CONF-780906; Second Pacific Basin Conference, Transactions of a Symposium, Tokyo, Japan, September 26-October 3, 1978, (pp. 213-214).(1978, September)

This paper outlines the preparatory efforts and plans related to disposal of low-level solid radioactive wastes (LLW) in Japan. With the support and guidance of the Japanese Government, a "Radioactive Waste Management Center" (RWMC) was founded in 1976 under sponsorship of the nuclear industry. The Center is conducting a study on quality control methods for conditioning the waste in cement in compliance with provisional guidelines set forth in a report by the Japan Atomic Energy Commission. An instrument has been developed to verify package integrity via measurement of the propagation speed of ultrasonic waves through the cement matrix. Since 1975, the Japan Atomic Energy Research Institute (JAERI) has performed mechanical integrity and leachability tests on cement packages under simulated sea-bottom conditions (500 kg/sq cm pressure, 2 C water temperature, 1-2 cm/sec current velocity). Similar tests at 700 kg/sq cm are being conducted at the Central Research Institute of the Electric Power Industry (CRIEPI). The Japan Marine Science and Technology Center has performed one dumping test with simulated cement packages and has confirmed that the packages reached bottom in sound condition. They are now analyzing the test performances. The RWMC has designed and is testing waste package handling equipment for sea dumping which requires a single operator; it is also designing modifications of conventional cargo ships for use in disposal operations, based on regulations of the Ministry of Transport. In the area of land disposal, CRIEPI has instituted research on waste packages, the Nuclear Safety Research Association is researching criteria for land storage

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facilities and packages, and JAERI is performing corrosion experiments on buried packages. In addition, the NRC is conducting surveys and research in preparation for demonstration tests of land disposal (to be implemented about 1980), and has initiated tests to demonstrate the safety of wastes stored in facilities such as nuclear power stations in the event of accidents or incidents. These demonstrations include: safety assurance in fire, assuring the soundness of waste packages emplaced underground, and safety assurance for radionuclide migration in soil. Other studies involve trial design of waste packages for land disposal, research on monitoring of the disposal site, and study of disposal facility layout. A feasibility study is underway to identify critical factors in the waste management business, and to find the most suitable methodology to establish an overall system for management of land disposal, sea disposal, and on-site storage of LLW. (LEM)

SEA DISPOSAL; CEMENTS; WASTES, LOW-LEVEL; WASTES, SOLID; WASTE PROCESSING; QUALITY ASSURANCE; FIXATION; INSTRUMENTS; PACKAGING; LEACHING; PHYSICAL PROPERTIES; PRESSURE EFFECTS; EQUIPMENT; DESIGN; CORROSION; BURIAL; STORAGE FACILITIES; STORAGE, INTERIM; SAFETY; MONITORING; MODELS; METHODS; WASTE DISPOSAL; WASTE STORAGE; WASTE MANAGEMENT; PROGRAMS, GOVERNMENT; PROGRAMS, INDUSTRIAL; REVIEWS

<316>
Steger, J.G., U.S. Energy Research and Development Administration, Division of Waste Management, Production and Processing, ERDA Waste Management Branch, Washington, DC.

Burial Technology. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 665-677), 1214 pp. (1979)

The purpose of this paper is to describe the current ERDA program to develop a technology for shallow burial of solid low-level radwaste. In late 1975, ERDA formed a Steering Committee on Land Burial composed of ERDA experts to review the situation and make recommendations. By mid 1976, the Steering Committee issued the ERDA Plan to Develop a Technology for the Shallow Land Burial of Solid Low-Level Radioactive Waste. The Plan contains an evaluation of the present state of knowledge and recommends a program to be followed which will lead to site selection criteria, proper burial practices, waste preparation requirements, and a systems analysis method to determine the least cost way of achieveing a predetermined level of performance. This program will be reviewed and the Plan updated annually until the desired results are achieved. ERDA approved this Plan and the recommended programs were implemented starting in October, 1976. This multi-laboratory, multi-disciplinary program is expected, in about 5 to 6 years, to produce a land burial technology, a systems analysis technique to optimize procedures, and a data file to keep investigators informed. (Auth) (LEM)

PROGRAMS, GOVERNMENT; WASTE MANAGEMENT; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, SOLID; BURIAL, SHALLOW; COST ESTIMATES; METHODS; PREDICTIONS; THEORETICAL STUDIES; REVIEWS

<317>
U.S. Nuclear Regulatory Commission, Office of Nuclear Materials Safety and Safeguards, Washington, DC; U.S. Nuclear Regulatory Commission, Office of State Programs, Washington, DC.

NRC Task Force Report on Review of the Federal/State Program for the Regulation of Commercial Low-Level Radioactive Waste Burial Ground. (2)

NUREG-0217; 60 pp. (1977, March)

This report is a general review of the program conducted by the NRC and the various state governments to regulate the disposal of commercial low-level radioactive waste. The standards, criteria, and regulations concerning site selection, operation, monitoring, decommissioning, and post-operational maintenance are reviewed and deficiencies identified. The report projects that there is an adequate capacity available at the present sites to handle the volume of low-level radioactive waste generated to the year 1990. The report concludes that (1) the present system for low-level waste management lacks national organization and direction; (2) at the present time, a comprehensive set of standards, criteria, and regulations does not exist; and (3) a national plan must be developed to insure against the uncontrolled proliferation of sites. Alternatives to shallow land burial include placement in deep geologic formations, in existing salt mines, disposal on ocean floors, hydraulic fracturing, disposal on-site (nuclear park), and retrievable engineered storage. (JT)

A review of the regulatory and legal concerns associated with the disposal of low-level radioactive waste. Directly applicable to low-level waste disposal. (DR/JT)

DISPOSAL SITE; WASTES, RADIOACTIVE; BURIAL; WASTE TREATMENT; STANDARDS, STATE; STANDARDS, FEDERAL; PREDICTIONS; SITE SELECTION; MONITORING; DECOMMISSIONING; WASTE VOLUME; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, INDUSTRIAL; WASTE DISPOSAL; REGULATIONS, FEDERAL; REGULATIONS, STATE; REVIEWS

<319>
U.S. Nuclear Regulatory Commission, Office of Nuclear Materials Safety and Safeguards, Washington, DC.

The Nuclear Regulatory Commission Low-Level Radioactive Waste Management Program. (3)

NUREG-0200; 29 pp. (1977, September)

The program for low-level waste management by the national regulatory commission is outlined. The program is broken down into 7 categories: general program and policy development, standards development for shallow-land burial, standards development for alternative disposal methods, regulation development, development of analytical models and staff review procedures, and development of regulatory guides. Topics under the general program include acceptable risk,

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REGULATORY AND ECONOMIC ASPECTS

<319> CONT.
classification of wastes, alternatives to shallow land burial, and regulatory authority and federal/state roles, and environmental survey on LLW disposal. Standards that are being developed for shallow-land burial are solids performance and waste acceptance, site suitability, site design, operation, monitoring, and post-operational maintenance and funding requirements. Coordination of this plan will be with other federal agencies, input from industry, states and the public. (MDV)

Time charts are included to show progress of each category.

BURIAL; CLASSIFICATION; DISPOSAL SITE; HAZARD ANALYSIS; LEGISLATION; LICENSING; MONITORING; REPOSITORY; STANDARDS, FEDERAL; STANDARDS, STATE; WASTE MANAGEMENT; WASTES, LOW-LEVEL; REVIEWS

<319>
Belford, G.G., I.H. Fisenne, and C. Sanderson, U.S. Department of Energy, Environmental Measurements Laboratory, New York, NY.

Summary Report of the Department of Energy, Division of Operational and Environmental Safety-Quality Assurance Program 1 through 4.. (U)

EML-336; 28 pp. (1978, January)

Intercomparison samples for radionuclide analysis of soil, water, air filters, tissue ashes, and vegetation ashes were requested by the Environmental Measurements Laboratory (EML) from laboratories which provide environmental radioactive contamination monitoring data as part of a Quality Assurance Program by DOE. Under the program, participating laboratories are supplied with 4-8 samples per quarter as intercomparisons (not standards). The first five quarters of operation have involved 25 laboratories. Gamma-spectrometry and tritium analyses received were generally satisfactory, but Sr 89 and Pu analyses tended to be poor. From the data, it appears that proper application of existing methods is needed, not development of new methods. Statistical evaluations of the data by QAP report number, matrix, and isotope are included. (LFS)

H 3; Pu 238; Pu 239; Sr 89; Ra 226; Th 228; Ra 228; U 238; U 235; U 238; Zn 65; Sr 90; Nb 95; Ru 103; Ru 106; Be 7; Na 22; I 40; Mn 54; Co 57; Co 58; Co 60; Fe 59; Sb 125; Cs 134; Cs 137; Ce 141; Ce 144

SAMPLES; SAMPLING; STANDARDS, FEDERAL; MONITORING; CONTAMINATION; STATISTICS; RADIONUCLIDES; RADIOACTIVITY; CHEMICAL ANALYSIS; SOILS; AIR QUALITY; WATER; FILTERS; ASHES; VEGETATION; CONTAMINATION; QUALITY ASSURANCE; PROGRAMS, FEDERAL; RADIATION, GAMMA; TRITIUM; STRONTIUM 89; PLUTONIUM; METHODS; LABORATORY STUDIES; EVALUATION

<320>
Wheeler, T.L., and W.J. Smith, Los Alamos Scientific Laboratory, Los Alamos, NM.

Considerations for the Long-Term: Perpetual is not Forever. (U)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 1, (pp. 11-30), 1214 pp. (CONF-770512). (1979)

Shallow land burial is intended to provide a waste emplacement with low probability for the release of radionuclides to the environment, and to provide a barrier against encroachment on the waste by man or his activities. This paper considers in general terms the possible long-term consequences of radionuclide uptake by plants and burrowing animals, of changes in site hydrology, and of inadvertent excavation of the buried waste by man at some distant future date. The bulk of the processes which might lead to significant waste exposure, or to drastic changes in the hydrogeology of a site, become significant only in a time frame of hundreds to thousands of years. A few mechanisms, like burrowing animals, are not sufficiently understood at this time to state their significance and require further investigation. The probability of some events, such as inadvertent excavation, cannot be definitely established, but would appear to approach a certainty with sufficient time. Release mechanisms most amenable to understanding are those chronic processes occurring now, at some observable rate. Site selection procedures and waste emplacement techniques can be used to provide some measure of protection against these processes. Site-control measures can provide near-term protection against some acute release processes. However, the judgement regarding the time period and level of such site control will be made, not by us, but by our successors, based on their perception of the hazards presented by the waste. There are some release processes which will inevitably lead to exposure of the waste, in a time frame of hundreds to thousands of years. It is necessary to determine the level of protection that should be provided to the occupants of our land in that time frame, and provide it at the time of burial by limiting the quantities of long-lived radionuclides present in the waste. There is a clear obligation to provide the mechanisms, such as "perpetual care" funds, for site control following decommissioning, in a time frame of tens to hundreds of years. Beyond that time period, it would not seem prudent to presume that site control can, or will continue. (Auth) (LFS)

BURIAL, SHALLOW; WASTE DISPOSAL; WASTE MANAGEMENT; ENVIRONMENTAL IMPACTS; ENVIRONMENTAL EXPOSURE PATHWAY; PLANTS; ANIMALS; MAN; INTRUSION; ANIMALS, BURROWING; HYDROLOGY; SITE SURVEILLANCE; ECONOMICS; RECOMMENDATIONS; REVIEWS

<321>
Conlon, F.B., and C.L. Pettigrew, U.S. Department of Health, Education, and Welfare, Public Health Service. Bureau of Radiological Health.

Summary of Federal Regulations for Packaging and Transportation of Radioactive Materials. (3)

CONF-781193; Environmental Impact of Nuclear Power Plants, Proceedings of a Conference, Atlanta, GA, November 26-30, 1978, (pp. 201-230), 586 pp. (CONF-781193). (1978)

This paper consists entirely of tabular data on Department of Transportation regulations, projected amounts of radioactive material to be transported, the amounts and types of radioactive materials present in the projected transport materials, external radiation fields on containers, container specifications, transport vehicle specifications, and population dose factors. (JC)

Report contains tabular data with no text. (DM/JC)

TRANSPORTATION; FUEL ELEMENTS; CASKS; ACCIDENTS; WASTE DISPOSAL; WASTE VOLUME; POPULATIONS; SHIELDED CONTAINERS; STANDARDS, FEDERAL; EXPOSURE RATE; REVIEWS; DOSE RATE

<322>
Grella, A.W., U.S. Department of Transportation, Materials Transportation Bureau, Office of Hazardous Materials Operations, Washington, DC.

A Review of Five Years (1971-1975) Accident Experience in the United States of America Involving Nuclear Transportation. (3)

IAEA-SM-10/5; Transport Packaging for Radioactive Materials, Proceedings of a Seminar, Vienna, Austria, August 1976, (pp. 225-240) (IAEA-SM-10/5). (1976)

This paper summarized the recorded accident experience during 1971-1975 in the USA involving nuclear materials transport. Since 1971, a uniform multimodal hazardous materials incident (HMI) reporting system has been in effect in the USA as a requirement of the U. S. Department of Transportation (DOT) regulations. Carriers of hazardous materials are now required to provide reports to DOT of transport incidents based on certain criteria which include death, personal injury, property damage, and in the case of radioactive materials (RAM), suspected radioactive contamination. Of the more than 32,000 HMI reports submitted to DOT during the five-year period, only 188 were noted to involve RAM. Recent studies indicate that approximately 2.5 million packages of RAM are transported annually in the USA. Examination of these 188 incident reports indicated that in only 36 cases was there any indication of release of contents or excess radiation levels. In most cases, releases involved minor contamination from low specific activity, 'exempt' or Type A packages. In many incidents Type A packages had been subjected to crushing, impact, or other similar accidental conditions with no release of contents. No deaths or significant injury to persons due to radiation or radioactivity from the shipments were experienced, which is a continuation of the excellent transport safety experience which has been observed over the past 30 years of nuclear transportation. The experience observed over this five-year period appears to demonstrate and confirm the adequacy of the packaging standards in providing safety for nuclear materials in transport. Continued accumulation and analysis of such data on a world-wide basis should be carried out in order to provide the public sector with the perspective necessary to allay their fears and overcome the lack of acceptance often held by the public concerning transport of radioactive materials. (Auth)

A general review of accident experience involving nuclear material in relation to other hazardous materials. (DM/JT)

TRANSPORTATION; HAZARD ANALYSIS; ACCIDENTS; PACKAGING; NUCLEAR MATERIALS; CONTAINMENT; STANDARDS, FEDERAL; WASTES, RADIOACTIVE; SAFETY; REVIEWS

<323>
Lash, J.A., U.S. Department of Energy, Supply Division, Transportation Branch, Oak Ridge, TN.

Transportation of Low-Level Radioactive Waste. (2)

CONF-770512; Management of Low-Level Radioactive Waste, H.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 1, (pp. 47-51), 1214 pp. (CONF-770512). (1979)

This paper presents an overview of the several alternatives available to industry in the selection, procurement, and administration of a safe, efficient, and economical system for transporting radioactive wastes to burial sites. Under U.S. Department of Transportation regulations, Title 49 CFR, Parts 171-179, radwastes may be packaged and shipped as: (1) Low specific activity (LSA) materials in truckload or carload quantities. Paragraph 173.392(b) specifies that LSA is exempt from packaging and labeling requirements when consigned as an "exclusive use of vehicle" shipment provided the shipment meets the requirements of Paragraph 173.392(c) - strong, tight packages, no significant removable surface contamination, external radiation levels do not exceed those set forth in Paragraph 173.393(j); shipments to be loaded by the consignor and unloaded by the consignee, no loose material in the vehicle; and adequate bracing and blocking to withstand the normal conditions of transport. Metal drums, metal or wooden boxes, and other specially designed containers meet these requirements. (2) LSA in less-truckload or carload quantities and packaged in Type A or B packages, depending upon the quantity of material are approved for transportation. Licensee shipments of LSA in packages exceeding Type A quantities (truckload or carload) must meet the additional requirements under Title 10 CFR, Part 71, Nuclear Regulatory Commission. Shippers use a variety of packages for low-level waste (LLW), including drums, wooden and metal boxes, and metal bins. The size and configuration of a package directly affects the handling (loading and unloading), transportation, and disposal of each shipment. About one-half of the states have adopted the DOT regulations. Several states and municipalities have passed laws regulating radioactive materials and/or

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TRANSPORTATION TECHNOLOGY

<323> CONT.
transport of these materials over state highways. There are many transportation services available to shippers. These services range from highly specialized operations for specific materials or equipment to general commodity operations, such as those offered by railroads and motor carriers. Currently, truck transportation offers the preferable service for moving LLW. With the projected growth of nuclear energy through the year 2000, other transportation modes (particularly rail) may become competitive. Additionally, we can expect that the nation's new energy policy and related conservation programs will affect all transportation and eventually lead to the increased use of rail services. (Auth) (LKH)

TRANSPORTATION; TRANSPORTATION, RAIL; TRANSPORTATION, TRUCK; REGULATIONS, FEDERAL; REGULATIONS, STATE; WASTES, LOW-LEVEL; PACKAGING; DRUMS; BOXES; WASTE MANAGEMENT; REVIEWS

<324>
Sisler, J.A., U.S. Energy Research and Development Administration, Transportation Branch, Washington, DC.

The United States Energy Research and Development Administration Transport Research and Development Program for Environment and Safety. (A)

IAEA-SR-10/27; Transport and Packaging for Radioactive Materials, Proceedings of a Seminar, Vienna, Austria, 1976, (pp. 103-108) (IAEA-SR-10/27). (1976, August)

A general description of the USERDA transportation environment and safety research and development program for energy fuels and wastes, including background, current activities and future plans. The objectives of the transportation Research and Development program are to (1) develop data and methodology for risk evaluation and the environmental effects of the shipment of nuclear fuels and wastes, (2) development of fuel cycle transport technology and systems for safety, security, cost and operating efficiency, (3) package and vehicle testing, (4) development of consistent and supportable safety standards and (5) develop informative public relations programs. Major Research and Development projects include transportation problems assessment, economics and safety of special trains, transport accident parameter, standards for package testing, risk assessment, crash tests, package failure due to sabotage, and development of systems for handling transuranic contaminated wastes. (Auth) (JT)

The paper describes the U.S. Energy Research and Development Administration's Transport Research and Development program. (DS/JT)

TRANSPORTATION; NUCLEAR MATERIALS; PACKAGING; STANDARDS, FEDERAL; ACCIDENTS; ECONOMICS; SAFETY; DESIGN; REVIEWS

<325>
Spitsyn, E.Ya.

Equipment for Transporting Radioactive Wastes. (A)

Treatment and Disposal of Radioactive Wastes. Israel Program for Scientific Translations, Ltd., Jerusalem. (1965)

Equipment used to transport radioactive wastes to the disposal facilities is designed to minimize potential environmental hazards should accidents occur. The gamma activity of waste is limited by sanitation regulations. These gamma activities are expressed as mg-eq Ra/l and vary as a function of gamma energy (expressed in MeV). High activity gamma wastes are transported in shielded containers whose dimensions vary as a function of the waste. Prisary means of transportation is in trucks whose internal surfaces are constructed with material which can be treated with decontamination solutions. (JT)

A general review of equipment used to transport radioactive wastes to the burial areas. No data presented. (DS/JT)

WASTES, RADIOACTIVE; TRANSPORTATION, TRUCK; WASTES, SOLID; WASTES, LIQUID; CONTAINERS; RADIATION, GAMMA; EXPOSURE, OCCUPATIONAL; REVIEWS

<326>
Alexander, C.W., and J.O. Blomeke, Oak Ridge National Laboratory, Oak Ridge, TN.

Origin and Characteristics of Low-Level Non-Transuranic Waste from the Nuclear Fuel Cycle. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 2, (pp. 55-78), 1214 pp. (CONF-770512).(1979)

Wastes from uranium mining and milling, UF6 conversion, enrichment, fuel fabrication, and fuel reprocessing are examined with respect to their radionuclide content, volume, and chemical composition. Projections of total quantities through the end of this century are also presented. Fuel cycles based on recycling only uranium, and on recycling both uranium and plutonium, are considered. The nuclear fuel cycle is comprised of seven basic steps: uranium mining, uranium milling, conversion, enrichment, fuel fabrication, reactor operations, and fuel reprocessing. Mining generates mainly Rn 222 as a waste form. Activity is approximately 0.06 Ci/MTHM (metric ton of heavy metal). Milling generates about 1.97 Ci/MTHM Rn 222, 1.31 X 10(E-4) Ci/MTHM airborne U, Ra 226, and Th 230 particulates, about 7.4 X 10(E+5) L/MTU (metric ton of U) of liquid waste (U, Ra 226, Th 230) amounting to 0.73 Ci/MTHM, and 317 cu m/MTU of U, Ra 226, and Th 230 as tailings (4.15 Ci/MTHM). Conversion of the U concentrate to UF6 generates 1.38 X 10(E-5) Ci/MTHM airborne U particles, 1.3 X 10(E+4) L/MTU liquid wastes (U, Ra 226, Th 230) with an activity of 1.07 X 10(E-6) Ci/MTHM, and 1.2 cu m/MTU solid wastes (U, Ra 226, Th 230, CaF2) with an activity of 9.40 X 10(E-3) Ci/MTHM. Conversion of recycle U uses a relatively high-purity uranyl nitrate feed rather than semi-refined U3O8. The different process required results in airborne particulates of fission products (8.73 X 10(E-6) Ci/MTHM), Pu 238,241 (2.46 X 10(E-6) Ci/MTHM), and U (3.32 X 10(E-5) Ci/MTHM), and about 1.3 cu m/MTU solid wastes including CaF2 and carbonate-leached ash, 0.57 Ci/MTHM fission products, 8.12 X 10(E-5) Ci/MTHM Pu 238,241, and 1.35 X 10(E-3) Ci/MTHM U. Enrichment of fresh U 235 via gaseous diffusion generates 1.96 X 10(E-5) Ci/MTHM U as gaseous and airborne particulates, and 675 L/MTU (1.11 X 10(E-6) Ci/MTHM) U liquid waste. Enrichment of fresh plus 10% recycle U produces gaseous and airborne particulates of U (1.98 X 10(E-5) Ci/MTHM), Np 237 (8.33 X 10(E-11) Ci/MTHM), Pu 239 (1.67 X 10(E-13) Ci/MTHM), and fission products (2.29 X 10(E-12) Ci/MTHM), as well as 675 L/MTU liquid wastes (1.16 X 10(E-6) Ci/MTHM U, 1.67 X 10(E-9) Ci/MTHM Np 237, 3.33 X 10(E-12) Ci/MTHM Pu 239, 3.40 X 10(E-6) Ci/MTHM fission products). Fuel fabrication (fresh plus 10% recycle) generates 5.6 X 10(E-6) Ci/MTHM airborne particulates (U, Th 230, Pa 234), 570,000 L/MTU liquid wastes (1.20 X 10(E-3) Ci/MTHM) and 8.6 cum/MTU solid wastes (7.83 X 10(E-3) Ci/MTHM); mixed oxide fuel fabrication results in 5.81 X 10(E-12) Ci/MTHM airborne U, 2.08 X 10(E-7) Ci/MTHM airborne Pu and Am, and about 2265 (98.2) cu m of solid waste per MT of Pu (U) processed (3.47 Ci/MTHM). Reprocessing of BWR-U and PWR-U generates 436-525 Ci/MTHM H 3, 0.655-0.936 Ci/MTHM I 127,129, 7330-9100 Ci/MTHM Kr 85, 0.539-0.598 Ci/MTHM C 14, and 0.53 Ci/MTHM Pu, As and fission products (as solid waste). Reprocessing of mixed oxide fuel yields 544-665 Ci/MTHM H 3, 0.686-0.992 I 131, 5000-6020 Ci/MTHM Kr 85, and 0.293-0.314 Ci/MTHM C 14, as well as the same level of solid waste as U-reprocessing. (LKH)

WASTES, SOLID; WASTES, LIQUID; WASTES, GASEOUS; WASTES, LOW-LEVEL; MINING; MILLING; ENRICHMENT; FUEL FABRICATION; FUEL REPROCESSING; WASTE VOLUME; CHEMICAL COMPOSITION; RADIONUCLIDES; PREDICTIONS; FUEL CYCLES; RECYCLING; URANIUM; PLUTONIUM; CONVERSION; RADON 222; RADIUM 226; THORIUM 230; TAILINGS; EFFLUENTS, AIRBORNE; EFFLUENTS, LIQUID; FLUORIDE COMPOUNDS; URANIUM COMPOUNDS; FISSION PRODUCTS; ASHES; NEPTUNIUM 237; TRITIUM; IODINE 127; IODINE 129; KRYPTON 85; CARBON 14; IODINE 131; WASTE MANAGEMENT; REVIEWS

<327>
Anderson, R.L., L.R. Cooley, T.J. Beck, and C.S. Strauss, University of Maryland, Radiation Safety Office, Baltimore, MD.

Institutional Radioactive Wastes. (2)

NUREG/CR-0028; 96 pp.(1978, March)

A national survey of 686 medical schools, hospitals with more than 500 beds, and universities and colleges with more than 5000 students was conducted in an effort to determine the contribution of these institutions to non-fuel cycle radioactive wastes. The study population consisted of 178 clinical hospitals, 148 teaching hospitals, 116 medical schools, and 248 universities and colleges. Each institution was sent a questionnaire requesting information concerning their radioactive waste disposal activities in 1975. Two hundred ninety-six (83%) responded with usable data. Statistical analysis and a telephone followup confirmed that the sample was representative, permitting extrapolations to the survey population. The findings showed that institutional wastes accounted for approximately one third (6862 cu m) of the volume of non-fuel cycle wastes buried in 1975. Wastes shipped for burial were dominated by medical sources and were largely contaminated with short-lived (half-life less than 60 days) nuclides. Activities of the major radionuclides shipped for burial were 36,023 mCi of H 3, 10,709 mCi of C 14, 37,573 mCi of Tc 99m, 12,737 mCi of I 125, and 7263 mCi of I 131; other radionuclides shipped included P 32, S 35, Cr 51, and Ga 67. Excluding H 3 accelerator targets, the average concentrations of the long-lived contaminants H 3 and C 14 were 4-5 times the maximum permissable concentrations for drinking water. Thus, the conclusion can be drawn that most non-fuel cycle waste is essentially high volume low activity waste. The wastes shipped for burial were predominantly (92 vol%) packaged in steel drums. The form of wastes consisted of dry solids (41%), scintillation vials (29%), solidified liquid (22%), and biological wastes (9%). Much of the solidified liquids were composed of waste scintillation fluids. Wastes produced by the study population appear to be increasing by about 10%/yr, with the most rapid increase by medical schools (about 20%/yr). A second study surveyed all licensees, excluding those in the institutional survey, in the cities of New York and Los Angeles and in the state of Maryland. Results of this survey for non-medical sources were inconclusive. Results for medical sources (primarily small hospitals and medical laboratories) were

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WASTE PRODUCTION

<327> CONT.
extrapolated nationally and combined with the institutional survey data to obtain an estimate of the total volume of medical radioactive waste buried in 1975. This volume is estimated at approximately 18,000 cu m, or 81% of the non-fuel cycle wastes buried in 1975. (Auth) (LWR)

Waste Volume

H 3; C 14; P 32; S 35; Tc 99m; I 125; I 131; Cr 51; Ga 67

RADIOACTIVITY; WASTE VOLUME; WASTE MANAGEMENT; BURIAL; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, LIQUID; TRITIUM; CARBON 14; TECHNETIUM 99m; IODINE 125; IODINE 131; FIELD STUDIES

<328>
Blomeke, J.O., and J.J. Perona, Oak Ridge National Laboratory, Oak Ridge, TN.

Controlling Airborne Effluents from Fuel Cycle Plants. (3)

CONF-760806; Controlling Airborne Effluents from Fuel Cycle Plants, Proceedings of a Symposium, Sun Valley, ID, August 5-6, 1976, (pp. 1-1 - 1-16) (CONF-760806). (1976)

This paper serves as a brief introduction into sources of wastes, their treatment and atmospheric levels both present and projected. High-, intermediate- and low-level wastes are defined and a brief description of their disposal is presented. Cladding wastes, noble gases, iodine, tritium, carbon-14, non-TRU wastes, and ore tailings are dealt with in the same way. The treatment of these wastes in both LWR and HTGR fuel processing is also discussed. Projections are then made as to the types and levels of nuclear wastes in the year 2000. This information is presented on charts for every year from 1970 to the year 2000. A chart predicting nuclear generating capacity also up to the year 2000 provides a frame of reference. The impact of Fuel Cycle Centers on the environment is examined. Finally, projected estimates of the global buildup of airborne effluents are given. (DD)

No measured data estimates and predictions (DM/DLD)

EFFLUENTS, AIRBORNE; CLADDING; EFFLUENTS; FUEL REPROCESSING; WASTES, GASEOUS; WASTES, HIGH-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; WASTES, TRANSURANIC; WASTE MANAGEMENT; REACTORS, LIGHT-WATER; REACTORS, HIGH-TEMPERATURE GAS-COOLED; WASTES, RADIOACTIVE; FUEL CYCLES; GASES; TAILINGS; PREDICTIONS; FUEL FABRICATION; REVIEWS

<329>
Booz-Allen Applied Research, Inc., Washington, DC.

Radioactive Waste, Atomic Energy Commission, Appendix A-12. (2)

A Study of Hazardous Waste Materials, Hazardous Effects and Disposal Methods, Volume 3, June, 1972, (pp. A-12-1 - A-12-81). (1972)

The amount of radioactive waste generated in the United States on an annual basis results from a developing nuclear power industry and from medical and industrial applications of radioisotopes. Primary emphasis is placed on discussion of those wastes associated with the nuclear fuel cycle. As of 1971, over 2½ million acres of the United States had been devoted to uranium mining. From this acreage, about 90 million tons of ore have been extracted. The total activity of wastes discharged from milling facilities to the air, land, and water total 2,500 Ci, 9,000 Ci, and 0.6 Ci, respectively. The ore (U_3O_8) is reduced and converted to UF_6 prior to shipment to the enrichment facilities. The estimated conversion waste discharges for 1970 are 0.4 Ci U 235, 0.5 Ci Ra 226 and 15.2 Ci Th 230. During UO_2 fuel fabrication operations conducted during 1970, the total activity of uranium isotopes released was 0.8 Ci. Low- and intermediate-level wastes generated at nuclear power stations include spent resins, solidified liquid wastes, control rods and general trash. The total volume of spent resins and solidified liquids generated from nuclear power stations in 1970 totaled 12,000 square feet with a total activity of 8,800 Ci. Radioactive wastes produced from medical and industrial sources are transported to licensed low-level waste burial sites throughout the country. Standard chemical waste treatment systems are used to collect, concentrate and immobilize radioactive wastes. Gases are filtered by high efficiency particulate filters (99.9% removal of particles with diameter greater than 0.3 microns) and then released (with or without delay) or removed by chemical means. Liquids undergo settling, precipitation, evaporation and ion-exchange prior to solidification. (Auth) (JT)

A general summary of the types and quantities of waste produced by the various portions of the fuel cycle. (DM/JT)

WASTES, RADIOACTIVE; GASES; HAZARD ANALYSIS; MINES; MILLS; ENRICHMENT; FABRICATION; DISCHARGE; FUEL REPROCESSING; WASTES, LIQUID; WASTES, SOLID; REVIEWS

<330>
Cline, J.E., and D.C. Metzer, Science Applications, Inc., Rockville, MD.

Study of Transuranium Concentration Levels in Solid Radioactive Waste from Commercial Power Reactors. (1)

EPRI NP-631, Research Project 613; 96 pp. (1978)

The results of isotopic analysis of the waste sources in operating light-water reactors with particular emphasis on the content of transuranic elements are presented in this study. Samples from seven different reactors including 5 BWRs and 2 PWRs were obtained and subjected to radiochemical analysis. Potential indirect methods of determining transuranic concentrations were investigated which are capable of providing rapid and economical determinations of the acceptability of radioactive waste with respect to future concentration limits for transuranics suitable for shallow land burial. Concentration limits of transuranics in LWR low-level waste have not been set as of yet; however, these limits are discussed with respect to the 10 nCi/gram limitation of transuranics for fuel reprocessing low-level waste. General description of the

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radioactive waste systems at the seven LWRs and the solid wastes generated at these plants are provided. The samples taken include reactor coolant water dissolved radionuclides, reactor coolant water insolubles, spent resins, crud, centrifuge sludges, filter sludges, fuel pool filters, waste hold-up tank filters, let-down filters, and evaporator bottoms. Descriptions of sample preparation and analytical procedures are provided. The results of a sample splitting round robin interlaboratory comparison are presented. The preliminary results of the studies on indirect assay for transuranic content suggest that the gamma emitters Ru 106 and Ce 144 may be used as transuranic indicators in low-level waste. (JC)

Although the radiochemical data is somewhat difficult to decipher with respect to labelling of samples, the data base presented here is very valuable. (DH/JC)

Cr 51; Mn 54; Fe 59; Co 57; Co 58; Co 60; Zn 65; Zr 95; Ru 103; Ru 106; Ag 108m; Ag 110m; Sb 124; Sb 125; Cs 134; Cs 136; Cs 137; Ce 141; Ce 144; Eu 152; Eu 154; Eu 155; Np 239; U 235; U 238; Pu 238; Pu 239; Pu 241; Pu 242; Am 241; Am 243; Cm 242; Cm 244

WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, TRANSURANIC; CONCENTRATIONS; BURIAL; FILTERS; SPECTROMETRY; EVAPORATES; RESINS; COOLANTS; REACTORS, ROLLING WATER; REACTORS, PRESSURIZED WATER; WASTES, SOLID; SLUDGES; ECONOMICS; LABORATORY STUDIES

<331>
Cline, J.E., D.C. Hetzer, and H.E. Lapides, Science Applications, Inc., Rockville, MD; Electric Power Research Institute, Palo Alto, CA.

Measurements of Transuranium Concentrations in Solid Radioactive Waste from Seven Commercial Power Reactors. (3)

American Nuclear Society Annual Meeting, Proceedings of a Symposium, San Diego, CA, June 18-23, 1978. (1978, June)

The concentration of transuranic elements as wastes from nuclear facilities will determine their ultimate disposal, however at present no clear specification has been set forth. So a program sampling wastes from seven operating commercial power plants was started to determine levels being produced. Samples were taken from evaporator bottoms, dewatered filter sludge, resins, reactor coolant filters, reactor coolant insolubles and prisary crud scrapings. Although the majority of the alpha activity is from curium isotopes, the Pu 239 and Pu 240 content is a more pressing concern. The range of Pu isotopes sampled were 4.6 X 10(E-7) to 510 nCi/gm with the highest values occuring in the primary crud scrapings. Only five of the samples of true plant wastes showed Pu concentrations greater than 10 nCi/gm and these were from the primary coolant filter sludge with many recent fuel failures. Concentrations of plutonium in evaporator bottoms and resins, the bulk of wastes from the plants, ranged from 0.01 to 1 nCi/gm. Hence, these data show the average transuranic levels for prepared waste to be substantially below 10 nCi/gm. The analyses used are difficult and expensive so an indirect method of measuring the Pu content is needed. A promising method is the use of Ce 144 to estimate plutonium concentration in solid wastes. (MDV)

Pu 238; Pu 239; Pu 240; Am 241; Cm 242; Cm 243; Cm 244

ALPHA PARTICLES; CONTAMINATION; EVAPORATOR CONCENTRATE; FILTERS; PLUTONIUM COMPOUNDS; HALF-LIFE, RADIOLOGICAL; SLUDGES; WASTE MANAGEMENT; WASTE DISPOSAL; WASTES, TRANSURABIC; WASTES, SOLID; RESINS; LABORATORY STUDIES

<332>
Ebersol, E.P., A. Barbertsen, J.K. Flygare, and C.W. Sill, ERDA-Idaho Operations Office, Health and Safety Division, Idaho Falls, ID.

Determination of Radium 226 in Mill Effluents. (4)

IDO-12023; 14 pp. (1959, October)

Variations in the thorium 230/radium 226 concentration ratios in mill effluents have been attributed to several factors, both processing and analytical. This variation has been attributed to the use of sulfuric acid to leach out the uranium from the ore. Thorium sulfate builds up in the aqueous wastes, while sodium sulfate remains in solid form and is eventually disposed of to the tailings area. The second factor influencing the thorium 230/radium 226 procedures which affect the forementioned ratios include (1) lack of use of filters in the analytical procedures and (2) presence of other radium isotopes. Liquid effluent samples were sent to Winchester Laboratory, Bureau of Standards and the Analysis Branch of M and S Division IDO for radium analysis. The results and the analytical techniques are compared. (JT)

A review of analytical procedures and processing techniques that may affect radium 226 concentration in the various mill wastes. (DH/JT)

Ra 223; Ra 226

MILLS; EFFLUENTS; CHEMICAL ANALYSIS; WASTE PROCESSING; RADIUM; THORIUM; CONCENTRATIONS; URANIUM; LEACHING; ACIDS; PRECIPITATION, CHEMICAL; LEAD SULFATE; BARIUM COMPOUNDS; SPECTROMETRY; ALPHA PARTICLES; LABORATORY STUDIES

<333>
Gelsond, R.J. and S.T. Windham, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC.

Radioactivity Distribution in Phosphate Products, By-Products, Effluents, and Wastes. (3)

ORP/CSD-75-3; 32 pp. (1975, August)

Samples of phosphate ores, products, by-products, effluents, and wastes from several mines, wet process phosphoric acid plants, and electric furnace facilities throughout the southern U.S. were analyzed for U, Ra 226, and Th. Radon 226 analyses were performed using the Rn emanation method; U and Th were detected by alpha spectroscopy after ion exchange concentration and

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coprecipitation. Only data from Florida are presently available; analysis of marketable rock showed 82 pCi/g Ra 226, 81 pCi/g U 238, 1.9 pCi/g U 235, 81 pCi/g U 238, 2 pCi/g Th 227, 0.61 pCi/g Th 228, 82.3 pCi/g Th 230, and 0.88 pCi/g Th 232; slimes contained 85, 82, 2.6, 88, 2.3, 1.2, 88, and 1.8 pCi/g, respectively; sand tailings had 7.5 pCi/g Ra 226, 5.2 pCi/g U 238, 0.38 PCi/g U 235, and 5.3 pCi/g U 238. Approximately 60% of the activity extracted in Florida phosphate mining remains as waste products after beneficiation; removal of suspended solids from the heavy slime before effluent discharge removes 92-99.9% of the Ra in the slimes. Analyses of effluents from seven mine and beneficiation plants found no Ra 226 discharge greater than 3.0 pCi/l. In wet process phosphoric acid production most of the Ra 226 remains with the phosphogypsum by-product, while most of the U and much of the Th enter solution and are transferred to the phosphoric acid product. Lime neutralization of effluents was found to be very effective in removing Ra 226, U, and Th 230. In the electric furnace process, most of the Ra 226 is retained in the calcium silicate slag; this may not be true of other radionuclides, such as Po 210, that may be volatilized in the furnace. Increased emphasis on assessing the potential impact of gypsum and slag by-products is recommended. The radioactivity concentrations in raw materials, products, wastes, by-products, and effluents detailed in this paper should enable additional work to model migration pathways of these radionuclides in the environment and to estimate individual and overall population impacts. (LKH)

Total Ion Concentration

Ra 226; U 238; U 235; U 234; Th 227; Th 228; Th 230; Th 232

PHOSPHATES; PHOSPHOROUS COMPOUNDS; MINING; MILLING; ORES; EFFLUENTS, AIRBORNE; EFFLUENTS; GYPSUM; URANIUM; RADIUM; THORIUM; WASTES, INDUSTRIAL; WASTES, RADIOACTIVE; RADIONUCLIDES; LABORATORY STUDIES

<334>
Weatherton, R.C., National Lead Company of Ohio, Fernald, OH.

Disposal of Fluoride Wastes. (A)

TID-7517 (Part 1A); Sanitary Engineering Aspects of the Atomic Energy Industry, Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 275-285) (TID-7515, Part 1A). (1956, October)

Generation, treatment, and disposal of fluoride wastes from uranium and thorium processing is discussed. Excess and process hydrofluoric acid and metal fluoride by-products are obtained from the processes. Hydrofluoric gas is condensed as either anhydrous or hydrous HF. The anhydrous HF is used in the UO2 to UF4 conversion and hydrous HF is sold. The KOH scrub solution is used to clean HF from off-gas and the KF solution is sold. Neutralized soluble fluorides are discharged with other treated waste liquors to the river. Insoluble fluorides are stored in the ground in a specially prepared pit on the site. Since the flow of the Miami River varies from 25,000 to 100 cfs with an average of 1000 cfs only additions that will add no more than 0.8 ppm fluoride to the stream are permitted. Peak concentration of 1.5 are permitted if the average does not exceed 1.2 ppm. If the flow is 100 cfs, then 650 pounds of fluoride discharged in one day would raise the fluoride level above the maximum allowable concentration. In some months not more than 2,000 pounds could be discharged each day. The storage pit has 500,000 cu ft capacity which holds the fluorides until the river can handle the load. In the first months of the year 15,000 pounds of F/month were discharged and contributed 0.1 ppm to the river. Also, 90,000 gal of liquor/day was discharged. At no time did the amount of fluoride introduced raise the fluoride level above the maximum permissible concentration. The estimated cost of removal of HF from the condenser gas is $0.04/pound of HF using lime scrub and $0.09/pound of HF using KOH scrub. Using the storage pit and the lime scrubber the cost is $0.05/pound HF. In 2.5 years of operation there is no evidence of fluoride pickup in the groundwater. (NDV)

River Flow Rate

ACIDS; CALCIUM COMPOUNDS; CONTAMINATION; COST BENEFIT ANALYSIS; DOSE RATE; FLUORINE; GROUND WATER, MAXIMUM PERMISSIBLE CONCENTRATION; WASTE STORAGE; WASTES, INDUSTRIAL; REVIEWS

<335>
Holcomb, W.F., U.S. Environmental Protection Agency, Washington, DC.

Characterization of Selected Low-Level Radioactive Waste Generated by Four Light Water Reactors Located in New York State. (T)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 2, (pp. 127-135), 1214 pp. (CONF-770512). (1979)

An investigation was made of the radionuclide makeup of light water reactors' radwastes presently being consigned to shallow land burial. The purpose of this study was to provide a data base on the radionuclide composition and concentration in spent ion exchange resins, evaporator concentrates, and filter sludges which result from waste management operations and contribute to the radioactive source term in the burial site. In addition, analyses of waste samples were made to determine gross alpha, beta, and gamma activities. Ten waste samples were obtained from four New York reactors - Indian Point No. 2, R. E. Ginna, Nine Mile Point, and James A. Fitzpatrick. Ion exchange resin samples were available from only the Nine Mile Point and Ginna facilities; in both, Cs 137, Cs 134, and Co 60 account for approximately 90% of the total activity, with Cs 137 predominant. Evaporator concentrate samples from all reactors were analyzed. In the sample from Indian Point No. 2, the major constituents in order of prominence were Cs 134, Co 58, and Fe 55, comprising about 90% of total activity. The Ginna sample contained mainly H 3, Cs 137, Cs 134, Co 58, and Co 60, in that order, comprising about 95% of total activity. In the Nine Mile Point sample 95% of the activity was Fe 55, Cs 137, Cs 134, Co 60, and Ni 59. The major constituents from Fitzpatrick, in order of predominance, were Mn 54, Co 58, Co 60, Cr 51, and Zn 65, accounting for 87% of the activity. Fitzpatrick and Indian Point are

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relatively new reactors and show both activation products and mixed fission products in the wastes, with the majority of the activity in the activation products. This is to be expected since the contribution from fission products should be minimal during the early stages of reactor operation. Nine Mile Point and Ginna, having been in operation for a number of years, show the majority of activity in the fission products. It should be pointed out that both of these plants have experienced some fuel performance problems in the past, which could possibly explain some of the fission product activity in the coolant. Analyses of transuranic elements in the wastes indicates that the maximum concentrations for all four reactors are a factor of 5 less than the 10 nCi/g exclusion limit used by EPA for burial at commercial sites. The principal value of this data lies in the assistance it can give to structuring and scoping any follow-up studies to be performed. (LKH)

Cs 134; Co 58; Fe 55; H 3; Cs 137; Co 60; Mn 54; Cr 51; Zn 65

REACTORS, LIGHT-WATER; CESIUM 137; CESIUM 134; RADIONUCLIDES; COBALT 58; COBALT 60; IRON 55; CHROMIUM 51; ZINC 65; MANGANESE 54; FISSION PRODUCTS; ACTIVATION PRODUCTS; WASTES, RADIOACTIVE; RESINS; EVAPORATOR CONCENTRATE; SLUDGES; CONCENTRATIONS; RADIONUCLIDES; CHEMICAL ANALYSIS; LABORATORY STUDIES

<336>
Phillips, J.W., and J. Gruhlke, U.S. Environmental Protection Agency, Office of Radiation Programs, Technology Assessment Division, Washington, DC.

Summary of Radioactivity Released in Effluents from Nuclear Power Plants from 1973 thru 1976. (8)

EPA-520/3-77-012; 118 pp. (1977, December)

The report is the second annual summary of radioactive releases and wastes shipped offsite by nuclear power plants in the United States. The information contained in these summaries is extracted from the individual plant semi-annual or annual operating reports filed by the operating utility. The information in this summary report is from all plants operating on or before December 31, 1976 and includes data from 25 operating BWR units and 36 operating PWR units. The report consists primarily of tables listing annual power production, airborne releases, liquid releases, and solid waste generation. The solid waste information given includes volume, activity, and the number of waste shipments. (JC)

Good summary data gathered together in one location. Unfortunately the information is neither radionuclide specific nor waste form specific. (DH/JC)

WASTES, RADIOACTIVE; WASTES, SOLID; WASTES, LIQUID; WASTE VOLUME; REACTORS, BOILING WATER; REACTORS, PRESSURIZED WATER; BURIAL; WASTE DISPOSAL; REVIEWS

<337>
Phillips, J.W., J. Gruhlke, and G.A. Gaul, U.S. Environmental Protection Agency, Office of Radiation Programs, Technology Assessment Division, Washington, DC.

Summary of Radioactivity Released in Effluents from Nuclear Power Plants from 1972 thru 1975. (8)

EPA-520/3-77-006; 111 pp. (1977, June)

This report is the first annual summary of radioactive releases and wastes shipped offsite by nuclear power plants in the United States. The information contained in these summaries is extracted from the individual plant semi-annual operating reports filed by the operating utility. The information in this summary report is from all plants operating on or before December 31, 1975 and includes data from 23 operating BWR units and 30 operating PWR units. The report consists primarily of tables listing annual power production, airborne releases, liquid releases, and solid waste generation. The solid waste information given includes volume, activity, and the number of waste shipments. (JC)

This report is updated annually dropping the first reporting year of the previous report and adding the new data from the latest year. See EPA-520/3-77-012. (DH/JC)

BURIAL; WASTES, RADIOACTIVE; WASTES, SOLID; WASTES, LIQUID; WASTE VOLUME; REACTORS, BOILING WATER; REACTORS, PRESSURIZED WATER; WASTE DISPOSAL; REVIEWS

<338>
Phillips, J.W., and G.A. Gaul, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC.

An Analysis of Low-Level Solid Radioactive Wastes from Light-Water Reactors through 1975. (2)

ORP-TAD-77-2; 98 pp. (1977, November)

A 1975 study by the U.S. Environmental Protection Agency (EPA) considered operating data from light-water-cooled nuclear power plants through 1978 and resulted in projected volumes of waste considerably greater than the volume being used at the time by the Atomic Energy Commission (now the Nuclear Regulatory Commission) in environmental impact statements. A current study by the Nuclear Regulatory Commission (NRC) resulted in estimated volumes of waste which are in relative agreement with the 1975 EPA study. Another recent study by the Atomic Industrial Forum (AIF) concluded that the volume of waste from an LWR will continue to increase over the first ten years of life and then level off at a value approximately twice that calculated by the NRC or the EPA. In consideration of the wide disparity of data bases and conflicting conclusions, this study updates the previous EPA study in an attempt to substantiate either the NRC study or the AIF study. In addition, the study also provides a break-down of projected annual volumes by type of waste, i.e., demineralizer resins and filter sludge, evaporator bottoms, and contaminated trash, and also identifies the relative composition of the wastes by major nuclides. The latter results are compared with similar results from the NRC

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WASTE PRODUCTION

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study and a recent study by Dames and Moore for the New York State Energy Research and Development Authority. The average annual volume of waste from boiling water reactors (BWRs) runs between 1000 and 2000 cu m. This is in basic agreement with the AIP study estimate of 55,000 cu ft/yr (1556 cu m/yr), and slightly higher than previously estimated by the EPA or NRC. The activity of BWR waste is approximately 3000 to 7000 Ci/yr. Therefore, the NRC estimate of 4100 Ci/yr may be low, but is definitely within an acceptable range. Volumes for pressurized water reactors (PWRs) are expected to amount to 200 to 500 cu m/yr. These estimates are slightly lower than the NRC estimate of 15,500 cu ft/yr (440 cu m/yr) and significantly lower than the AIP estimate of 40,000 cu ft/yr (1130 cu m/yr). The activity of PWR solid wastes averages between 500 and 1500 curies as compared to the NRC estimate of 1900 curies. (Auth) (NAP)

REACTORS, LIGHT-WATER; REACTORS, BOILING WATER; REACTORS, PRESSURIZED WATER; WASTES, LOW-LEVEL; WASTE VOLUME; WASTES, SOLID; THEORETICAL STUDIES; RADIONUCLIDES

<339>
Soehalein, J.H., Battelle-Pacific Northwest Laboratories, Environmental Evaluations Section, Occupational and Environmental Safety Department, Richland, WA.

Hanford Waste Disposal Summary 1972. (2)

BNWL-1779; 10 pp. (1973, December)

The purpose of this report is to provide a single summary of waste quantities disposed of at Hanford in 1972. Tables list the following information: direct discharge of radionuclides to the Columbia River; radioactive liquid waste reaching the Columbia River from 100-N after discharge to the ground; quantities of reagent consumed in 100 areas and presumed discharged to Columbia River in liquid waste streams; liquid waste discharged to the ground; nonradioactive liquid waste discharged to the ground at the 300 area; 200 areas active liquid disposal sites; radioactive waste discharged to the atmosphere; nonradioactive waste discharged to the atmosphere; and radioactive solid waste buried. Environmental measurements demonstrated compliance with applicable environmental standards (AEC Manual, Chapter 0524). All measurements of radioactivity outside the plant boundaries were much less than 10% of the concentration guides. Radiation dose estimates for population groups in the plant environs for 1972 were all less than 1% of applicable standards for plant operations. Off-site measurements of non-radioactive air and water quality parameters were also well within the applicable criteria and showed no significant evidence of plant operations. (NAP)

Waste Volume

Na 24; Cr 51; Zn 65; Mn 56; Co 58; Fe 59; Co 60; Zr 65; Nb 95; Mo 99; Ru 103; Ru 106; Sb 125; I 131; Xe 133; Cs 136; Cs 137; Ba 140; La 140; Np 239; H 3; Sr 89; Sr 90; U; Pu 239

WASTE DISPOSAL; WASTES, LIQUID; RADIONUCLIDES; AIR; WATER; TRITIUM; ARGON 41; RIVERS; GROUND WATER; CRIBS; PONDS; TRENCHES; GASES; ERBIUM; PLUTONIUM; STRONTIUM; ALPHA PARTICLES; BETA PARTICLES; SULFUR OXIDES; NITROGEN COMPOUNDS; ALDEHYDES; PARTICLES; WASTES, SOLID; WASTES, TRANSURANIC; WASTE VOLUME; BURIAL; RADIATION DOSE; WASTES, NONRADIOACTIVE; FIELD STUDIES

<340>
Zima, G.E., Battelle-Pacific Northwest Laboratories, Richland, WA.

A Brief Assessment of Some Technical and Radiological Hazard Factors Affecting Clad Waste Management. (8)

BNWL-2104, 38 pp. (1976, July)

This report is an attempt to assess the relative importance of the high-level and clad waste streams to the total reactor radioactive waste picture. In assessing the significance of clad wastes, two fuel models are used for volume comparison for a LWR(B) reactor and a 33 GWD/MT burnup, i.e., the Reference Fuel Assembly and the Diablo Canyon reference fuel model. Comparison of the projected total volume of clad waste generated between 1979 and 1999, as projected by the two models, showed a range of 61.0 cu m 64.8 cu m. Analysis of the effect of burn up and fuel model on other clad waste characteristics are presented. (Auth) (JT)

This report addresses primarily high-level and clad wastes. Applicable to shallow land burial is that some facilities, e.g., Nuclear Fuel Services, have disposed of clad wastes by shallow land burial. (DH/JT)

CHEMICAL COMPOSITION; ZIRCALOYS; STAINLESS STEELS; HAZARD ANALYSIS; CLADDING; WASTES, HIGH-LEVEL; WASTE VOLUME; COMPACTION; VITRIFICATION; WASTE MANAGEMENT; REACTORS; REVIEWS

Albrecht, H.L., Tennessee Valley Authority, Knoxville, TN.

Application of Volume Reduction to a Boiling Water Reactor Radwaste System. (2)

CONF-770512; Management of Low-Level Radioactive Waste, H.W. Carter, A.A. Moghissi, and B. Kahn (Eds.). Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 295-306), 1214 pp. (1979)

The Tennessee Valley Authority (TVA) is considering the installation of volume reduction facilities in three two-unit boiling water reactor power plants (two at Hartsville and one at Phipps Bend, TN) it is building or planning to build. These facilities would replace presently designed equipment for packaging waste in admixture with cement. The volume reduction facilities would process evaporator concentrates, ion exchange resins, filter sludges, and possibly combustible trash. Various systems are being considered for this application, including fluid bed calciners and incinerators, extruder-evaporators, and thin-film evaporators. Two new systems, in which drying or combustion is carried out in a hot liquid medium (such as molten salt), also are possibilities. Equipment that does no more than incinerate combustible trash does not appear to be cost effective for the TVA system at today's costs, although it may become so in the future. Cost savings of the new system are conservatively estimated to be $580,000 per year for each plant in 1977 dollars, representing a comparison of the present system with a thin-film evaporator-asphalt mix process (the most expensive of those considered). These savings would increase if, as expected, waste transportation and disposal costs increase drastically in the future. (Auth) (LKH)

VOLUME REDUCTION; COSTS; EQUIPMENT; REACTORS, BOILING WATER; REACTORS; EVAPORATOR CONCENTRATE; RESINS; SLUDGES; CALCINATION; INCINERATION; EVAPORATION; COST BENEFIT ANALYSIS; WASTE MANAGEMENT; WASTE TREATMENT; WASTES, RADIOACTIVE; WASTES, LIQUID; WASTES, SOLID; FIELD STUDIES

Allen, B.P., and H.W. Arrowsmith, Battelle-Pacific Northwest Laboratories, Richland, WA.

Electropolishing as a Decontamination Technique. (4)

BNWL-2205; Nuclear Waste Management Quarterly Progress Report, October Through December 1976, A.M. Platt (Comp.), (pp. 12.1 - 12.5), 60 pp.(1977, April)

The objective of the discussed program is the development of a large scale electroplating decontamination technique for radioactive metal surfaces. During this initial reporting period substantial progress was made in establishing a demonstration decontamination system in the Hanford 231-Z Building. A 1500-liter electropolishing tank and the associated rinse tanks and ventilation system were installed, and hot testing of the facility was initiated using low-level beta/gamma-contaminated material. The first items decontaminated were a traveling wire flux monitor (2 mR/hr to background in 15 min.) and the interior of a waste sampling tube (2 mR/hr to background in 20 min.). A criticality safety analysis of the demonstration facility and of the proposed decontamination procedures was completed. Preparation of the criticality safety specification for operation with plutonium-contaminated material is in progress. Surface contamination-level studies show that even for the restrictive initial safety limits it should be possible to decontaminate more than 0.2 sq m of plutonium-contaminated surface area per liter of electrolyte. (RT)

Information pertinent to metal surface decontamination is presented. (DS/RT)

Pu

DECONTAMINATION; METALS; SURFACE CONTAMINATION; SAFETY; WASTE TREATMENT; CONTAMINATION; PLUTONIUM; SURFACE PROPERTIES; DECOMMISSIONING; ELECTROPOLISHING; LABORATORY STUDIES

Amberson, C.B., and D.W. Rhodes, Phillips Petroleum Company, Atomic Energy Division, Idaho Falls, ID.

Treatment of Intermediate- and Low-Level Radioactive Wastes at the National Reactor Testing Station (NRTS). (3)

CONF-651202; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 419-437), 988 pp. (1966)

Liquid intermediate- and low-level waste treated at the NRTS consists of three types: (1) chemical solutions generated by laboratories, fuel processing operations, and decontamination procedures; (2) contaminated water from fuel storage basins and reactor coolant loops; and (3) waste organic solvents generated by the fuel reprocessing plant. Wastes are concentrated by evaporation or ion exchange into small volumes which are then buried or calcined as high-level waste in the Waste Calcining Facility (WCF). A decontamination factor of 10(E+4) is achieved by the continuous waste evaporator at the Idaho Chemical Processing Plant (ICPP); approximately 1.5 million gallons of solution wastes are treated annually. Evaporator condensates are treated with water before release to the water table; the criteria for release of Sr 90 is 3 X 10(E-6) uCi/ml. Approximately 1 million gallons annually of low-level effluent from the fuel storage basin at ICPP are passed through clinoptilolite ion-exchange beds, reducing the Sr concentration from an average of 7 X 10(E-8) to 2.6 X 10(E-6) uCi/ml before discharge. The maximum concentration of radioisotopes released is 0.22 Ci of beta emitters per million gallons, of which about 90% is tritium. The primary coolant systems on some of the water-cooled reactors use ion-exchange resins in a by-pass demineralizer; both anion and cation beds are used, handling flows of approximately 300 l/min. Small concentrations of Pu are removed from waste organic solvents by steam distillation; decontamination factors of 10(E+8) and 10(E+2) are obtained for Pu and fission products, respectively. Maximum amount of Pu permitted in the waste solvent

<(3e3)>

WASTE TREATMENT

<(3e3)> CONT.
is 1.5 eq/l. The direct operational cost of evaporating high-salt wastes is $19/cum, resin ion-exchange $0.04/cum, and clinoptilolite ion-exchange $0.28/cum. Organic liquid waste costs $70/cum for treatment. Solid wastes such as clothing and equipment are cleaned without special procedures or thrown away. (LAH)

Total Ion Concentration; Waste Volume

Sr 90; Pu; B 3

WASTE TREATMENT; REVIEWS; WASTES, LIQUID; WASTES, SOLID; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, HIGH-LEVEL; WASTES, ORGANIC; BURIAL; CALCINATION; ECONOMICS; EVAPORATORS; ION EXCHANGE; REACTORS; RESINS; SALTS; STRONTIUM; PLUTONIUM; TRITIUM; DECONTAMINATION FACTORS; WASTE VOLUME; CLINOPTILOLITE; PLANTS

<(3e4)>
Baikova, V.D., V.V. Kulichenko, A.I. Bazarov, A.V. Siberev, and P.V. Pauzen, State Commission on the Use of Atomic Energy of the USSR, Moscow, USSR.

Latest Research and Advances in the Treatment of Low- and Intermediate-Level Radioactive Wastes in Bulgaria, Hungary, the USSR and Czechoslovakia. (3)

ORNL-tr-4417; CONF-651202; Practices in the Treatment of Low- and Intermediate-Level Radioactive Waste, Proceedings of a Symposium, Vienna, December 6-10, 1965. International Atomic Energy Agency, Vienna and European Nuclear Energy Agency, (29 pp.) (CONF-651202, ORNL-tr-4417).(1966)

Coagulation, ion exchange, evaporation, electrodialysis, foam extraction, and freezing were considered as methods for purifying water of radioactive wastes. The coagulation method was successful in removing 70-80% of the radioactive isotopes by use of ferric hydroxide at pH 8-10. The "sediment" had a combined radioactivity of 10(E+4) to 10(E+3) curies/l. Radioisotopes of metals with a valence greater than 2 decreased in content between 50 to 1000 times during coagulation depending on the isotope and chemical composition. Detergents (sodium hexametaphosphate, etc.) decreased the purification factors of zirconium and ruthenium while no effect was noted on strontium and cesium. The ion exchange method for purifying low-level liquid wastes was found effective as a two-stage method or in conjunction with coagulation. Further research was underway particularly on natural sorbents such as tuff and pumice rhyolite. Evaporation, while still experimental, had a purification coefficient of 10(E+4) to 10(E+6). Electrodialysis also showed promise because there was no periodic regeneration of the ion exchangers. Liquid wastes with an intermediate level of radioactivity (1 curie/l) were removed from solutions after alkali precipitation by mineral sorbents such as manganese ores. Consideration was also given to vitrification and cement-fixation of Sr 90, Ce 137, and incineration of Sr 90 and Ru 106. (NDV)

Distribution Coefficient; Ion Exchange Capacity

ABSORPTION; ASHES; BASALTS; BENTONITE; BURIAL; CEMENTS; CHEMICAL PROPERTIES; COMPLEXES; RESINS; GLASS; HEAT TRANSFER; ION EXCHANGE; LABORATORY STUDIES; LEACHING; MANGANESE; MAXIMUM PERMISSIBLE CONCENTRATION; METALS; ORES; pH; FUEL REPROCESSING; RESINS; RHYOLITES; SALT DEPOSITS; SEPARATION PROCESSES; SOLIDIFICATION; SULFUR COMPOUNDS; TUFFS; VERMICULITE; VOLUME REDUCTION; WASTE STORAGE; WASTE TREATMENT; WASTES, GASEOUS; WASTES, HIGH-LEVEL; WASTES, INDUSTRIAL; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, SOLID; ELECTRODIALYSIS; ENCAPSULATION

<(3e5)>
Barbour, W.A., South African Atomic Energy Board, National Nuclear Research Centre, Pelindaba, Republic of South Africa.

Review of New Developments in the Field of Low and Intermediate Radioactive Waste Disposal in the Republic of South Africa. (8)

CONF-651202; IAEA-SM-71/63B; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 911-919), 948 pp. (CONF-651202, IAEA-SM-71/63B). (1966)

All radioactive material used in South Africa is under the statutory control of the Atomic Energy Board, and since 1957 a total of 1019 Ci have been imported into the country. The disposal of radioactive waste produced by the use of this material has not presented a problem since the activity levels involved are very low. No national regulations covering the disposal of radioactive waste from isotope users have been promulgated but, in view of the rapid expansion and use of radioactive material, a National Committee of Control over Radioactive Waste Disposal has been appointed to assist and advise the Board with regard to the manner and conditions under which radioactive waste should be disposed of. The uranium industry, while producing fifty thousand tons of uranium oxide over the past thirteen years, has not presented a serious waste management problem. The only major development in radioactive waste disposal has taken place at Pelindaba, the National Nuclear Research Centre. Here liquid wastes are segregated at source and drained to a central waste-treatment facility. Intermediate-level waste of low volume (45 cu m/month) and high salinity is treated by a batch chemical blending or precipitation process followed by evaporation and mixed-bed ion exchange. Low-level waste (5-10 cu m/d), contaminated in excess of 10(E-5) pCi/ml, is treated by an identical but separate process. It is expected that decontamination factors of the order of 10(E+4) - 10(E+6) will be achieved by this combination of treatments. Concentrates from the evaporators are collected in a central dump tank from where they are transferred to a batch solidification facility, utilizing a pre-mixed blend of cement and exfoliated vermiculite. The solidified concentrate will be stored on-site in a structure designed to prevent penetration by underground water. The volume of low-level solid waste is reduced in a fully contained pneumatic baling press before permanent burial on site. (Auth)

Gives some description of solidified product of waste treatment. Otherwise not directly applicable to low-level waste. (DE/GR)

WASTES, RADIOACTIVE; WASTE DISPOSAL; WASTE

<345> CONT.
TREATMENT; SOLIDIFICATION; COMPACTION; EVAPORATION; ION EXCHANGE; DECONTAMINATION FACTORS; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; PRECIPITATION, CHEMICAL; WASTE VOLUME; CEMENTS; VERMICULITE; WASTE MANAGEMENT; REVIEWS

<346>
Barboer, W.A., and D.J. Ayre, South African Atomic Energy Board, National Nuclear Research Centre, Pelindaba, Republic of South Africa.

The Treatment of Radioactive Waste at the South African National Nuclear Research Centre, Pelindaba. (A)

CONF-651202; IAEA-SM-71/11; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 427-446), 938 pp. (CONF-651202, IAEA-SM-71/11). (1966)

This paper outlines the plans and the design of low- and intermediate-level radioactive waste facilities now under construction. At Pelindaba, research and development covering the wide field of nuclear energy and allied sciences is centered on an OPP-type reactor (light-water-cooled and moderated) designed for ultimate operation at 20 MW. The total staff employed at present numbers about 500 and is expected to reach 700 within three or four years. Liquid wastes from Pelindaba are discharged into a small river-dam complex with a high water utilization factor. As a result, very restrictive waste discharge limits must be met. The maximum allowable concentration for unidentified contamination in the mixed waste before discharge is 4 x 10(E-8) uCi/ml. A high degree of liquid-waste segregation is achieved at source from where it is drained to a central waste-treatment facility. Intermediate-level waste of low volume (45 cu m/month) and high salinity is treated by a batch chemical blending or precipitation process followed by evaporation and mixed-bed ion exchange. Low-level waste (5-10 cu m/d), contaminated in excess of 10(E-5) uCi/ml, is treated by an identical but separate process. It is expected that decontamination factors of the order of 10(E+4) to 10(E+6) will be achieved by this combination of treatments. Concentrates from the evaporators are collected in a central deep tank from where they are transferred to a batch solidification facility, utilizing a pre-mixed blend of cement and exfoliated vermiculite. The solidified concentrate will be permanently buried on-site in a structure designed to prevent penetration by underground water. The volume of low-level solid waste is reduced in a fully contained pneumatic baling press before permanent burial on site. (Auth)

Describes liquid waste treatment for purpose of release into local river. Solid disposal gives container description, otherwise not directly applicable to low-level waste. (DH/GR)

WASTES, RADIOACTIVE; WASTE TREATMENT; WASTES, LIQUID; FILTRATION; EVAPORATION; ION EXCHANGE; SOLIDIFICATION; COMPACTION; WASTE STORAGE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; PLANTS, WASTE TREATMENT; VOLUME REDUCTION

<347>
Bond, W.E., J.W. Doty, J.W. Koenst, Jr., and D.F. Lathy, Mound Laboratory, Miamisburg, OH.

Volume Reduction of Low-Level Combustible, Transuranic Waste at Mound Facility. (U)

MLM-2585(OP). (1978)

Low-level combustible waste (<100 nCi per g of waste) generated during plutonium 238 processing is collected and stored in 55-gallon (200-liter) drums. The composition of this waste is approximately 32 wt% paper, 46% plastic, 16% rubber and cloth, and 6% metal. Treatment of this waste is initiated by burning in the Mound Cyclone Incinerator, which consists of a burning chamber, deluge tank, venturi scrubber, and blower. During the two years of operating the Cyclone Incinerator, experiments have been performed on particle distribution throughout the system using various mixtures of feed material. Measurements were taken at the incinerator outlet, after the spray tank, and after the venturi scrubber. An average emission of 0.23 g of particles per kg of feed at the venturi outlet was determined. The distribution of chlorine from the combustion of polyvinyl chloride was studied. Analyses of the off-gas and scrubber solution show that approximately 75 wt% of the chlorine was captured by the scrubber solution and approximately 17 wt% remained in the off-gas after the venturi scrubber. Measurements of the amount NOX present in the off-gas were also made during the chloride studies. An average of approximately 200 ppm NOX was produced during each incineration run. Immobilization of the incinerator ash is being studied with regard to long-term behavior of the product. The immobilization matrix which looks most promising is ash mixed with Portland 1A cement in a 65/35 wt% ash-to-cement ratio. This matrix exhibits good mechanical properties while maintaining a maximum volume reduction. (Auth)

VOLUME REDUCTION; WASTES, LOW-LEVEL; WASTES, TRANSURANIC; PLUTONIUM 238; NUCLEAR FACILITIES; WASTE STORAGE; INCINERATION; PARTICLES; DISTRIBUTION; CHLORINE; PLASTICS; GASES; SCRUBBERS; NITROGEN COMPOUNDS; IMMOBILIZATION; ASHES; CEMENTS; FIELD STUDIES

<348>
Bond, W.E., J.W. Koenst, and D.F. Lathy, Mound Laboratory, Miamisburg, OH.

The Treatment of Low-Level Waste at Mound Laboratory. (U)

Proceedings of the Fifteenth DOE Air Cleaning Conference, Boston, MA, August 7-10, 1978, 11 pp.

The progress at Mound Laboratoy to handle low-level radioactive waste has two major objectives: 1) to design a volume reduction system for low-level combustible waste, both solid and liquid, and 2) to develop separation methods for removing radionuclides from liquid waste, both low-level and intermediate-level. The Cyclone Incinerator has been demonstrated on wastes containing <100 nCi Pu 238/gram of waste with volume reductions in excess of 37:1. Although batch operations (in situ) have been the major mode of burning, a continuous feed mode for both

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liquid and solid incineration has been developed. Off-gas analysis has shown the acceptability of the effluents for both modes of operation. The Ultrafiltration Pilot Plant has processed contaminated waste streams from both floor drains and a laundry, achieving decontamination factors of 10(E+3) while yielding a product containing <0.1 dis/min/ml. During continuous operation of the pilot system, volume reductions of 200:1 were obtained. (Auth) (RAP)

WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, LIQUID; WASTES, INTERMEDIATE-LEVEL; SEPARATION PROCESSES; INCINERATION; VOLUME REDUCTION; FILTRATION; COSTS; GASES; PLUTONIUM 238; PLUTONIUM 239; URANIUM 233; FIELD STUDIES

<(349)>
Bonhote, P.A., and E.D. Hespe, Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales, Australia.

Low-Level Sludge Concentration by Solar Evaporation. (3)

CONF-651202; IAEA-SM-71/5; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 439-447), 948 pp. (CONF-651202, IAEA-SM-71/5). (1966)

Solar-evaporation was developed as a method to treat low-level sludge at Lucas Heights in Australia. The low-level effluent generated by research done on a beryllia-moderated, high-temperature, gas-cooled reactor system was used in developing the method. Once the effluent was collected into delay tanks, it was pumped into a treatment plant for scavenging/flocculation using sodium carbonate to keep the pH between 6.0 and 6.5. The process is capable of producing 68 cu m/yr. Levels of contamination in the sludge are 10(E-5) to 10(E-3) uCi/ml gross alpha, 10(E-3) to 10(E-1) uCi/m gross beta, and 5 to 10 ppm beryllium. Solar evaporation was thought feasible because the annual rainfall averages 122 cm, and the sun shines for 6.7 h/day. For the initial experiment a drying bed with a 5 cm thick gravel and sand filter and drain were used with a transparent cover. Ultimately the transparent covers were abandoned. The evaporation rates averaged 3.275 liters/sq m which compares favorably with the annual evaporation rate of 2.949 liters/sq m/day. A larger experimental design with 92% of the annual evaporation rate was tried next. The larger evaporation pan was designed to evaporate 15,000 gal of sludge. The evaporation rate of 9,000 gal of sludge was 3.03 liters/sq m/day with an average of 2.65 liters/sq m/day. Overall volume reduction was 5.3, and no significant airborne contamination or radiation fields were detected. Capital costs were initially $A 5200 and over a 25 yr life span of the equipment the cost per gallon is 1.5 cent. The experience at Lucas Heights gives a favorable indication as to the viability of the method. (NDV)

pH; Evaporation Rate; Mean Precipitation; Waste Volume

ALPHA PARTICLES; BETA PARTICLES; EFFLUENTS; EVAPORATION; EVAPORATORS; METHODS; PLANTS, WASTE TREATMENT; SLUDGES; VOLUME REDUCTION; WASTE MANAGEMENT; WASTE TREATMENT; WASTES, LIQUID; WASTES, LOW-LEVEL; DESIGN; COST BENEFIT ANALYSIS; WASTE VOLUME; FIELD STUDIES

<(350)>
Bonnevie-Svendsen, H., K. Tallberg, P. Aittola, and H. Tollback, Institutt for Atomenergi, Kjeller, Norway; Technical Research Center of Finland, Finland; AB Atomenergi, Studsvik, Sweden.

Studies on the Incorporation of Spent Ion Exchange Resins from Nuclear Power Plants into Bitumen and Cement. (3)

CONF-760310; STI/PUB/433; IAEA-SM-207/78; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (pp. 155-178) 824 pp. (IAEA-SM-207/78, CONF-760310, STI/PUB/433). (1976)

This paper presents the results of studies on the effects of simulated and actual spent ion-exchange resins on the quality of bitumen and cement into which they are incorporated. Blown and distilled bitumen and three kinds of Portland cement were tested. Products were characterized by properties relevant to safe waste management, storage, transport, and disposal. The bitumen experiments showed that 40-60% dry resin can be incorporated without harming product quality. Higher resin contents cause swelling in water. Products exhibit a high leach resistance; leach coefficients for Co were 10(E-13)-10(E-10) sq cm/d and 10(E-10)-10(E-8) sq cm/d for Cs. Also, form-stability of the bitumen was greatly improved by addition of resins. Distilled bitumen qualities appear to be somewhat better suited for incorporation of ion-exchange resins than blown bitumen. Incorporation of pure resins into cement tended to result in products that decomposed in water. Product quality was strongly affected by physico-chemical variables, such as resin characteristics, water/cement ratios, cement types, and additives. Major problems with cement incorporation were the weight and volume increase involved and the high Cs-leachability (10(E-5)-10(E-2) sq cm/d). Stabilizing and Cs-retaining additives such as Silix and vermiculite were used to improve leach resistance. Another disadvantage of this product at present is that the water content of resins limits incorporation to 40-50 wt% (12-23% dry). (LKH)

Leaching Rate

ION EXCHANGE; RESINS; BITUMENS; CEMENTS; WASTE MANAGEMENT; WASTE DISPOSAL; WASTE STORAGE; VERMICULITE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; LABORATORY STUDIES; SOLIDIFICATION; STRENGTH, MECHANICAL; LEACHING

<(351)>
Bordoin, L.C., W.E. Draper, R.A. Koenig, A.S. Meuls, and C.L. Warner, Los Alamos Scientific Laboratory, Los Alamos, NM.

Controlled-Air Incineration of Transuranic-Contaminated Solid Waste. (3)

<351> CONT.
CONF-760822; Proceedings of the Fourteenth ERDA Air Cleaning Conference, Sun Valley, ID, August 2-6, 1976, (pp. 36-50) (CONF-760822). (1977, February)

A controlled-air incinerator and an associated high-energy aqueous off-gas cleaning system are being installed at the Los Alamos Scientific Laboratory (LASL) Transuranic Waste Treatment Development Facility (TDF) for evaluation as a low-level transuranic-contaminated (TRU) solid waste volume reduction process. Program objectives are: 1) assembly and operation of a production scale (45 kg/hr) operation of "off-the-shelf" components representative of current incineration and pollution control technology; 2) process development and modification to meet radioactive health and safety standards, and 3) evaluation of the process to define the advantages and limitations of conventional technology. The results of the program will be the design specifications and operating procedures necessary for successful incineration of TRU waste. Testing, with nonradioactive waste, will begin in October 1976. This discussion covers commercially available incinerator and off-gas cleaning components, the modifications required for radioactive service, process components performance expectations, and a description of the LASL experimental program. (Auth)

AIR; ASHES; ATMOSPHERE; CONTAINMENT; CONTAMINATION; EQUIPMENT; EXHAUST GASES; FILTERS; INCINERATION; MONITORING; SCRUBBERS; VOLUME REDUCTION; WASTE MANAGEMENT; WASTES, SOLID; WASTES, TRANSURANIC; WASTES, LOW-LEVEL; LABORATORY STUDIES

<352>
Borrowman, S.R., and P.T. Brooks, U.S. Bureau of Mines.

Radium Removal from Uranium Ores and Mill Tailings. (4)

BI-8099; Bureau of Mines Report of Investigations, 1975; 10 pp. (1975)

Methods were investigated for removing radium from uranium mill tailings, including sand-slime separation and leaching with solutions of either hydrochloric acid or EDTA. Although a serious permissible concentration of radium in mill tailings allowing unrestricted usage has not been promulgated in the United States, a value of about 10 picocuries of radium per gram appears not particularly hazardous. None of the radium removal methods tested were able to produce tailings meeting this value, and their costs were considerable. A method was devised for leaching both uranium and radium from several uranium ores using hydrochloric acid; however, sulfur contained in the ores apparently prevented complete radium extraction. (Auth) (LS)

Interesting paper although the methods used are not currently practical. (DB/LS)

Ra 226

RADIUM; TAILINGS; WASTE DISPOSAL; WASTE TREATMENT; URANIUM; LEACHING; MAXIMUM PERMISSIBLE CONCENTRATION; HALF-LIFE, RADIOLOGICAL; MINES; SEPARATION PROCESSES; ACIDS; RETENTION PONDS; MILLS; ORES; EXTRACTION;

LABORATORY STUDIES

<353>
Boerrier, H.

Computational Method for Evaluating the Evolution of Percolated Ions in a Porous Medium as a Function of the Percolation Rate. (3)

OLS-78-252; Retention and Migration of Radioactive Ions in Soils, Proceedings of an International Colloquium, Saclay, France, October 16-18, 1962, Presses Universitaires of France, (19 pp.). (1963; 1978)

Development of equipment for water decontamination or for stockpiling radioactive effluents is presented on the theoretical and practical levels. The phenomena governing the retention rate in a porous medium and the exchange are described mathematically. The partial differential equations are solved in detail with an integrable Bessel function. The apparatus built was a sorption column with the contaminated water under pressure at the top so it would be forced through the column. Only preliminary tests had been run with the apparatus. (HDT)

SORPTION; DECONTAMINATION; HYDRODYNAMICS; FILTRATION; ION EXCHANGE; LABORATORY STUDIES; PLANTS, WASTE TREATMENT; WASTE TREATMENT; WASTES, LIQUID; WASTES, RADIOACTIVE; EQUATIONS; MODELS

<354>
Burns, P.H., J.H. Clarke, L.D. Wright, and J.H. Wyatt, Atomic Energy Research Establishment, Harwell, Didcott, Berkshire, England.

Present Practices in the Treatment of Liquid Wastes at the Atomic Energy Research Establishment, Harwell. (4)

CONF-651202; IAEA-SM-71/56; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 17-29) (CONF-651202, IAEA-SM-71/58). (1966)

The present practices in chemical treatment methods at A.E.R.E., Harwell, are described. These are a calcium-iron-phosphate precipitation at a pH value of 11.5 and a calcium-phosphate-copper ferrocyanide precipitation at a pH value of 10.0. Both are shown to be effective whether used in settlement tanks or in a sludge blanket precipitator, giving decontamination factors of up to 20. Reference is made to the use of crude vermiculite in the sodium form as a second stage after chemical precipitation, the over-all treatment giving a decontamination factor of 500. A new plant has recently been commissioned with facilities available for two-stage batch chemical treatment, continuous chemical treatment in a sludge blanket precipitator, evaporation, and ion-exchange using natural materials. Flow-rates of up to 2.3 cu m/h are possible depending on the processes used. Early experiences with all the processes are described. Particular reference is made to the use of a basket centrifuge for the

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WASTE TREATMENT

<354> CONT.
ion-exchange stage using vermiculite as the ion-exchanger. This 2.3 cu m/h plant has recently been commissioned, and the results of the first few weeks of operation are described. Sludges produced in the chemical treatment processes are settled in specially designed columns, and the thickened material is either absorbed on the exfoliated vermiculite or frozen, thawed, and centrifuged depending on the activity level. Details are given of the new freezing plant which will be commissioned this year and which is designed to handle up to 7 cu m/d. Finally, reference is made to the proposed sludge insolubilization plant. (Auth)

Discusses waste treatment at Harwell. Only relevance to shallow land burial is description of treatment end product. (DB/GH)

WASTES, RADIOACTIVE; WASTES, LIQUID; PRECIPITATION, CHEMICAL; ION EXCHANGE; VERMICULITE; SLUDGES; VOLUME REDUCTION; DECONTAMINATION FACTORS; BITUMENS; SOLIDIFICATION; WASTE TREATMENT; LABORATORY STUDIES

<355>
Clark, B.E., and R.E. Lerch, Hanford Engineering Development Laboratory, Richland, WA.

Volume Reduction Options for the Management of Low-Level Radioactive Wastes. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 4, (pp. 235-285), 1218 pp. (CONF-770512). (1979)

This paper examines volume reduction options that are now or soon will be available for low-level wastes. These wastes generally are in the form of combustible solids, noncombustible solids, and wet wastes (solid/liquid). Initially, the wastes are collected and stored onsite. Preconditioning may be required, e.g., sorting, shredding, and classifying the solids into combustible and noncombustible fractions. The volume of combustible solids can be reduced by compaction, incineration/pyrolysis, acid digestion, or molten salt combustion. Options for reducing the volume of noncombustible solids include compaction, size reduction and decontamination, meltdown-casting, dissolution, and electropolishing. Burnable wet wastes (e.g., organic wastes) can be evaporated or combusted; nonburnable wet wastes can be treated by evaporation, evaporative crystallization, drying, calcination, reverse osmosis, flocculation (and carrier precipitation), filtration, and ion exchange. In general, these treatments are well understood and have been used in commercial or ERDA facilities for a number of years. Improvements in present technology are steadily being made and development of advanced technologies is underway at DOE laboratories for commercial application when needed in the 1980's. All radioactive waste processing operations result in some equipment contamination and the production of additional contaminated wastes (secondary wastes). The additional waste quantities must be considered in evaluating performance and overall volume reduction factors for the various systems. In the selection of an optimum waste management plan for a given facility, other important factors (e.g., relative stability of the waste product form) should be considered along with the savings accrued due to volume reduction. (Auth) (LKH)

VOLUME REDUCTION; METHODS; WASTE PROCESSING; WASTE TREATMENT; WASTE MANAGEMENT; WASTES, LOW-LEVEL; COST BENEFIT ANALYSIS; WASTES, SOLID; WASTES, LIQUID; COMPACTION; INCINERATION; SALTS; COMBUSTION; CHEMICAL REACTIONS; DECONTAMINATION; DISSOLUTION; ELECTROPOLISHING; WASTES, ORGANIC; EVAPORATION; DRYING; CALCINATION; OSMOSIS; FLOCCULATION; PRECIPITATION, CHEMICAL; FILTRATION; ION EXCHANGE; METHODS; EVALUATION; REVIEWS

<356>
Colombo, P., and R.E. Neilson, Jr., Brookhaven National Laboratory, Department of Nuclear Energy, Nuclear Waste Management Research Group, Upton, NY.

Properties of Radioactive Wastes and Containers, Progress Report No. 5, April-June 1977. (1)

BNL-NUREG-50763; 83 pp. (1977, December)

The results obtained to date on several specific studies on radioactive waste properties are presented in this progress report. Parameters studied include decontamination factors for free standing water resultant after cement solidification, the recalcitrance of Portland cement, urea formaldehyde, asphalt, and a water extendable polymer, the compressive strengths of Portland cement and urea formaldehyde containing various simulated wastes in varying waste to agent ratios, the gamma radiation shielding characteristics of various solidification agents, the thermal properties of various waste forms, and the solidification verification for the relatively new Dow polymer product. Decontamination factors for Cs 137, Sr 85, and Co 60 were found to be 1 11 and 200, respectively, as determined by analysis of free standing water. The concentration of organic carbon potentially available as nutrients for microorganisms in leachant water after ten days were 0, 3.4, 34 and 9500 ppm for Portland cement, bitumen, Dow polymer, and urea formaldehyde. The results of the compressive strengths for various mixtures is presented in tabular form. The total activity levels capable of being emplaced in waste forms solidified in 55 gallon drums for transportation in "non exclusive use" vehicles under 49 CFR 173 have been calculated. The results of thermal property studies for various waste forms are also presented. (JC)

The gamma shielding data may be useful in predictions of necessity of overpack use in transportation studies. The biodegradability of various wastes forms is informative in light of the dissolved organic carbon concentrations being observed in trench leachate samples. (DB/JC)

CEMENTS; BITUMENS; UREA FORMALDEHYDE; POLYMERS; SOLIDIFICATION; DECONTAMINATION FACTORS; CARBON; MICROORGANISMS; LEACHING; LEACHATES; THERMAL PROPERTIES; TRANSPORTATION; LABORATORY STUDIES

<357>
Cooley, C.R., and R.P. Lerch, U.S. Energy Research and Development Administration.

Chemical Digestion of Low-Level Nuclear Solid Waste Material. (3)

Canadian Patent No. 991961; 8 pp. (1976, June)

An invention for processing low-level light weight Galley Combustible nuclear solid waste material is described. Waste is reacted with sulfuric acid at 230-300 degrees C and is simultaneously or subsequently (or both) oxidized with nitric acid or nitrogen oxides. This converts carbonaceous material to gaseous by-products plus residue. This may be done batchwise or by incremental additions of waste and nitric acid or oxides. The residue may be separated into a neutral, noncombustible solid and an aqueous solution. Volume reductions up to 160:1 have been achieved in the laboratory, but are dependent on the amount of inorganic chemicals in the waste. Very little acid is consumed, since it is used only as a low-temperature chemical combustion medium; most of the acid can be recycled. Wastes which may be processed by this method include solid organic and inorganic materials, spent ion exchange resins, and solid waste containing uranium or plutonium. (ERA)

WASTES, LOW-LEVEL; ACIDS; COMBUSTION; OXIDATION; RESIDUES; VOLUME REDUCTION; WASTES, ORGANIC; RESINS; WASTES, SOLID; LABORATORY STUDIES

<358>
Corey, J.C., and A.L. Boni, Savannah River Laboratory, Aiken, SC.

Removal of Plutonium from Drinking Water by Community Water Treatment Facilities. (4)

DP-MS-75-26; CONF-751105; IAEA-SR-199/81; Transuranium Nuclides in the Environment, Proceedings of an International Symposium, San Francisco, CA, November 17-21, 1975, (11 pp.) (CONF-751105, IAEA-SR-199/81, DP-MS-75-26). (1975, November)

A study was conducted during a nine month period to determine the effectiveness of drinking water treatment plants in removing plutonium from the Savannah River water. Treatment and removal was accomplished by using alternating cation-anion exchange columns. Removal factors between raw and finished water ranged between 5 and 25. The similarity between removal factors observed for both plutonium and suspended solids suggests a colloidal behavior for plutonium. Treatment of colloidal plutonium is dependent on colloidal size, pH and presence or absence of chemical additives. Flocculation and filtration appear to be the primary factors in water treatment process contributing to removal plutonium. The 70-year bone dose commitment to an individual from consumption for one year of 1.65 liters per day of raw water was 6 X 10(E-8) area; of 1.65 liters per day of treated water was 4 X 10(E-5) area. (Auth) (JC)

Applicability to shallow land burial is marginal. Primarily concerned assessment of population dose and environmental consequences of transuranics in drinking water. (DM/JT)

Pu 239; Pu 240

PLUTONIUM; ION EXCHANGE; DRINKING WATER; COLLOIDS; RADIATION DOSES; FLOCCULATION; FILTRATION; MAXIMUM PERMISSIBLE CONCENTRATION; WASTE VOLUME; DECONTAMINATION FACTORS; PLANTS, WASTE TREATMENT; LABORATORY STUDIES

<359>
Croff, A.G., Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN.

An Evaluation of Options Relative to the Fixation and Disposal of Carbon 14 - Contaminated Carbon Dioxide as Calcium Carbonate. (3)

ORNL-TM-5171; 57 pp. (1976, April)

A paper study was conducted to determine the best method for fixing the C 14-contaminated CO2 resulting from an HTGR fuel block burner as CaCO3, and to determine the best methods for disposing of the CaCO3 thus produced. The fixation method selected was the direct reaction of a Ca(OH)2 slurry with the CO2. The least expensive disposal options which are likely to be acceptable appear to be the shallow-land burial of either drummed CaCO3 solid (total cost = $19.47/kg heavy metal) or drummed CaCO3 concreted with cement (total cost = $83.33/kg heavy metal). Neither placing the CO2 fixation process before the Kr removal process nor separating the bulk of the graphite fuel block from the fuel particles is attractive on both technical and economic grounds. However, reduction of the HTGR fuel nitrogen content appears to be a more attractive method of reducing the C 14 release rate. (Auth)

THEORETICAL STUDIES; CARBON 14; CALCIUM CARBONATE; SLURRY; FIXATION; WASTE DISPOSAL; PACKAGING; TRANSPORTATION; BURIAL; DRUMS; CEMENTS; CONCRETES; KRYPTON; SEPARATION PROCESSES; NITROGEN; FUELS; REACTORS, HIGH-TEMPERATURE GAS-COOLED; COSTS

<360>
De Robien, E., J. Pomarola, and M. Brolsky, Centre d'Etudes Nucleaires de Grenoble, France.

Experience Acquired in Regard to Evaporating Liquid Radioactive Waste and Solidifying Evaporation Sludge at the Centres d'Etudes Nucleaires de Fontenay-aux-Roses and de Grenoble. (1)

ORNL-tr-4819; CONF-651202; Practices in the Treatment of Low-and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965, (pp. 279-290). (1966)

This paper presents specific and complete analysis of the evaporators used at the radioactive effluent processing stations of the Grenoble and Fontenay-aux-Roses Centres. The reasons for selecting the evaporation method are given, with reference being made to the regulations governing disposed of liquid effluents. After a comparative description of the characteristics of the two installations, the paper describes the experience gained in the course of operation, discussing concentration factors; decontamination factors; precautions taken to avoid corrosion risks; and difficulties encountered, modifications and improvements

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<360> COST.
made. Laboratory studies carried out on the solidification of sludges are described as well as the various stages leading to the completion of the present installations. Finally, the authors present an economic assessment. (Auth)

Very complete in its analysis of the topic. (DS/DLO)

CORROSION; DECONTAMINATION; DISTILLATION; EVAPORATION; WASTES, LIQUID; DECONTAMINATION FACTORS; SLUDGES; EFFLUENTS; EVAPORATORS; METHODS; SOLIDIFICATION; LABORATORY STUDIES; COST BENEFIT ANALYSIS; VOLUME REDUCTION

<361>
Dejonghe, P., Centre d'Etude de l'Energie Nucleaire, Mol, Belgium.

Waste Disposal Operations at Mol, Belgium. (2)

Ground Disposal of Radioactive Wastes, W.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959, University of California, Berkeley, CA, (pp. 37-39), 168 pp. (1961, July)

Disposal of wastes at Mol are discussed. Underlying the area are formations that are largely sand and have virtually no exchange capacity. The lagoons in the area are connected to the water supply of the city of Antwerp and the water table is one or two meters below the surface. The present approach to low and intermediate-level waste treatment is the use of a ferric hydroxide scavenger. The process has provided up to 99.5% cesium removal and 99% strontium removal. There are situations where this process may not be feasible in the future so lignite has been investigated as a natural ion exchanger. Lignite has an exchange capacity of 0.85 meq/g. Long-term storage of chemical sludges is achieved by insolubilizing by immersing the blocks in hot tar or parrafin. The blocks had a volume of 2.53 cu cm, surface area 18 sq cm, and contained about 2 x 10(E+6) cpm of Sr 90. Elutions tests show these blocks to be highly resistant. More studies are needed to determine the practical significance of the method. The flow rate of the ground water was found to be 50 m/yr. Studies are also underway to determine the suitability of sludge storage in a clay layer which is 140 m thick. (MOV)

Depth to Water Table; Ion Exchange Capacity; Hydraulic Velocity; Stratigraphic Unit Thickness

BITUMINOUS MATERIALS; BITUMINIZATION; CONTAINMENT; FIXATION; IMMOBILIZATION; ION EXCHANGE; WATER TABLE; LIGNITES; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, SOLID; SOILS; CLAYS; SOLIDIFICATION; ENCAPSULATION; DISPOSAL SITE; REVIEWS

<362>
Dejonghe, P., and L. Baetsle, Centre d'Etude de l'Energie Nucleaire, Mol, Belgium.

Ion Exchange and Adsorption of Ligneous Material. (2)

Ground Disposal of Radioactive Wastes, W.J. Kaufman (Ed.), Proceedings of a Conference, Berkeley, CA, August 25-27, 1959. University of California, Berkeley, CA, (pp. 83-87), 168 pp. (1961, July)

The possibility of using lignite as a natural ion exchanger in a combined chemical and physicochemical treatment scheme for the handling of radioactive effluents was examined. The presence of calcium in wastes was found to seriously reduce the strontium capacity of the lignite, and, to a lesser degree, the cesium capacity. When calcium was removed by chemical methods (sodium carbonate and sodium phosphate), large amounts of Na+ were introduced which then interfered with cesium removal. The conclusion was reach that when dealing with mixed fission products in laboratory effluents, cesium should be removed first. This could be accomplished by employing small amounts of copper sulfate and potassium ferrocyanide. Following cesium removal, the waste stream can be softened by the phosphate process and then treated with lignite, the latter serving as the finishing step. The kinetic properties of lignite columns were studied to establish the predictability of early breakthrough. The rate constant, K(hr), was found not to be influenced by column length and by the exchange system, i.e., nature of the ions involved. Particle size and flow rate influence on the rate constant was also examined. Two pilot plant studies on normal laboratory effluents containing mixed fission products were conducted with final step treatment being a lignite column and a horizontal centrifuge, respectively. The centrifuge method was found to be nearly equivalent to the column method and was found to have important operational advantages. (Auth) (MT)

Ion Exchange Capacity; Porosity; Bulk Density; Moisture Content

Cs 137; Sr 90

ADSORPTION; BREAKTHROUGH DISTRIBUTION; CALCIUM; DECONTAMINATION; EFFLUENTS; ION EXCHANGE CAPACITY; LIGNITES; CESIUM; STRONTIUM; ION EXCHANGE; WASTE TREATMENT; WASTES, LIQUID; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; SOLIDIFICATION; ENCAPSULATION; LABORATORY STUDIES; SEPARATION PROCESSES

<363>
Dejonghe, P., and H. Van de Voorde.

Fixation of Low and Intermediate Active Concentrates by Inclusion in Low Melting Inert Media. (3)

TID-7613; Fixation of Radioactivity in Stable, Solid Media, Proceedings of the 2nd Working Meeting, Idaho Falls, ID, September 27-29, 1960. U.S. Atomic Energy Commission, Office of Technical Information, Washington, DC, Book 1, (pp. 251-269), 782 pp. (TID-7613). (1961, February)

Fixation methods of low and intermediate-level concentrates were considered for wastes at the Mol facility. It was necessary to choose a technique that would protect the area around the facility because the soil has a low fixation capacity and the population density is high. Tar or some similar organic product was chosen due to its relatively low melting point and

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ability to be easily homogenized. The idea in this type of process is to coat the sludge particles with tar and not to form an insoluble one-phase system as does vitrification. Sludge composed of Cu2Fe(CN)6, Fe(OH)3(PO4)2, and 10-year-old fission products was filtered 6 ft with a 50% moisture content and mixed with tar at 230 degrees C for 45 minutes. Leaching tests indicated a daily average rate ranging from 1.2 x 10(E-5) to 7 to 10(E-5) g/sq cm/day depending on whether the sample was irradiated or not. The elution also decreased with time. Leaching tests in a sandbed indicated an elution rate as low as 6 x 10(E-7) g/sq cm/day. More tests show the rate in the sandbed to be typically 2 10(E-5) as compared to the water column which was 8 x 10(E-5) g/sq cm/day. These tests indicate that ground disposal of the treated sludge could lead to a slower leaching rate than originally thought. Using this method, the worst possible total yearly elution is expected to be 29.2 mc for low activity effluents and 15 Ci for high activity effluents. (NDV)

Leaching Rate; Moisture Content

ASPHALTS; BINDERS; CONTAINERS; FISSION PRODUCTS; IMMOBILIZATION; LEACHING; MOISTURE; ORGANIC COMPOUNDS; SANDS; WASTE TREATMENT; WASTES, LIQUID; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; ENCAPSULATION; FIELD STUDIES

<364>
DeLora Soria, F., and B. Lopez Perez.

Practices in the Treatment of Low-and Intermediate-Level Radioactive Waste (Spain). (3)

ORNL-tr-4421; CONF-651202; Practices in the Treatment of Low- and Intermediate-Level Radioactive Waste, Proceedings of a Symposium Vienna, Austria, December, 1965, (pp. 403-410. (CONF-651202, ORNL-tr-4421). (1966)

The CIEN pilot plant is designed to process the liquid radioactive wastes from the hot plant at the National Center of Nuclear Energy at Juan Vigon. Radioactive wastes are classified according to specific activity and salt content. Low-level wastes have a specific activity of less than 1 mCi/l and low salt content. Intermediate-level wastes are either wastes with a specific activity of less than 1 mCi/l and high salt content or waste with a specific activity between 0.1 mCi/a and 10 mCi/l. High-level wastes have a specific activity exceeding 10 mCi/l. Low- and intermediate-level wastes will be decontaminated by a coagulation-refinement-ion exchange system. Decontamination factors range from 160 for zirconium 95/niobium 95 to 12,000 for cobalt 60. (JT)

A brief review of planned low-level waste treatment, no significant data presented. (DR/JT)

WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTE TREATMENT; DECONTAMINATION FACTORS; COAGULATION; ION EXCHANGE; ACTIVATED CARBON; VOLUME REDUCTION; THEORETICAL STUDIES

<365>
Donato, A., CNEN-CSN, Casaccia, Rome, Italy.

Incorporation of Radioactive Wastes in Polymer Impregnated Cement. (3)

CONF-760310; STI/PUB/433; IAEA-SM-207/87; Management of Rad ioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (pp. 143-153), 428 pp. (IAEA-SM-207/87, CONF-760310, STI/PUB/433). (1976)

Polymer-impregnated cement is investigated as a medium for low and intermediate-level radioactive waste immobilization. The process under consideration involves 1) incorporation of wastes in cement or concrete, 2) dehydration of product and impregnation with an organic monomer (styrene or methylmethacrylate), and 3) thermal polymerization of the monomer. Advantages of this type of product include: 1) compressive strengths as much as 200% greater than concrete; 2) very low flammability, even with nitrates incorporated; 3) radiation resistance good to at least 1 x 10(E+8) rads; 4) low leachability. The incremental leach rate for Cs 137 is about 10 times lower [1.2 x 10(E-5) versus 1.2 x 10(E-4) cm/d for cement, both after 100 days]. For Co 58 the rate is 8 times lower [1.2 x 10 (E-4) versus 1.5 x 10(E-5) cm/d after 88 days]. Sr 5n shows the best results, 1 x 10(E-8) cm/d compared to 3.2 x 10(E-7) cm/d after 88 days, a decrease of 312 times. A demonstration pilot plant is under construction. (LKM)

Leaching Rate

Cs 137; Co 58; Sr 85

POLYMERS; CONCRETES; CEMENTS; WASTE TREATMENT; TRACERS; ORGANIC COMPOUNDS; PHYSICAL PROPERTIES; LABORATORY STUDIES; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; IMMOBILIZATION; LEACHING; CESIUM 137; COBALT 58; STRONTIUM 85

<366>
Duckworth, G.H., Jr., Arizona Nuclear Power Project.

Palo Verde Nuclear Generating Station Low-Level Radwaste Management. (3)

Waste Management and Fuel Cycles '78, R.G. Post (Ed.), Proceedings of a Symposium, Tucson, AZ, March 6-8, 1978, (pp. 263-266). (1978, March)

The Palo Verde Nuclear Generating Station (PVNGS) consists of 3 identical 1270 MWe pressurized water reactors (currently under construction). As the basic feature of the waste management program no liquids used in PVNGS operation will be discharged offsite. All radwaste will be collected, processed, recycled if possible, and unusable waste concentrated and permanently solidified in cement. The solidified wastes are then shipped to a Federally licensed burial ground in Nevada. Liquid radwastes are collected in a specialized drain system and routed to one of three 33,000 gallon hold-up tanks. Low dissolved solid waste is filtered, put through a resin adsorption and ion exchanger beds, and collected in recycle monitor tanks. High dissolved-solids waste is treated by an evaporator with decontamination factors ranging from 10(E+5) to 10(E+6). The

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cleaning solvent used in the laundry is recycled and purified within each machine. The waste sludge from the machines is processed with other solid waste. Concentrates from the liquid radwaste system are mixed with Portland cement in drums or steel containers. Spent resins are held for 30 days of radioactive decay and then fed into the solidification system. Gas radwaste is collected and held in a decay tank for 45 days before discharging. Occupational exposure from this type of operation is expected to run 61.6 man-rem and offsite exposures are expected to be low also. (MDV)

ADSORPTION; CEMENTS; DECONTAMINATION; DECONTAMINATION FACTORS; DRUMS; EVAPORATION; EXPOSURE RATE; IMMOBILIZATION; ION EXCHANGE; RESINS; WASTE MANAGEMENT; WASTES, RADIOACTIVE; REACTORS, PRESSURIZED WATER; FIELD STUDIES

<367>
Smelity, L.A., C.W. Christenson, and E.B. Fowler, Los Alamos Scientific Laboratory, Los Alamos, NM.

Disposal of Americium 241-Plutonium 239 Raffinate Solutions by Fixation with Cement. (4)

LA-3150-MS; 20 pp. (1965, March)

This report presents a general review of the experimental procedures used and results obtained in determining the acceptable solidification procedures to be utilized for a raffinate waste containing 0.1-1.0 mg of americium 241 per liter and 1.0 mg of plutonium 239 per liter. High nitric acid content presented a problem in producing an acceptable grade mortar. Experiments indicate that a 50% caustic solution is required to neutralize the waste. Twenty gallons neutralized waste was put into 55 gallon steel burial drums which were filled with Portland cement, 9 lbs. of exfoliated vermiculite, and 2 halves of a standard brick (added to improve mixing). The drums were tumbled for 15 minutes and allowed to "set" for 24 hours. The activity of the mortar ranged from 11.2 X 10(E+6) to 2160 X 10(E+6) cpm, with an average of 167 X 10(E+6) cpm. This mixture produced an acceptable grade mortar. Leach test studies indicate a decreasing leach rate with respect to time. The total percent of the original leached within one year ranged from 0.001 to 0.2%. Total material cost per gallon of delivered waste was $0.98. (JT) (PTO)

In 1959 a raffinate waste containing 1 mg/liter plutonium and 0.1 to 1.0 mg/liter americium was delivered to the industrial waste section. Activity was too high to be handled by standard procedures. As a result, tests were carried out to determine feasibility of incorporating waste in cement. (DH/JT)

Am 241; Pu 239

WASTES, RADIOACTIVE; SOLIDIFICATION; CEMENTS; VERMICULITE; MONTMORILLONITE; CHANDALLITE; WASTE TREATMENT; LEACHING; FIXATION; AMERICIUM 241; PLUTONIUM; COST BENEFIT ANALYSIS; DRUMS; ENCAPSULATION; REVIEWS

<368>
Smelity, L.A., C.W. Christenson, and W.H. Kline, Argonne National Laboratory, Argonne, IL; Los Alamos Scientific Laboratory, Los Alamos, NM.

Operational Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes: Argonne and Los Alamos Laboratories. (3)

IAEA-SM-71/24; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965, (pp. 187-205), 988 pp. (IAEA-SM-71/24). (1966)

The "concentrate and contain" philosophy for treating radioactive wastes has been adopted at both the Argonne and Los Alamos Laboratories. Whereas at Argonne solids are compacted, packaged, and shipped off-site, at Los Alamos a sparsely populated region permits on-site burial. All liquid radioactive-waste solutions at the Argonne National Laboratory are analyzed for radioactivity after collection in tanks. When the concentration of activity is below recognized international limits, wastes are discharged to the sanitary sewer. When the concentration is excessive, wastes are directed to the processing building. The annual output is about 1000 cu m. At the processing plant, the methods used include evaporation and concentration, filtration and ion exchange, filtration only, flocculation, and absorption or entrainment in concrete. The evaporation-concentration system has been used to process the bulk of the liquid wastes. Treatment costs, encompassing all operations, vary from $3106-$5365/cu m. Low-level liquid wastes at the Los Alamos Scientific Laboratory are collected in separate sewer systems and delivered to two treatment sites. The volume processed is approximately 3800 cu m/month at the principal facility and 760 cu m/month at the outlying location. The main contaminant at both plants is Pu 230, but the concentration of fission products is increasing. Design data for the recently completed main plant, which incorporates coagulation, co-precipitation, and ion exchange for processing alpha, beta, and gamma active solutions, are discussed. Treatment at this site results in a decontamination factor of 100 and a volume reduction factor of 800. Respective factors for the smaller plant, at which the alpha activity is 50 to 100 times as high, are 2000 and 300. Precipitated sludges are concentrated, vacuum de-watered, and packaged for burial. Intermediate-level liquid wastes are treated batch-wise with the effort directed toward fixation in media which will resist leaching. Quantities up to 7.5 cu m/month of an acid americium-plutonium solution are incorporated in a cement-vermiculite mortar. Brief mention is made of other batch methods used which include the gelling of contaminated soils and incineration of liquid organic wastes. Liquid-waste treatment costs vary from $7.00 to $690/cu m. (Auth)

Discusses waste treatment facilities. Brief discussion of packaging and burial at these sites; hence, may be relevant to shallow land burial. (DH/GR)

WASTES, RADIOACTIVE; WASTE TREATMENT; WASTES, LIQUID; EVAPORATION; FILTRATION; ION EXCHANGE; FLOCCULATION; ABSORPTION; WASTES, SOLID; SOLIDIFICATION; BURIAL; COMPACTION; WASTE VOLUME; ECONOMICS; VOLUME REDUCTION; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; DECONTAMINATION FACTORS; FISSION PRODUCTS; PLUTONIUM 230; FIELD STUDIES

<369>
Farmer, W.J., M. Yang, J. Letey, and W.F. Spencer, University of California, Department of Soil Science and Agricultural Engineering, Riverside, CA.

Land Disposal of Hazardous Wastes Containing Hexachlorobenzene. (8)

CONF-760968; Disposal of Residues on Land, Proceeding of a National Conference, St. Louis, MO, September 13-15, 1976, (pp. 83-86), 216 pp. (CONF-760968).(1977)

Hexachlorobenzene (HCB) is present in industrial waste as a result of production of chlorinated solvents and is a registered fungicide. Disposal of HCB includes municipal landfills, land burial, lagooning, deep-well injection, and incineration. The primary means of dissipating HCB is by vapor phase transport. The effectiveness of various coverings, e.g., soil, water, and polyethylene, on HCB volatilization was determined. Compacted soil was found to reduce HCB fluxes from HCB containing wastes by 2 times. Water (1.83 cm) was found to reduce HCB flux by 10(E-3). Polyethylene (4-6 mil thickness) was showed to reduce flux by between 37-80%. The vapor diffusion rate was shown to be dependent on vapor density gradient and diffusion coefficient. Both factors were shown to increase with temperature. (JT)

Reviews the problems associated with the disposal of HCB and emphasizes the vapor phase transport problem. Directly applicable to shallow-land burial. (DR/JT)

HEXACHLOROBENZENE; TRANSPORTATION; SOILS; MOISTURE CONTENT; WATER; POLYETHYLENE; DENSITY; GASES; DIFFUSION; WASTES, NONRADIOACTIVE; WASTES, INDUSTRIAL; WASTE DISPOSAL; WASTE MANAGEMENT; SEALING; SEAL MATERIALS; FIELD STUDIES

<370>
Ferrigno, D.P., Gilbert/Commonwealth, Reading, PA.

Volume Reduction Processes in Light Water Reactor Radwaste Treatment. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 307-321), 1218 pp. (1979)

This paper addresses state-of-the art process equipment available to further reduce the quantity of radioactive waste shipped from an existing commercial nuclear power plant to the low-level burial site. Recognizing that the nuclear plant must be given a low-cost, high efficiency means to reduce the volume of radioactive waste shipped offsite, this paper reviews the economic and technical feasibility of installing a volume reduction system at an existing light water reactor. Realistic waste quantities from a two-unit pressurized water reactor are used to calculate the transportation, burial and in-plant solidification costs over a twenty-year period, with ten percent interest and ten percent escalation. Waste sources and quantities considered were evaporator bottoms (363 cu m total), resin slurry (28 cu m total), compacted trash (317 cu m), and probability wastes -- spent steam generator cleaning solution (229 cu m of NH3-EDTA at 10% by weight), primary decontamination solution (227 cu m at 10% by weight), and demineralizer regeneration waste during a primary to secondary leak (181 cu m). Systems studied were crystallization with solidification (polyester binder), fluid bed dryer with solidification (polyester binder), extruder/evaporator, and incineration with solidification (polyester binder). The overall conclusion is that these systems are technically capable of being installed in an existing structure and meet federal and local regulations in addition to plant technical specification limitations. Operation, maintenance, and capital backfit costs are compared to the potential operating savings when installing volume reduction equipment. The cost-saving ranges, which include annual and probability wastes, are $9.2 million to $16 million, not including a burial tax of $.10/lb, and $10.5 million to $19.3 million including the $.10/lb burial tax. The conservative review shows that available radwaste volume reduction equipment backfitted in an existing nuclear power plant is technically and economically feasible. (Auth) (LEH)

COST BENEFIT ANALYSIS; EQUIPMENT; COSTS; VOLUME REDUCTION; INCINERATION; SOLIDIFICATION; CRYSTALLIZATION; EVAPORATION; WASTE VOLUME; REGULATIONS, FEDERAL; REGULATIONS, STATE; WASTE MANAGEMENT; REACTORS, LIGHT-WATER; REVIEWS

<371>
Ferrigno, D.P., and D.P. White, Gilbert/Commonwealth, Reading, PA.

Feasibility of Radwaste Volume Reduction at the Three Mile Island Nuclear Generating Station. (3)

Power Generation, Proceedings of Pennsylvania Electric Association Committee Spring Meeting, Harrisburg, PA, May 5-6, 1977, (16 pp.).(1977, May)

Burial costs for radioactive waste have been increasing at an annual rate of 28% to 250%. Due to this inflation rate, a study was undertaken to assess the technical and economic feasibility of incorporating commercial volume reduction (VR) systems into the radwaste systems at Three Mile Island (TMI). The results indicate that the following VR systems are technically compatable: crystallization (forced-circulation evaporator), fluid bed dryer (anhydrous salt in a polyester binder), an extruder/evaporator (using bitumen) and incineration (calciner and incinerator). Economic evaluation was based on estimated waste quantities, projected operation and maintenance costs, solid waste packaging systems and burial cost projections. (JT)

A review of those volume reduction systems considered technically and economically compatable with the Three Mile Island Station system. No significant data are presented. (DR/JT)

WASTES, RADIOACTIVE; VOLUME REDUCTION; DRYING; EVAPORATORS; RESINS; INCINERATION; EVAPORATION; BURIAL; ACIDS; BITUMENS; WASTES, SOLID; COST BENEFIT ANALYSIS; SOLIDIFICATION; REVIEWS

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WASTE TREATMENT

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Fitzgerald, C.L., H.H. Godbee, R.E. Blanco, and W. Davis, Oak Ridge National Laboratory, Oak Ridge, TN.

The Feasibility of Incorporating Radioactive Waste in Asphalt or Polyethylene. (3)

Nuclear Applications and Technology 9:921-929. (1970, December)

Residues from aqueous and organic intermediate-level radioactive waste can be incorporated in asphalt or polyethylene to reduce the mobility of radionuclides subsequent to burial. Asphalt or polyethylene products containing up to 50 wt % of nonoxidizing inorganic solids have a chemical resistance similar to that of pure asphalt or polyethylene. Leach solids have a chemical resistance similar to that of pure asphalt or polyethylene. Leach rates from leachability tests are presented in tabular form and in grams per square centimeter per day units. Leach rates projected over 200 years indicate that approximately 5 percent of a relatively soluble radionuclide such as Na 22 or Cs 137 or less than 1% of a relatively insoluble radionuclide such as Ru 106 would be leached from a 55 gallon drum submerged in water. Polyethylene was shown to accomodate up to 50 wt % of organic liquids such as tributyl phosphate (TBP), while asphalt was not shown to be capable of tolerating 25 wt % of TBP satisfactorily. The polyethylene process was shown to be superior to the asphalt in flammability and radiation stability tests. Incorporating of wastes containing oxidants into asphalt appears inadvisable. (Auth) (JC)

Report contains some relatively rare polyethylene leachability data. (DH/JC)

WASTES, RADIOACTIVE; WASTE PROCESSING; WASTE DISPOSAL; BURIAL; ASPHALTS; POLYETHYLENE; SOLIDIFICATION; LEACHING; LEACHATES; BITUMENS; TRIBUTYL PHOSPHATE; IMMOBILIZATION; LABORATORY STUDIES

<373>
Foldes, E., and H. Stark, Institut fur Radiochemie, Technische Hochschule Munchen, Munich, German Federal Republic.

The Institute for Radiochemistry and the Research Reactor FRM Evaporation Plant for Treating Low- and Intermediate-Level Liquid Radioactive Wastes. (8)

IAEA-SM-71/6; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965, (pp. 175-185), 988 pp. (1966)

In 1964 a two-stage evaporation plant for treating radioactive liquid wastes was built on the grounds of the research reactor FRM, Munich. The dimensions of this plant are such that all low- and intermediate-level liquid wastes, both from the reactor and from the Institute for Radiochemistry, can be evaporated. The first stage of concentration is carried out by a forced-circulation evaporator with a throughput of 250 liters/h by 50-kW thermal current consumption. This electrically and steam-heated evaporator is equipped with cyclone separator and a compressor to transfer the vapor in superheated steam. The second stage is a film evaporator with a stirring gear to get a high degree of concentration (50-70% solids in concentrate). For final storage these highly-concentrated intermediate-level wastes will be fired in bitumen. The evaporation plant was designed and constructed by the Pintsch-Bamag Company, Federal Republic of Germany. After the plant was completed, some technical investigations were made concerning capacity, heat transfer, and efficiency of the forced-circulation evaporator by various experimental conditions. In this way the variation of the number of rotations, the influence of the encrustations, and variations of temperature and pressure differences were studied. The decontamination factors (D.F.) of the evaporation plant are of main interest. Therefore, some experiments with intermediate-level activities of Na 24 and I 128 were performed. The evaporation experiments with 0.1-0.2 Ci Na 24 activities were used to determine the D.F. at various points of the evaporation system; the test indicated a D.F. of 10(E+6) between feed and condensate. The evaporation tests with iodine required 10-20 Ci I 128 activities to determine the D.F. during some hours, because of the short half-life (25 min) of this isotope. In these experiments the relationship between the D.F. and the pH-conditions was especially studied. In the region of pH 8 to pH 4.0, the D.F. values were between 10(E+5) and 10(E+6); with lower pH values the D.F. decreased rapidly. The advantage of the short-lived I 128 activity is that it does not leave any radioactive waste behind and the plant can be used immediately afterwards. The results obtained showed that the plant is suitable for the evaporation of radioactive liquid wastes. (Auth)

Evaporator concentate must be solidified for burial; hence, indirectly relevant to shallow land burial. (DH/GR)

EVAPORATION; WASTE TREATMENT; DECONTAMINATION FACTORS; EVAPORATORS; WASTES, LIQUID; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; BITUMENS; PLANTS, WASTE TREATMENT; LABORATORY STUDIES

<374>
Francioni, W.M., and J.W. Crabbs (Translator), Federal Institute for Reactor Research, Wuerlingen, Switzerland.

Pilot Incineration Plant for Solid, Combustible and Low-Level Wastes. (8)

ORNL-tr-4510; EIR-299; 34 pp. (1976, May)

A pilot plant for incineration of lo. level, combustible waste is described. The radwastes are derived from the Federal Institute for Reactor Research (FIRR), hospitals, sanitoria, and nuclear power plants. Such treatment of the wastes will allow the maximum possible volume reduction and the ashes can be consolidated in a stable block for long-term storage. The plant will handle low-level wastes, alpha wastes-especially plutonium containing wastes, and the capacity will be 25-30 kg/hr. Expected fuels are plastics, cotton, paper, rubber, neoprene, and wood. The caloric value will vary between 2,700 and 10,000 kcal/kg. A complete description of the plant, the workings, and the licensing is provided. (NDV)

<374> CONT.
WASTES, LOW-LEVEL; INCINERATION; WASTES, SOLID; ASHES; EXHAUST GASES; FILTERS; PLANTS, WASTE TREATMENT; WASTE TREATMENT; VOLUME REDUCTION; FIELD STUDIES

<375>
Franz, J.A., and L.L. Burger, Battelle-Pacific Northwest Laboratories, Richland, Wa.

Polymeric Media for Tritium Fixation. (A)

BNWL-B-430; 28 pp. (1975, May)

The synthesis and leach testing of bakelite, polyacrylonitrile, and polystyrene for the fixation of tritium are presented in this report. In order to study the synthesis scheme and to study the properties of the polymers to be used for fixation, samples of phenolic resins, polyacrylonitrile, and hydrogenated polystyrene were prepared. The results of leach tests run using tracer quantities of tritium showed negligible release quantities after preliminary rinsing. The tests performed for this study indicate that only polystyrene and the phenolic resins warrant study in view of process feasibility, product properties, and cost. The thermal and radiation stability of the polymers is also discussed. Cost estimates for use of the polymeric media is compared in tabular form with other fixation and storage alternatives. (JC)

Report is geared mostly towards process descriptions. The leach data are not reported in International Atomic Energy Agency standard format. (DH/JC)

FIXATION; SOLIDIFICATION; TRITIUM; POLYMERS; RESINS; CONCRETES; COST BENEFIT ANALYSIS; ENCAPSULATION; LABORATORY STUDIES

<376>
Gaudernack, B., and J.E. Lundby, Institut for Atomenergi, Kjeller, Norway.

Waste Treatment at the Institute for Atomic Energy, Kjeller. (A)

CONF-651202; IAEA-SM-71/22; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 147-161), 988 pp. (1966)

The facilities of the Institute for Atomic Energy, Kjeller, include two research reactors, laboratories for radioisotope production, chemical and metallurgical "hot" laboratories, a small reprocessing pilot plant, etc. The operation of these facilities creates radioactive waste products of different categories. After monitoring, some of the low-activity liquid effluent is released directly into the River Nitelva, in the neighborhood of the Institute. The maximum release permitted by the authorities is, for the time being, 0.5 Ci (weighted) per 30 d. This will be extended to 2 Ci (weighted) per 30 d after the completion of a special effluent rerelease line now under construction. The remaining low- and intermediate-level liquid wastes are treated in a waste-treatment plant before release or storage. Most of the low-level waste can be purified conveniently by ion exchange. Separate beds of synthetic cation and anion exchange resins are used for this purpose. Some isotopes are absorbed with high effciency (Cs, Sr), whereas others (Zr, Nb, Ru) are not efficiently removed in this process. By preceding the ion-exchange step with a flocculation treatment (addition of alum and adjustment of pH to 6.5), the over-all efficiency was considerably improved. When saturated, the ion-exchange resins are regenerated by means of nitric acid and sodium hydroxide. The regenerant solutions are mixed, concentrated by evaporation, and solidified by the addition of Portland cement. The same procedure is used for intermediate-level wastes from the reprocessing pilot plant and other laboratories. Some waste solutions, not suited for evaporation, are solidified directly. Solid wastes are collected and cast into concrete in drums or blocks. When possible, the volume is reduced by means of a hydraulic press. The waste-treatment plant at Kjeller has been in operation since 1962, and the experience obtained so far is discussed. The cost of treating some of the waste types has been calculated. The amounts of liquid waste needing treatment are relatively small, resulting in batch-wise plant operation. All solid waste (including solidified liquids) is at present stored on the site of the Institute. The final method of storage or disposal has not yet been decided. (Auth)

Describes waste treatment at Kjeller. Some description of solidified waste, otherwise not directly applicable to shallow land burial. (DH/GB)

WASTES, RADIOACTIVE; WASTE TREATMENT; WASTES, LIQUID; WASTES, SOLID; WASTES, GASEOUS; ION EXCHANGE; EVAPORATION; COAGULATION; SOLIDIFICATION; FUEL REPROCESSING; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; CEMENTS; FLOCCULATION; VOLUME REDUCTION; PLANTS, WASTE TREATMENT; REVIEWS

<377>
Geswein, A.J., U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

Liners for Land Disposal Sites - An Assessment. (J)

SW-137; 6 pp. (1975)

A relatively recent development in sanitary landfill design technology is the use of barriers to inhibit the movement of leachate into ground and surface water. Many materials have been proposed and used as barriers to live land disposal sites. They include conventional paving asphalts, hot sprayed asphalt, asphalt sealed fabric, polyethylene, polyvinyl chloride, butyl rubber, hypalon, ethylene propylene diene monomer, chlorinated polyethylene, compacted clay, and mixtures of native soil with either montmorillonite or cement. Almost all of these materials have been used successfully at one or more land disposal sites. A brief discussion of some of the sites, material properties, construction methods (subgrade preparation, liner installation, and line protection), costs, future materials, and leak detection is given. For each liner material a construction specification is included. Only materials that could be used

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to collect leachate are given. The leachate that is collected must be removed from the base of the sanitary landfill for treatment or recirculation. Because none of the proposed materials has been judged superior to another, cost is likely a determining factor in the selection of suitable liners. (HAF)

LINERS; WASTES, NONRADIOACTIVE; SANITARY LANDFILLS; LEACHATES; ASPHALTS; CEMENTS; MONTMORILLONITE; SOILS; CLAYS; POLYMERS; COSTS; LEAKAGE; REVIEWS

<378>
Godbee, H.W., and D.S. Joy, Oak Ridge National Laboratory, Oak Ridge, TN.

Assessment of the Loss of Radioactive Isotopes from Waste Solids to the Environment. Part 1: Background and Theory. (1)

ORNL-TM-4333; 62 pp.(1974, February)

Assessments of the amounts of radioactivity from waste solids that enter the environment are needed for engineering, economic, and safety evaluations of proposed waste treatment, storage, transport, and disposal systems. Nearly all progress on the incorporation of radioactive wastes in solid media have included studies to determine the time dependency of losses from the products formed. Frequently, recourse has been made to empirical and semi-empirical relations in order to transpose the experimental data to a broad spectrum of real situations and to extrapolate these results. However, too much reliance on empirical and semi-empirical relations tends to obscure an understanding of the fundamental mass transport through waste solids, is hopelessly complicated, and not amenable to treatment by established mass transport theory. In view of the foregoing, this report presents several theoretical expressions based on mass transport phenomena that relate the radioactivity escaping from such solids to diffusion, dissolution processes, surface conditions, and radioactive decay. Representative available data for radioactive waste solids incorporated in cement, asphalt, ceramic, and glass media are analyzed using the theoretical expressions presented. These analyses show that an expression taking into account diffusion and concentration-dependent dissolution gives good agreement with the data for most of the products considered. In the main, these products can be categorized as waste solids of low solubility incorporated in inert matrices. The effective diffusivities obtained are in the range of mid 10(E-17) to mid 10(E-12) square centimeter/second, the dissolution rate constants are in the range of high 10(E-9) to low 10(E-7)/sec, and the surface transfer constants are in the range of low 10(E-4) to low 10(E-3)/sec for the products analyzed. Once determined, such parameters can be used to compare various waste products and to estimate releases from these products in particular, long-term releases. (Auth)

The common misconceptions and problems associated with the interpretation of leachability data are presented and suggestions offered. The report contains a significant amount of curve fitting mathematical expressions to approximate dissolution, diffusion, and surface phenomena. (DH/JC)

WASTES, RADIOACTIVE; SOLIDIFICATION; LEACHATES; LEACHING; DIFFUSION; DISSOLUTION; RADIOACTIVE DECAY; BURIAL; CEMENTS; ASPHALTS; CERAMICS; GLASS; THEORETICAL STUDIES

<379>
Golinski, E., Z. Kziazak, J. Sarata, and H. Dziubachi, Institute of Nuclear Research, Radioactive Waste Disposal Department, Otwock-Swierk, Poland.

Results of Exploitation of a Pilot-Plant Installation for Bitumenization of Radioactive Sludges. (3)

INR-1498/XIII/C/R; 17 pp.(1974)

Results are discussed of exploitation of a pilot-plant installation for bitumenization of radioactive sludges of an efficiency of 25 l/h. In a time period of 20 month 120 cycles were carried out in which 60 cu m of 2.8% sludges from treatment of low-level waste by the phosphate-ferrocyanide method were solidified. The P-60 asphalt was used for bitumenization. The bitumenization products contained 5-13.5% of mineral substances. Their activity was in the range of 5 x 10(E-4) - 5 x 10(E-3) uCi/g for alpha emitters and 1.2 - 3.8 x 10(E-2) uCi/g for beta emitters. The process is briefly described. In the next year increased mineral content in the sludges (up to 15-20%) and in the bitumen (up to 25-30%) is expected due to increased efficiency of the centrifuging and filtering apparatus. The cost of incorporating sludge (from 1 cu m of waste) into bitumen is 84 zl and into cement 175 zl. (Auth) (NDV)

Waste Volume

BINDERS; BITUMENS; BITUMINIZATION; CEMENTS; EVAPORATION; EVAPORATORS; FILTRATION; IMMOBILIZATION; SOLIDIFICATION; ENCAPSULATION; METHODS; ECONOMICS; PLANTS, WASTE TREATMENT; RESINS; SLUDGES; VOLUME REDUCTION; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, LIQUID; LABORATORY STUDIES

<380>
Granlund, E.W., Pennsylvania State University, University Park, PA.

Incineration of Waste Liquid Scintillation Fluid. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 819-827), 1210 pp.(1979)

Incineration appears to be a logical method for disposal of the low-activity, flammable waste from liquid scintillation counting. An obvious advantage is that volume reduction is almost 100% (with the exception of the glass vials). No burial space is required, the organic solvent problem at burial sites is eliminated, and, if incineration is done at the institution generating the waste, transportation cost are eliminated. The simplest incineration method is open burning of the waste liquid; the main objection to this method is the generation of dense smoke,

<3990> CONT.
eliminating use of the method at institutions near populated areas or areas with air pollution control. An extension of the technique is to place the liquid in a pan (to ease handling and allow ash collection for examination) inside a conventional waste incinerator, using the burners and draft air to control the smoke. Using a class VI incinerator at the Central Biological Laboratories of Pennsylvania State University (PSU), little difference was observed in the burning rate of plastic vials containing scintillator and the plain scintillation fluid. The maximum burning rate (at which there was no visible smoke from the stack with all burners in operation) was 95 L/hr of waste fluid. However, burning at high rates for extended periods may overheat the incinerator, and specifications for individual units need to be checked. Glass vials did not lose their contents as quickly as the plastic ones and the burning rate was slower, with less smoke generation. One possible hazard noted was from exploding vials injuring personnel if the charging door is not closed immediately after loading. It was found that mixture of 40% sawdust in scintillation fluid slowed the burning rate by half and almost eliminated smoke. Other combustible absorbents could be used instead of sawdust to control the burning rate. If waste scintillation fluid is separated from the vials it can be burned as fuel in an incinerator or boiler. Waste has been burned experimentally at rates of 8-20 L/hr in a former steam boiler converted for research use at the PSU Combustion Laboratory. Some problems were encountered with clogged filters and lines, adding to the handling problems and labor costs of this method. It was also found that some types of scintillation fluid can be burned in a standard residential burner designed for #2 fuel oil. The waste was combined with the fuel oil; however, certain proportions resulted in gels, which could not be pumped. Incineration of liquid scintillation fluid appears to be a desirable disposal method with no significant radiological hazard. One or more of the methods investigated should be usable at most institutions. The additional handling of the waste required may increase the risk from fire and personnel exposure to toxic chemicals; there is also some atmospheric release of radiation, but only a very small fraction of permissable levels. (Auth) (LKM)

INCINERATION; SCINTILLATION COUNTERS; WASTES, LIQUID; VOLUME REDUCTION; METHODS; WASTES, LOW-LEVEL; WASTE PROCESSING; WASTE TREATMENT; WASTE DISPOSAL; WASTES, INSTITUTIONAL; LABORATORY STUDIES

<3981>
Harris, W.B., and M.S. Weinstein, U.S. Atomic Energy Commission, Industrial Hygiene Branch, New York, NY.

Open Field Burning of Low-Level Radioactive Contaminated Combustible Wastes. (2)

TID-7517 (Part 1A); Sanitary Engineering Aspects of the Atomic Energy Industry, Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 229-235) (TID-7517, Part 1A); American Industrial Hygiene Association Quarterly 17:388-390. (1956, October)

Combustible materials have been burned in large very costly incinerators, but with the expanding scope of the Atomic Energy Program this method is not the best. Upon examination of the nature of the waste materials some of the precautions seem to be unnecessary. It was decided to burn the low-level contaminated paper as if it were non-contaminated. Three tests were set up. In the first, 500 lbs were burned, in the second 8000 lbs, and in the third 13,500 lbs. For all cases a superficial examination of the meteorology was made and the height of the smoke plume was estimated. The weight was reduced by 66, 93, and 93% for cases 1, 2, and 3 respectively. The volume was reduced by 90% for both cases 2 and 3. Case 1 had an estimated recovered fallout of 3.26 uc. For case 2 it was 20 uc and case 3, 100 uc. Maximum fallout for all cases was 40,000 d/m/sq ft (Case 3) and the minimum was neglible (Case 1). Air contamination by gamma particles ranged from 1.4 to 3.2 uc/ml X 10(-12). The beta particles ranged from 1.4 to 8.0 uc/ml X 10(-12). The results of the three experiments indicated no biologically significant contamination either of the soil or of the air during incineration. If incineration of the type considered is carried out, then the volume and weight of materials to be disposed of will be significantly reduced. (NDV)

ASHES; BETA PARTICLES; FALLOUT; INCINERATION; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, SOLID; RADIATION, GAMMA; VOLUME REDUCTION; LABORATORY STUDIES

<3982>
Mecald, W.F., R.C. Roberts, and M.K. Williams, Mound Laboratory, Miamisburg, OH.

Development of Ultrafiltration and Inorganic Adsorbents for Reducing Volumes of Low-Level and Intermediate-Level Liquid Waste: July-September 1978. (2)

[illegible]-2566; 18 pp. (1978, October 31)

During the 4th quarter of 1978, tests of seven adsorbents were continued using the engineering column pilot plant. Low-level liquid waste was passed through the ultrafiltration (UF) pilot plant removing solids and most of the radioactivity. Samples were spiked with U 233, Np 237, or Pu 238, pH-adjusted, and passed through 2-in diameter engineering columns at flow rates of 50-220 ml/min. Best decontamination factors were obtained using bone char (952.86 for Np at pH 10 and 185.57 for U at pH 6.5) and IRA-939 resin (220.90 for Pu at pH 7.3). Other adsorbents tested were HSA-1, HSC-1, IR1010, AG1X8, and IRA-904. Flow rates were not observed to have significant effects on the results. Decontamination factors for a mixed resin bed column through which the combined raffinate streams from the engineering columns were passed were as high as 177.21 for U at pH 2.8, 666.24 for Np at pH 10, and 12.5 for Pu at pH 8.2. The UF system was shut down and cleaned in June; after cleaning total flux was found to be about 5 gal/min. Three closed-system concentration runs were made; in each case suspended solids increased from 35 mg/l initially to 3000 mg/l at the end of the run. Flux declined from 2-3 gal/min to 1-1.5 gal/min. The radiation level of the permeate (product) remained less than 10 dis/min/ml throughout, even when the solution in the recycle loop was over 5000 dis/min ml. The

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<382> CONT.
system was cleaned again, using only tap water and a sponge ball; it was demonstrated that this technique removes much of the fouling from the membranes, and greatly reduces the amount of downtime and detergent-contaminated solution resulting from the usual detergent cleanup. In another set of tests, UF membranes are being exposed to alpha radiation to determine if degradation occurs. The first experiment will measure viscosity changes in exposed and unexposed membranes which are dissolved in solvent; changes in viscosity will indicate changes in molecular weight of the polymer. This study should be completed next quarter, when determinations of water-flux and flux-rejection changes due to radiation will be made. Also included in this report are year-end summaries of inorganic adsorbent and UF milestones. (LKB)

pH

U 233; Np 237; Pu 238

ADSORBENTS; WASTES, LIQUID; WASTES, LOW-LEVEL; FILTRATION; FILTERS; DECONTAMINATION; DECONTAMINATION FACTORS; RESINS; DEGRADATION; POLYMERS; VISCOSITY; RADIATION EFFECTS; WASTE TREATMENT; BONE CHAR; LABORATORY STUDIES; SOLIDIFICATION; ENCAPSULATION

<383>
Hermann, E.R., and E.F. Gloyna, University of Texas, Sanitary Engineering Research Laboratory, Department of Civil Engineering, Austin, TX.

Summary of Investigation on the Removal of Radioisotopes from Waste Water by Oxidation Ponds. (2)

TID-7517 (Part 1A); Sanitary Engineering Aspects of the Atomic Energy Industry, Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 27-46) (TID-7517, Part 1A).(1956, October)

Oxidation ponds were used in laboratory and pilot-plant investigations to test the possibility of using these to concentrate certain radioactive isotopes and stabilize putrescible wastes. The value of using the oxidation ponds lies in the effects of biochemical processes, chemical precipitation and ion exchange in combination with relatively long detention periods. The radionuclides involved in the study were P 32, I 131, Cs 137, Sr 89, Sr 90, Ce 141, and an aged fission product. Biological activity and stable phosphorus controlled the amount of P 32 removed. When the waste solution was free of silt and clay, Cs 137 was readily removed. While the decontamination factor of Sr 89 and Sr 90 was 1.5, it is encouraging to note that the uptake is partly dependent on the biological population. For Ce 141, a decontamination factor of 20 is obtained and is dependent on the number of organisms and the rate of growth. The pH also affected the removal of Ce 141. A decontamination factor of 5 can be had in oxidation ponds for aged fission products when a dosing cycle is used on a period of once every 10 days. The primary advantage of using oxidation ponds as a storage and treatment device is to equalize the count in the effluent and also remove some radioisotopes. The most economical filter of the algae were the coarse grades diatomaceous earth. Chemical coagulation was found to cost 3 cents/1000 gallons and the sludge concentrate still needed further filtration adding 2 cents/100 gallons to the cost. Tests were run to determine the operating criteria for the oxidation ponds: light, temperature, surface agitation, depth, recirculation, and detention. Evaporation in hot, dry areas will increase the retention time of the wastes due to evaporation. (HDV)

P 32; I 131; Cs 137; Sr 89; Sr 90; Ce 141

COAGULATION; CONTAMINANTS; COST BENEFIT ANALYSIS; DECONTAMINATION; DIATOMACEOUS EARTH; ECOSYSTEMS, AQUATIC; FILTRATION; FISSION PRODUCTS; ION EXCHANGE; LABORATORY STUDIES; MICROORGANISMS; OXYGEN; pH; PLANTS, WASTE TREATMENT; PRECIPITATION, CHEMICAL; PONDS; EVAPORATION; WASTE MANAGEMENT; WASTE TREATMENT; UPTAKE; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; DECONTAMINATION FACTORS; VOLUME REDUCTION; ECOLOGICAL STUDIES

<384>
Hild, W., W. Klager, and H. Krause, Gesellschaft fur Kernforschung mbH, Karlsruhe, German Federal Republic.

Bituminization of Radioactive Wastes at the Nuclear Research Center, Karlsruhe. (3)

CONF-741017; American Nuclear Society Winter Meeting, Washington, D.C., October 27-31, 1974, (pp. 206) (CONF-741017); Transactions of the American Nuclear Society, 19, 206.(1974)

The operation of a self-cleaning screw-extruder-evaporator in the Karlsruhe Nuclear Research Center bituminization plant is discussed. It is operated at 200 degree C and has the evaporation capacity of about 140 kg H2O/hour at very low residence times (2 to 3 min) and low material holdup. The apparatus concurrently is homogeneously mixing and coating the radioactive salt residues and efficiently evaporating the water contained in the evaporator concentrates. In the past two years more than 1000 drums were filled with bitumen products (50 wt%; final humidity less than or equal to 0.5 wt%). These products contained 80,000 Ci fission products from more than 25,000 cu m low- and intermediate-level radioactive effluents. Disposal is in the Asse salt mine. A bench scale screw-extruder unit is used to guarantee the production of bitumen products of the same characteristics as those in the full-scale plant. Also, this has been used for determining the optimum conditions for power reactor wastes, concentrates containing chemically and thermally instable compounds. Bituminization is a safe and effective means for the solidification of low- and intermediate-level radwaste. (HDV)

Waste Volume

BITUMENS; BITUMINOUS MATERIALS; BURIAL; EVAPORATORS; EVAPORATOR CONCENTRATE; FIELD STUDIES; FISSION PRODUCTS; QUALITY ASSURANCE; WASTE TREATMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; BITUMINIZATION

<385>
Hofstatter, K., J. Glock, and H. Jakusch, Schoeller-Blecksmann Stahlwerke AG, Vienna, Austria.

<385> CONT.
Process and Equipment for Treating Radioactive or Toxic Waste Waters. (3)

German Patent No. 23 04 901; OLS-73-204; 7 pp. (1976; 1974)

A method for treating low- and intermediate-level liquid radwastes is described. The liquid wastes would first be evaporated by a thin-layer evaporator with a rotating drum and fixed blades. Solids produced in this process would then be sent to a vessel where a hot binder such as bitumen would encapsulate the solids. The solids would not be mixed in, but settle down through the bitumen under gravity. This method allows complete encapsulation of each solid particle and overall homogeneous appearance of the bitumen block when it is cooled. As well as being a better method for producing a less leachable block, the method also reduces the cost and amount of equipment required. A flow sheet of the process is provided. (NDV)

BITUMENS; ECONOMICS; EVAPORATION; EVAPORATOR CONCENTRATE; FIXATION; PATENTS; WASTE TREATMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, LOW-LEVEL; ENCAPSULATION; VOLUME REDUCTION; SOLIDIFICATION; LABORATORY STUDIES

<386>
Hutchinson, J.P., C.W. Christenson, and E.R. Mathews, Los Alamos Scientific Laboratory, Los Alamos, NM.

Treatment of Wastes Containing Radioactive Barium, Lanthanum, Strontium and Yttrium. (3)

TID-7517 (Part 1A); Sanitary Engineering Aspects of the Atomic Energy Industry, Proceedings of a Seminar, Cincinnati, OH, December 6-9, 1955, (pp. 310-322) (TID-7517 Part 1A). (1956, October)

A discussion of the treatment of radioactive wastes at Los Alamos Laboratories is presented. Treatment consists of two stages. Due to their relatively short half-lives, Ba 140 and La 140 are treated through storage. Other radionuclides, the major one being Sr 90 with a half-life of 58 days, are removed by passage through a cation exchange resin column. The paper goes on to discuss the planning and implementation of the treatment facilities at Los Alamos. First, the composition of the waste is examined (data are presented in a table). Next, the various possible treatment methods were investigated, resulting in the choice of ion exchange. The design (which includes a flow diagram) and operation of the facility are then examined. An analysis of the results of treatment is given. Finally, six conclusions are reached as a result of the plant's operation. (DD)

Very possibly outdated now. (DH/DLD)

Ion Exchange Capacity

Ba 140; La 140; Sr 89; Sr 90; Y 90; Pu 106; Cs 137

CATION EXCHANGE CAPACITY; CONCENTRATIONS; EFFLUENTS; FILTRATION; BETA PARTICLES; MAXIMUM PERMISSIBLE CONCENTRATION; WASTE TREATMENT; RESINS; CATIONS; PRECIPITATION, CHEMICAL; RADIOACTIVITY; VOLUME REDUCTION; REVIEWS

<387>
International Atomic Energy Agency, Vienna, Austria.

The Management of Radioactive Wastes Produced by Radioisotope Users. (3)

Safety Series No. 12; 58 pp. (1965)

The report was written, primarily, as a framework manual for radioisotope users. Emphasis is placed on the control of use and disposal of radioisotopes and contaminated wastes; the waste management practices; treatment procedures for non-routine wastes; and the methods of storage and containment of wastes. Storage and containment of radioactive wastes are discussed in terms of temporary storage, long-term storage, environmental containment (ground disposal), disposal into the sea, and monitoring requirements. Treatment methods for waste that are discussed include compression, incineration, evaporation, ion-exchange and biological processing. Ground disposal of radioactive wastes is considered to be long-term disposal if the site and method of burial have correctly selected. (JT)

The report deals only with wastes generated from radioisotope users. It is intended as a manual which provides a framework for waste control. Limited applicability to shallow-land burial. (DH/JT)

WASTES, RADIOACTIVE; WASTE MANAGEMENT; WASTE STORAGE; WASTE DISPOSAL; MAXIMUM PERMISSIBLE CONCENTRATION; EVAPORATION; COAGULATION; SOLIDIFICATION; WASTES, SOLID; WASTES, LIQUID; LICENSING; INCINERATION; COMPACTION; PARTITIONING; DILUTION; VOLUME REDUCTION; DECONTAMINATION FACTORS; BURIAL; REVIEWS

<388>
International Atomic Energy Agency, Vienna, Austria.

Final Product Conditioning. (2)

Technical Report Series No. 136; Use of Local Minerals in the Treatment of Radioactive Waste, Ch. 6, (pp. 67-70), 113 pp. (1972)

After exhaustion of their exchange capacity, inorganic ion exchangers must be prepared for storage or final disposal. There is no generally applicable treatment for these materials; the preferred method of conditioning depends upon the history of the exchanger in question and particularly on which method of disposal has been selected. After exhaustion of the exchange capacity of clinoptilolite in steel drums at the Idaho Chemical Processing Plant, the drums are capped and sealed, and buried in the ground along with other solid radioactive wastes. At Harwell (United Kingdom), spent vermiculite is discharged directly into shielded disposal containers. Spent exchangers can also be incorporated into bitumen or concrete, fixed in glasses, or have their leachability decreased by heat treatment. In addition to the use of minerals as ion exchangers in the treatment of low- and intermediate-level radioactive effluents, these materials can also be applied as conditioners in the processing of radioactive residues. The leach rates of radionuclides (such as Cs 137) for asphalt,

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WASTE TREATMENT

<389> CONT.
cement, and glasses can be lowered by the incorporation of certain natural materials. (AUTH)

Information pertinent to pre-burial waste processing is presented. (DH/AUTH)

ION EXCHANGE; WASTES, RADIOACTIVE; VOLUME REDUCTION; CLAYS; ZEOLITES; VERMICULITE; CLINOPTILOLITE; MINERALS; MONTMORILLONITE; TUFFS; MORDENITE; ILLITE; ASHES; CEMENTS; GLASS; ASPHALTS; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; REVIEWS

<389>
International Atomic Energy Agency, Vienna, Austria.

Plant Scale Applications. (2)

Technical Series No. 136; Use of Local Minerals in the Treatment of Radioactive Waste, Ch. 5, (pp. 57-66), 113 pp. (1972)

The principal techniques that have been considered at various installations for use of minerals on a plant scale can be broadly categorized under two headings: (1) use of minerals as ion exchangers in both the batch and column type of contacting devices, and (2) use of minerals as additives and product conditioners as well as barriers in disposal pits. For several years, a treatment system using a sludge blanket precipitator and vermiculite column was in operation at Harwell in the United Kingdom. This ion exchange treatment has been modified by use of a basket type centrifuge for which better results have been obtained. A vermiculite ion exchange unit has been in operation at Trombay, India for waste treatment since June, 1966. Waste water is decontaminated at the National Reactor Testing Station in Idaho by a clinoptilolite exchange unit consisting of four columns in parallel, each column comprising two 200 liter mild steel drums connected in series. A number of clays are used at Oak Ridge National Laboratory as sorbents and conditioners in waste processing. Mordenite has been used at Battelle Northwest as a cesium sorbent in the cement mortar method of waste immobilization. Bentonite has been used on a non-routine basis to provide a waterproof barrier around burial solid wastes to reduce the leaching of radionuclides. Pelagonite tuff has been used in the Federal Republic of Germany for decontamination of chemical laboratory effluents. Pilot plant studies utilizing a number of minerals have been carried out in Czechoslovakia, but the industrial plant scale use of natural minerals for liquid waste treatment has been limited to barite. (AUTH)

Information pertinent to pre-burial waste processing and waste containment is presented. (DH/AUTH)

MINERALS; ION EXCHANGE; ZEOLITES; CLAYS; PELAGONITE; TUFFS; BENTONITE; MORDENITE; BARITE; ILLITE; ATTAPULGITE; WASTES, RADIOACTIVE; CLINOPTILOLITE; VOLUME REDUCTION; WASTE TREATMENT; PLANTS, WASTE TREATMENT; REVIEWS

<390>
International Atomic Energy Agency, Vienna, Austria.

Natural Materials for Radioactive Waste Management. (2)

Technical Report Series No. 136; Use of Local Minerals in the Treatment of Radioactive Waste, (pp. 3-33), 113 pp. (1972)

Minerals can remove radionuclides from radioactive liquid waste solutions by (1) distribution of the radioactive microcomponent between solid and liquid phases, (2) coprecipitation, (3) coagulation and flocculation of colloids, (4) adsorption from the solutions, (5) ion exchange reactions, (6) mineral replacement reactions, and (7) oxidation-reduction reactions. A detailed description of each is included in the text. Many minerals can exhibit one or more of the useful sorption or chemical reactions. Although an over-simplification, a useful guide to the selection of minerals for radioactive waste treatment is that the minerals should be ionic solids capable of forming insoluble compounds with alkali or alkaline earth cations. The classes of minerals of use in waste treatment are silicates (clays, zeolites), oxides (aluminum oxide, oxides and hydroxides of manganese), halides (fluoride, cryolite), carbonates (calcite, dolomite, siderite), phosphates (apatite, variscite), and sulfates (barite). A great deal of work has been performed using clay minerals and zeolites as waste treatment media. Unlike the other mineral classes in which coprecipitation and isomorphous replacement are the major reactions involving radionuclides, these minerals are ion exchangers. (AUTH)

Information pertinent to pre-burial waste processing is presented. (DH/AUTH)

MINERALS; ADSORPTION; ADSORBENTS; ION EXCHANGE; IONIC PROCESSES; ZEOLITES; SILICATES; OXIDES; HALIDES; CARBONATES; PHOSPHATES; SULFATES; VOLUME REDUCTION; WASTE TREATMENT; WASTES, LIQUID; WASTES, RADIOACTIVE; COAGULATION; FLOCCULATION; PRECIPITATION, CHEMICAL; LABORATORY STUDIES

<391>
International Atomic Energy Agency, Vienna, Austria.

Use of Local Minerals in the Treatment of Radioactive Waste. (2)

Technical Report Series No. 136; 113 pp. (1972)

The decontamination of radioactive solutions by use of minerals is discussed. Included in the seven chapters is information on the kinds and properties of useful minerals, the possible mineral-waste solution reactions, mineral processing for waste treatment, plant scale applications, final product conditioning, and economic aspects of treatment. The three appendices include a list of natural materials useful in waste treatment, a section on the definition and determination of capacities of natural ion exchangers, and communications concerning national experience in various countries. (AUTH)

Information pertinent to pre-burial waste processing is presented. (DH/AUTH)

<391> CONT.
MINERALS; ADSORPTION; ADSORBENTS; ION EXCHANGE; IONIC PROCESSES; ZEOLITES; SILICATES; OXIDES; HALIDES; CARBONATES; PHOSPHATES; SULFATES; ECONOMICS; VOLUME REDUCTION; WASTE TREATMENT; LABORATORY STUDIES

<392>
International Atomic Energy Agency, Vienna, Austria.

Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes. (3)

CONF-651202; Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, 988 pp. (CONF-651202).(1966)

The Symposium on Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes dealt mainly with the practical aspects of low and intermediate-level solid and liquid waste treatment. Four papers of the 51 presented were regional reviews of pertinent studies entitled "General Management in the Treatment of Low- and Intermediate-Level Radioactive Wastes" (2 seminars), "Operating Experience with Existing Facilities" (3 seminars), "Treatment of Solid Wastes" (1 seminar), and "Special Techniques" (1 seminar). Thirty-three papers were selected for inclusion in the Shallow Land Burial data base. (LKH)

DESIGN; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTE MANAGEMENT; REVIEWS

<393>
Jacobs, D.G., U.S. Atomic Energy Commission.

Mineral Exchange Work at Oak Ridge National Laboratory. (2)

TID-7668; Use of Inorganic Exchange Materials for Radioactive Waste Treatment, D.E. Janison, et al (Eds.), Proceedings of a Working Meeting, Washington, DC, August 13-14, 1962. U.S. Atomic Energy Commission, Division of Technical Information, Washington, DC, (pp. 187-199), 238 pp. (TID-7668).(1963, January)

The first topic of mineral exchange work at Oak Ridge National Laboratory concerns the determination of exchange capacity for the Richfield sand. An average value of 6.96 meq/100 g was found. The strontium-calcium selectivity varies around 1.25 and appears to increase with increasing concentrations of sodium. Behavior of cesium and vermiculite systems, in particular the physical-chemical behavior of the layer-lattice silicates, is investigated. One way to achieve a collapsed lattice system is to pretreat vermiculite with K, which for low Cs concentrations is highly selected for removal. In this system increasing Cs concentrations lower the selectivity of Cs. Sodium-treated vermiculite shows a repressed replica of the K-treated vermiculite curve for low concentrations. This is probably a result of biotite impurities, since the improvement of Cs distribution coefficient is 2.7 times, which corresponds to 40% biotite. Once the edge sites are satisfied the lattice will collapse at a critical concentration, entrapping the Cs. The object of further experimentation is to be able to describe the system and use interlayer or edge fixation to obtain the highest removals. Pretreating vermiculite with K and running several columns with 0.5 M $NaNO_3$, the Cs Kd increased with decreasing exchange capacity and with an increasing number of collapsed lattice units. When K is present in the influent, the Cs Kd went through a maximum at 0.36 M K and then started decreasing. The effect of K addition increasing competition for external sites is less cesium desorbed. Similar results occur when ammonium, rubidium or cesium are added. In this system the breakthrough waves come closer together at the higher concentrations. Temperature studies on the system showed lower temperatures with a lower exchange capacity and higher Kd. Loading studies are planned for the future. (MDV)

Ion Exchange Capacity; Distribution Coefficient

SORPTION; BREAKTHROUGH DISTRIBUTION; DECONTAMINATION; DISTRIBUTION COEFFICIENT; CESIUM; ION EXCHANGE CAPACITY; LABORATORY STUDIES; LATTICE; LEACHING; POTASSIUM; FIXATION; TEMPERATURE; WASTE TREATMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; WASTES, LIQUID; SOLIDIFICATION; ENCAPSULATION

<394>
Jacobs, D.G., Oak Ridge National Laboratory, Oak Ridge, TN.

Cesium Exchange by Vermiculite. (3)

TID-7628; Ground Disposal of Radioactive Wastes, J.W. Morgan, Jr., et al (Eds.), Proceedings of a 2nd Conference, Chalk River, Canada, September 26-29, 1961, (pp. 282-300), 635 pp. (TID-7628).(1962, March)

A theoretical and experimental investigation of the sorption mechanism of Cs from low- and intermediate-level liquid radioactive waste streams by vermiculite revealed that high concentrations of Cs or K result in reduction of the (001) lattice spacing and interlayer entrapment of the cations. Below these concentrations, no lattice collapse occurs, sorption being by "edge fixation" only. It was shown that addition of potassium salts to the waste stream improved Cs sorption by converting the reaction mechanism from predominantly edge fixation to predominantly interlayer fixation. In the specific experiment conducted, optimum K concentration was between 10(E-1) and 10(E-2) M for a 0.5 M $NaNO_3$ solution containing the mass equivalent of 20 uc Cs 137/ml using Zonolite BO-3. This yielded Cs 137 Kd's of 44-925 ml/g. (LKH)

Distribution Coefficient

Cs 137

VERMICULITE; THEORETICAL STUDIES; LABORATORY STUDIES; SORPTION; CESIUM; POTASSIUM; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; SALTS; DISTRIBUTION COEFFICIENT; CLAYS; LATTICE

<395>
Jakusch, H., K. Knotik, J. Zeger, and C.E. Schilling (Translator), United High-Grade Steel Works, Research and Development, Nuclear Engineering and Special Purpose Mechanical

<395>

WASTE T ..FMENT

<395> CONT.
Engineering, Seibersdorf, Austria; Institute for Chemistry of the Austrian Atomic Energy Studies Association at the Research Institute Seibersdorf, Seibersdorf, Austria.

New Developments in the Treatment of Radioactive Wastes with Asphalt. (J)

J and T 93(11):502-507; OLS-78-95A; 15 pp.(1976; 1978)

A new technology for handling the large quantities of low- and intermediate-level liquid radwastes produced by nuclear power reactors in Austria is presented. Asphalt is the principal material for solidification of concentrated solutions and slurries. The concentrates are dried, mixed with asphalt, allowed to sediment out in the cement, and finally placed in storage drums. Leaching experiments with distilled water displayed typical values of 10(E-4) g/sq cm.d. Thermoanalytical studies suggest that even nitrate-, and nitrite-bearing products containing Fe(+3) ions can be processed at temperatures up to 300 degrees C and stored without spontaneously catching fire during the process. (MDV)

Leaching Rate; Temperature

SOLIDIFICATION; ENCAPSULATION; ASPHALTS; EVAPORATION; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; LEACHING; TEMPERATURE; SLURRY; NITROGEN COMPOUNDS; LABORATORY STUDIES

<396>
Jamison, D.K. (Ed.), B.H. (Ed.) Kornegay, W.A. (Ed.) Vaughan, and J.M. Morgan, Jr. (Ed.), U.S. Atomic Energy Commission.

The Use of Inorganic Exchange Materials for Radioactive Waste Treatment. (J)

TID-7684; Proceedings of a Working Meeting, Washington, DC, August 13-14, 1962. U.S. Atomic Energy Commission, Division of Technical Information, Washington, DC; 239 pp. (TID-7684).(1963, January)

The proceedings of a conference on mineral exchange to fix low- and intermediate-radwaste products are presented. Institutions represented at the conference were the University of North Carolina, Oak Ridge National Laboratory, Hanford, National Reactor Testing Station, U.S. Geological Survey, and Chalk River Laboratory, Canada. Most of the work involved the use of clinoptilolite, but montmorillonite, kaolinite, and zeolites were also used in determining the behavior, physical and chemical, of layered silicates. Most of the studies presented were theoretical combined with laboratory work, only a few were actual site investigations. Each chapter in the proceedings is abstracted separately. (MDV)

SORPTION; MINERALS; CLAYS; CLINOPTILOLITE; CATION EXCHANGE CAPACITY; DECONTAMINATION; FIXATION; DISTRIBUTION COEFFICIENT; EQUATIONS; SOILS; IONS; MONTMORILLONITE; KAOLINITE; WASTE TREATMENT; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; SOLIDIFICATION; ENCAPSULATION; THEORETICAL STUDIES; LABORATORY STUDIES

<397>
Kershner, C.J., F.W. Bobrowicz, and R.E. Ellis, Mound Laboratory, Miamisburg, OH.

Tritiated Liquid Waste Decontamination (Molecular Excitation). (J)

MLM-2542; Tritium Waste Control: April - June 1978, (pp. 7-11), 22 pp. (MLM-2542).(1978, July 28)

A method for detritiation of low-level aqueous waste by selective molecular photoexcitation is being tested. Equipment is an infrared laser consisting of a LiNbO3 optical parametric oscillator (OPO) operating over a 2.9-4.2 um range, pumped by a Q-switched Nd:YAG oscillator-amplifier chain and a xenon ultraviolet flashlamp in an all-glass system. Reproducable conversions for 20-hour irradiations of 1:1 mixtures of H2O/(H2)2 at 15 torr and 25 pps were only 0.01%. Geometry of the flashlamp allowed only about 4% of the 10 J output to be utilized. A new photolysis cell, 1 cm X 5 cm, and a new flashlamp assembly were constructed to allow maximum exposure to the laser output. Preliminary results show a 2.4% conversion after 1 hour on a 1:1 H2O/(H2)2 mixture at 25 pps and 15 torr partial pressure, and a 29% conversion after 36 hours. Photon flux has been increased over three orders of magnitude. An irradiation of 1:1 (H2)2O/H2 mixture converted only 0.29% after 1 hour. Studies are being conducted to determine the mechanism for the increased H2 production (as much as 13 times that predicted thermodynamically) during irradiation. Use of an ArF excimer laser to increase the amount of radiation in the less than 195 nm region and permit more meaningful two-photon exchange experiments is planned. (LKM)

H 2; H 3

WASTES, LOW-LEVEL; WASTES, LIQUID; WASTES, RADIOACTIVE; WASTE TREATMENT; WATER; TRITIUM; ENRICHMENT; EQUIPMENT; ISOTOPES; ISOTOPIC SEPARATION; LABORATORY STUDIES; METHODS; DEUTERIUM; DETRITIATION; VOLUME REDUCTION

<398>
Kershner, C.J., R.E. Ellis, and F.W. Bobrowicz, Mound Laboratory, Miamisburg, OH.

Tritiated Liquid Waste Decontamination (Molecular Excitation). (J)

MLM-2851; Tritium Waste Control Project: October 1976 - March 1977, H.P. Anderson and C.J. Kershner (Eds.), (pp. 9-11), 27 pp. (MLM-2851).(1977, October 6)

A method for detritiation of low-level aqueous waste by selective molecular photoexcitation is being developed. Equipment is an infrared laser consisting of a LiNbO3 optical parametric oscillator (OPO) operating over a 2.9-4.2 um range, pumped by a Q-switched Nd:YAG oscillator-amplifier chain and a Xe ultraviolet flashlamp in an all-glass system. The scavenger and irradiation cell apparatus for the two-photon ISP system has been completed; the Xe flashlamp was adapted to the photolysis cell; modifications are being made to the laser power supply to correct a problem with the OPO due to degradation in isolator rejection. The rejection ratio of the isolator has been

<398> CONT.
found to be only 20:1; thus most of the amplifier power is bled off in a long (100*us) pulse before the Q-switch trigger, and power density is degraded below the threshold for optical parametric pumping. The H2O/H2 flow and reaction cell system was completed and the reaction flow meters calibrated. A quadrupole mass spectrometer was installed and a sampling port connected to the photolysis cell system. The spectral emissions characteristics of the uv flashlamp were determined using a Jobin Yvon HR52 monochromator with a 2400 g/mm grating, a RCA 8837 photomultiplier, and a Boloctron LP-20 gated integrating photometer. Radiation in the 185-195 nm range was obtained from the Xe flashlamp after replacing the supplied focusing lens with a suprasil lens; approximately 1% of the total energy is transmitted in this region. Only about 5% of the total 10 J output can be directly utilized; about 5 X 10(E+18) photons/sq cm per pulse at 190 nm will be available. Longer wavelength radiation from the flashlamp will be used in control experiments on H2O/H(H2)O mixtures. Objectives for the next reporting period are: (1) achievement of consistent OPO operation; (2) measurement of OPO tuning capabilities; (3) determination of "control" parameters such as exchange rates without irradiation and with uv irradiation only; and (4) initiation of two-photon ISP using H(H2)O. (LKH)

WASTES, LOW-LEVEL; WASTES, LIQUID; WASTES, RADIOACTIVE; WASTE TREATMENT; WATER; TRITIUM; ENRICHMENT; EQUIPMENT; ISOTOPIC SEPARATION; LABORATORY STUDIES; DETRITIATION

<399>
Khonikevich, A.A., M.P. Yakushev, I.L. Rybal'chenko, and A.V. Peimyakov.

Treatment of Liquid Radioactive Wastes at the Leningrad Station. (3)

OLS-78-139; 10 pp.; Isotopenpraxis 12(4):177-179.(1976, April; 1978)

Some of the aspects of decontamination of low level liquid radwastes at the Leningrad Station are elucidated. A three stage system using coagulation and precipitation, distillation, and ion exchange on resins is presented. Coagulation is accomplished by continuously adding ion sulphate solution at a pH of 10.5 to 11. For coprecipitation sodium phosphate and calcium chloride are used. The volume reduction factor is 150. The maximum capacity of the plant assuming 24 hr operation is 30,000 cu m/yr. Capital expenditures for the plant are 16.7 rbl./yr/1 cu m of treated water. An annual total operating cost is about 540.3 TRbl. The liquid concentrates are deposited in cement or asphalt. (HDV)

DECONTAMINATION; PLANTS, WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, LIQUID; COAGULATION; PRECIPITATION, CHEMICAL; DISTILLATION; ION EXCHANGE; EVAPORATION; VOLUME REDUCTION; pH; ECONOMICS; ASPHALTS; CEMENTS; FIELD STUDIES

<400>
Klingler, L.M., D.M. Batchelder, and E.L. Lewis, Mound Laboratory, Miamisburg, OH.

TRU Waste Cyclone Drum Incinerator and Treatment System: April-June 1978. (3)

MLM-2541; 18 pp.(1978, July 28)

The laboratory-scale cyclone incinerator at the Mound Facility operated throughout the April-June reporting period, testing a new lid assembly and a slip joint in the exhaust system. Solid wastes with activities less than 10 nCi/g were burned at an average rate of 35.1 kg/hr, up 9 kg/hr over last quarter. Preliminary data also indicated equipment life expectancies had increased. A spray dryer system is being tested for use in processing sludges from the off-gas treatment system. Tests of a vertical thin-film contact dryer are scheduled. A quality control program for the incinerator and treatment system was instituted this quarter. Evaluation tests of ash/cement matrices for TRU waste immobilization were completed this quarter. As in previous tests, wet-cured pellets had higher crush strengths, with the 80/20 ash/cement matrix performing best. The 60/35 matrix was best among dry-cured pellets. Data on incorporation of sodium metasilicate to improve dry-cured crush strengths are not complete yet. Thermogravimetric analyses have been completed, but the data are not yet available. An ash sintering process to reduce carbon contents to less than 0.10% has been successfully tested. (LKH)

Density

INCINERATION; CEMENTS; ASHES; DESIGN; EQUIPMENT; LABORATORY STUDIES; PHYSICAL PROPERTIES; SLUDGES; TRANSURANICS; WASTE TREATMENT; WASTES, RADIOACTIVE; WASTES, SOLID; WASTES, TRANSURANIC; MECHANICAL STRENGTH; WASTES, LOW-LEVEL; VOLUME REDUCTION

<401>
Klingler, L.M., D.M. Batchelder, and E.L. Lewis, Mound Laboratory, Miamisburg, OH.

TRU Waste Cyclone Drum Incinerator and Treatment System: January-March, 1978. (3)

MLM-2516; 14 pp.(1978, May 5)

Good combustion on all runs during January and February was achieved in the cyclone incinerator. Low-level solid radwaste was the fuel. Neutralization of acid gases in the flue gas stream by caustic scrubber solution results in high salt concentrations of scrubber liquor. The liquor will be treated in a pilot plant desalting and sludge handling system. Evaporation has been selected as the desalination technique. A new remotely controlled ash handling system and a new heat exchanger in the liquid scrubber system loop along with a new lid assembly are the improvements in the incinerator system. Refinements in the continuous feed operation are being considered because there is a tendency for the storage hopper to be bridged and the rotary valve to be jammed. Experiments were run to determine the best ash-cement matrix for pressed pellet immobilization. Both the dry-cure and wet-cure methods produce pellets with uniform compressive strength, density and final weight. However, the wet-cure method produces an ash-cement matrix with a higher compressive strength. Incineration and immobilization with the ash-cement matrix

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WASTE TREATMENT

<401> CONT.
reduces the weight of the radwaste 95% and the volume 99%. Wet-cured sludge-cement pellets had a higher compressive strength than did the dry-cured pellets. Studies of the elements and particle distribution in the sintered ash were also made. (HDV)

ASHES; CEMENTS; COMBUSTION; ACIDS; EVAPORATION; IMMOBILIZATION; INCINERATION; SLUDGES; VOLUME REDUCTION; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, RADIOACTIVE; SCRUBBERS; SOLIDIFICATION; ENCAPSULATION; LABORATORY STUDIES

<402>
Koehnstedt, P.L., J.N. Hartley, and D.K. Davis, Battelle-Pacific Northwest Laboratories, Richland, WA.

Use of Asphalt Emulsion Sealants to Contain Radon and Radium in Uranium Tailings. (T)

BNWL-2190; 50 pp. (1977, January)

Battelle Pacific Northwest Laboratories have been conducting a study of asphalt emulsions as a sealant for uranium mill tailings. Tests using tailings from the Vitro site in Salt Lake City, Utah and the United Nuclear Site in Ambrosia Lake, New Mexico found a 3.2 mm Arsak E-63 or Arsak 13 MP cationic asphalt emulsion seal to be very effective in preventing Rn diffusion. Rn diffusion was calculated to be 9 X 10(E-4) pCi/sq cm sec. A 6.4 mm Arsak E-63 seal prevented Rn, Ra, and F. penetration under 3.5 kg/sq cm (50 psi) pressure for 17 days. Integrity of the seal was unaffected by 0-72 degree F freeze/thaw cycles or by 100,000 R gamma radiation. U-V and O2 exposures produced some deterioration that could be avoided by a simple soil cover in the case of U-V, or by anaerobic burial (1.5 m or 0.8 m with highly humic soil). Microorganisms degrade asphalt at less than 0.008 mm/yr. Application of the asphalt emulsion with an airless spray system is the most satisfactory. (LFH)

Diffusion Coefficient

Rn 222; Ra 226

ASPHALTS; TAILINGS; URANIUM; SEAL MATERIALS; MILLS; RADIUM 226; RADON 222; METHODS; EVALUATION; LABORATORY STUDIES; WASTE MANAGEMENT; WASTE TREATMENT; WASTES, SOLID; WASTES, LOW-LEVEL

<403>
Koenst, J.W., W.R. Herald, and R.C. Roberts, Mound Laboratory, Miamisburg, OH.

Development of Ultrafiltration and Inorganic Adsorbents for Reducing Volumes of Low-Level and Intermediate-Level Liquid Waste: October-December 1977. (3)

MLM-2503; 13 pp. (1978, February 24)

Exposures of noncellulosic ultrafiltration membranes to a radioactive environment simulating up to 24 months of exposure to a beta dose of 10 uCi/cu cm and a gamma dose of 10(E-5) uCi/cu cm showed no effects on membrane performance. Some degradation did occur after a simulated six months exposure to an alpha dose of 8.9 X 10(E-3) uCi/cu cm. Experiments with a laboratory-scale reverse-osmosis unit using the product from ultrafiltration as feed yielded rejections of activity from 88 to 99%. A pilot run of the ultrafiltration system processed approximately 40,000 gal in 70 hrs of operating time without shutdown for cleaning. During the run, flux remained relatively steady within a range of 5-9 l/min. Gross alpha rejection was also steady, between 93 and 99.5%, depending on ionic content of the waste. Engineering column tests using U 233 with product from the ultra-filtration plant were continued with flow rates and pH being varied to determine optimum operating conditions. Various ion exchange resins were tested, and the best results were obtained with ESA-1 at pH 3-9. (LKH)

Activity Rejection

ADSORBENTS; RESINS; FILTERS; FILTRATION; ION EXCHANGE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, RADIOACTIVE; PLANTS, WASTE TREATMENT; METHODS; EQUIPMENT; ULTRAFILTRATION; BETA PARTICLES; RADIATION, GAMMA; MEMBRANES; DEGRADATION; RADIATION EFFECTS; PARTICLES, ALPHA; IRRADIATION; OSMOSIS; WASTE PROCESSING; FLOW RATE; pH; URANIUM 233; ACTIVITY REJECTION; LABORATORY STUDIES

<404>
Koenst, J.W., and R.C. Roberts, Mound Laboratory, Miamisburg, OH.

Evaluation of Ultrafiltration Membranes for Treating Low-Level Radioactive Contaminated Liquid Waste. (2)

MLM-2448; 11 pp. (1978, March)

Experiments have been conducted on alpha-contaminated low-level waste solutions from the Waste Disposal (WD) Facility at Mound Laboratory to determine the feasibility of ultrafiltration as a decontamination method. Romicon hollow fiber UF modules GM-80, XM-50, PM-30, PM-10, PM-5, and AM-2, with cutoffs from 80,000 to 2000 mol wt were tested individually. Solutions were fed through the modules at inlet pressures of 20-25 psig, blowdown rate was 2400-3300 ml/min, and flux rates averaged 65-250 ml/min/sq ft. It was shown that removal of radioactivity by membranes is dependent upon the nature of the waste stream; removal of suspended or colloidal material is high, while that of ionic material is not, as reflected by conductivity rejections. Rejection of radioactivity was 99-99.9% for laundry waste water, 85-88% for PP-Building decontamination water, and 90-97.7% for WD Facility influent (a mixture of waste solutions from Pu processing). Conductivity rejection was 0-76.8% for laundry waste water, 0-10.7% for decontamination water. Several runs were made using WD influent plus additives such as cationic polyelectrolytes, anionic polyelectrolytes, non-ionic polyelectrolytes, EDTA, sodium phosphate, laundry detergent, and citric acid, processed through filter PM-5 at pH 7.5-7.8. Additives showed no effect on rejection of radioactivity or conductivity. Tests using WD influent at pH's from 8-11 showed increase in radioactivity rejection at higher pH's, but data is insufficient at present. (LKH)

pH

<404> CONT.
WASTES, LOW-LEVEL; WASTES, LIQUID; FILTRATION; DECONTAMINATION; WASTE TREATMENT; LABORATORY STUDIES

<405>
Krause, H., Gesellschaft fur Kernforschung mbH, Karlsruhe, German Federal Republic.

Experiences in the Treatment of Radioactive Wastes. (3)

Kerntechnik, 19(8):171-179. (1977)

A general discussion on the methods of handling low- and medium-level radwastes is presented. For treatment liquid radwastes chemical precipitation, ion exchange, and evaporation have been and are being used. Chemical precipitation is good for treating low activity, strongly pollated effluents of high salt content. The decontamination factors, may range up to 10(E+3) but are typically 2 to 100. Ion exchangers work well when the effluent has a low salt content. Evaporation is the most effective, most universal, and the most expensive with decontamination factors of 10(E+4) to 10(E+6). Before the disposal of the effluents from the three processes above solidification must be done by either cementation, bituminization, or incorporation in plastics. The advantages and disadvantages of the three methods are briefly discussed. Tank storage for highly active fission product solutions is very satisfactory in spite of leakages in some of the earlier tanks. Highly active fission product solutions can be solidified by calcination or by converting them into glasses. The technique of first storing high-level wastes in tanks and then converting them into glasses appears promising. Compaction and incineration are two ways of treating solid radwastes. The ash would then be fixed in cement as would the compacted wastes. Those waters containing plutonium would require extra processing. (PDF)

ALPHA PARTICLES; ASHES; CEMENTS; CERAMICS; CLADDING; COMPACTION; CONCRETES; EVAPORATION; FISSION PRODUCTS; IMMOBILIZATION; INCINERATION; ION EXCHANGE; LEACHING; LEAKAGE; PACKAGING; PLASTICS; PRECIPITATION, CHEMICAL; SLUDGES; TANKS; WASTE TREATMENT; WASTES, HIGH-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, SOLID; DECONTAMINATION FACTORS; BITUMINIZATION; METHODS; REVIEWS

<406>
Krause, H., and G. Wentwich, Karlsruhe Nuclear Research Centre, Karlsruhe, German Federal Republic.

The Treatment of Low-Level and Medium-Level Liquid Radioactive Wastes at the Karlsruhe Nuclear Research Center. (4)

CONF-651202; IAEA-SM-71/48; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 317-337), 948 pp. (CONF-651202, IAEA-SM-71/48). (1966)

The Nuclear Research Centre at Karlsruhe at present has a semi-technical plant for the decontamination of radioactive waste water. It comprises a batch-operated precipitating plant with a throughput of some 25 cu m/d as well as an ion-exchange device consisting of six columns with a throughput of 3 cu m/h. In addition, there is a vapor compression evaporator of 1.3 cu m/h capacity and a film evaporator with a capacity of 150 liters/h. The waste-water, having activity concentrations less than 10(E-4) Ci/cu m, is generally treated by chemical precipitation. Ion exchange is provided for water having a very low salt content, e.g., from the reactor cycles. Occasionally, water which has not been sufficiently decontaminated by chemical precipitation is treated a second time by ion exchange. Above all, in the film evaporator the regenerating water of the ion exchangers, which is rich is salt, as well as the waste water collected in bottles at the laboratories, is evaporated. The concentrates having a salt content of 35-50% are mixed with cement by stirring in a volume ratio of 1:1. The water which comes from the waste-water collecting station has activity concentrations less than 10(E-4) Ci/cu m that are mostly concentrated in the vapor compression evaporator down to a salt content of 15-20%. The concentrates are stirred into hot bitumen. In the case of chemical precipitation a method of precipitation by using iron hydroxide/potassium phosphate is frequently used. If there are fission products present, this step is generally preceded by a nickel ferrocyanide precipitation. The decontamination factors attained by simple precipitation are between 2 and 30; by combined precipitation, they are several hundred. In the precipitation of 100 cu m of waste water 0.7-1 cu m of filter residues is produced. In the vapor compression evaporator, decontamination factors of 10(E+3) are attained. The energy requirements for the evaporation of 1 cu m of water are 35 kg of additional steam, 40 kW of electric energy, and 1 cu m of cooling water. (Auth)

Gives brief description of end product of solidifications. Otherwise not directly applicable to shallow land burial. (DM/GR)

WASTES, RADIOACTIVE; WASTES, LIQUID; WASTE TREATMENT; PRECIPITATION, CHEMICAL; ION EXCHANGE; EVAPORATION; BITUMINIZATION; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; DECONTAMINATION FACTORS; LABORATORY STUDIES

<407>
Kulichenko, V.V., P.S. Dukhovich, O.I. Volkova, M.V. Boyarinova, I.A. Sobolev, L.M. Khomichik, Yu. M. Bazhenov, A.I. (Ed.) Nazarova, and S.D. Blalock, Jr. (Translator), Academy of Sciences of the USSR, Moscow; Institute of Physical Chemistry, USSR; Moscow Radioactive Wastes Burial Station, Moscow, USSR.

The Fixation of Radioactive Wastes in Cement. (3)

ORNL-tr-4418; CONF-651202; KFK-tr-490; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Agency, Vienna, (pp. 1-12) (ORNL-tr-4418, CONF-651202, KFK-tr-490). (1966; 1976)

<807>

WASTE TREATMENT

<807> COST.
Leaching of Sr 90 and Cs 137 was studied with respect to cement-fixation. High emanations occurred no matter whether sodium nitrate (100 g/l) or ferrichydroxide was added to the cement. For Cs 137 the values were 2-12 x 10(E-2) g/sq cm/24h and 2-6 x 10(E-2) for Sr 90. In all cases 7.5% bentonite clay was added to the cement. When the specific activity level is less than 10(E-6) ci/l stable fixation of radioisotopes occurs and hydraulic insulation of buried grounds can be reduced. For activity levels greater than 10(E-6) Ci/l hydraulic insulation is required. Gas volumes were lower than for liquid at the high activity levels. Preliminary evaluation of the magnitude of radiation and gassing is vital for types of cement blocks when transferring to wastes with intermediate levels of activity. The fixation ratio (solution/concrete) was 0.75. (NDV)

Sr 90; Cs 137

SOLIDIFICATION; ENCAPSULATION; CEMENTS; WASTES, LIQUID; LEACHING; GASES; FIXATION; CONTAINMENT; WASTE TREATMENT; WASTES, LOW-LEVEL; LABORATORY STUDIES

<808>
Larsen, L.

Decontamination of Low-Level Radioactive Waste Water at Riso, the Danish Atomic Energy Commission Research Establishment. (E)

CONF-651202; IAEA-SM-71/49; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 291-302), 948 pp. (CONF-651202, IAEA-SM-71/49). (1966)

The low-level radioactive waste water treatment plant at Riso, Denmark utilized the evaporation method and has been operative for more than six years. The waste water is classified as: a) radioactive waste water, b) normally inactive waste water which may accidentally become radioactive and c) inactive sewage. Samples of the radioactive waste water are transported to the waste treatment station and evaporated, whereas samples of normally inactive water and inactive sewage are collected, evaporated, and counted. The evaporation plant consists of two storage tanks, a feed tank, a forced circulation type evaporator, two distillate tanks, two preconcentrate tanks, and a final evaporator. The forced circulation type evaporator, which makes the evaporation process difficult, has been overcome by use of an anti-foam agent which permits evaporation without foam. In the evaporation process, 0.800 Cu m is reduced to 1 Cu m. (JW)

Doesn't discuss shallow land burial at all, but does present an interesting and apparently effective method of treating low-level radioactive waste water. (ORNL/JW)

CONTAMINATION; TANKS; SLUDGES; pH; DECONTAMINATION; EVAPORATORS; VOLUME REDUCTION; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTES, LIQUID; EVAPORATION; LABORATORY STUDIES

<809>
Learmont, E.P., U.S. Steel Corporation, Pittsburgh, PA.

Method for the Removal of Radioactive Waste during In-Situ Leaching of Uranium. (E)

U.S. Patent 4,058,329; 8 pp. (1977, October 18)

A method for the removal of radium and other wastes from solution via ion exchange during in situ leaching of uranium is proposed. The method utilizes a sand pack containing barium salts, which remove Ra ions from the circulating leach solution before it reaches aboveground equipment. The equipment typically would consist of a 6-inch diameter pipe screened over the lower 40 feet and surrounded by a sand pack of 8 cm radial thickness, specific gravity 3.8 g/cu cm, and a void volume of 40%, composed of size-graded $BaSO_4$. Where the flow rate of a production well averaged about 60 gal per min, the superficial velocity of the leach solution through the sand pack was calculated at about 3 cm per min, providing 99+% Ra 226 reduction. $BaSO_4$ is preferred, but barium carbonate or other barium compounds may be employed. For maximum effectiveness the particles in the pack should be 10 mesh or below. This invention may also be used to surround injection wells to reduce the build-up of contamination in recirculated leach solutions. (LKH)

PATENTS; RADIUM; URANIUM; LEACHING; ION EXCHANGE; SALTS; BARIUM; WELLS, INJECTION; WASTES, RADIOACTIVE; EXTRACTION; THEORETICAL STUDIES

<810>
Lee, S.H., and W.J. Sung, Korea Atomic Energy Research Institute, Radioactive Waste Management Division.

Chemical Treatment of Low-Level Radioactive Liquid Wastes. 2. The Determination of Cation Exchange Capacity on Various Clay Minerals. (E)

Journal of the Korean Nuclear Society 9(2):75-81. (1977, June)

Experiments were carried out to determine the pH dependent cation exchange capacity concerning the sorption phenomenon of long-lived radionuclides contained in low-level liquid radwaste on several clay minerals. Sawhney's method was used for this series of experiments. The pH dependent CEC due to organic matter is the major contributor to the total CEC. For vermiculite 27% is due to organic matter, 30% for montmorillonite, 46% for clinoptilolite and 30% for sodalite. The fixation due to organic matter is considered reversible, so in clay minerals neutral salt CEC is believed to be true fixation. The amount of fixation due to neutral salt CEC accounts for up to 70% of the total CEC. Na-clinoptilolite, sodalite, vermiculite, and montmorillonite showed good efficiency in removing strontium and cesium. (NDV)

Ion Exchange Capacity; pH

SORPTION; ION EXCHANGE CAPACITY; CLINOPTILOLITE; VERMICULITE; SODALITE; pH; FIXATION; LABORATORY STUDIES; ORGANIC COMPOUNDS; WASTES, RADIOACTIVE; WASTE TREATMENT

<#11>
Lenneman, W.L. (Chairman), U.S. Atomic Energy Commission.

Incineration of Radioactive Solid Wastes. (1)

WASH-1160; 142 pp. (1970, August)

In order to assess the feasibility of incinerating low-level radioactive waste, a study was conducted to evaluate (a) the decrease in volume and (b) the procedures and techniques used to safely handle and store radioactive solid wastes. Investigations into incineration experience at AEC facilities, e.g., Rocky Flats, Los Alamos Scientific Laboratory, and Argonne National Laboratory; non-AEC facilities, e.g., Bureau of Mines and Nuclear Materials and Equipment Corporation; and foreign facilities, e.g., Chalk River, Ontario, Canada; Marcoule, France; and Hopewell, England, were conducted and summaries presented. The benefits associated with the incineration of combustible solid low-level radioactive waste include volume reduction (greater than 95%), conversion of residue into a non-combustible form, retrievability and reduction of land requirements. The report concludes that (a) incineration techniques in the U.S. are still medieval, (b) incineration is cost-effective for large volumes of waste, (c) fire-box and rotary kiln type incinerators can be effectively modified to burn radioactive waste, and (d) research and development for incineration of radioactive waste is required. (JT)

A review of the applicability of incineration of solid low-level radioactive wastes for the purpose of volume reduction. (DR/JT)

WASTES, RADIOACTIVE; WASTES, SOLID; INCINERATION; EQUIPMENT; PITS; COST BENEFIT ANALYSIS; WASTE TREATMENT; FILTRATION; SCRUBBERS; VOLUME REDUCTION; PARTICLES, AIRBORNE; WASTES, LOW-LEVEL; REVIEWS

<#12>
Lerch, R.E., W.O. Greenhalgh, J.A. Partridge, and G.L. Richardson, Hanford Engineering Development Laboratory, Westinghouse Hanford Company, Richland, WA.

Treatment and Immobilization of Intermediate-Level Radioactive Wastes. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 513-550), 1214 pp. (1979)

This paper discusses a new program underway at the Hanford Engineering Development Laboratory (HEDL) to develop and demonstrate treatment and immobilization technologies for intermediate-level wastes (ILW) generated in the nuclear fuel cycle. For comparative purposes, reference is also made to certain aspects of low-level wastes (LLW). Initial work has defined the sources, quantities, and types of wastes which comprise ILW. The various types of ILW have been grouped into categories amenable to similar treatment. The categories are: salt solutions, precipitates and slurries, surfactants/detergent solutions, organic liquids, wet particulates, dry particulates, combustible solids, noncombustible solids, and cartridge filters. Laboratory studies are underway to define treatment technologies for liquid ILW which contains volatile contaminants and to define immobilization parameters for the residues resulting from treatment of ILW. The program also includes development of acceptable test procedures for the final immobilized products as well as development of proposed criteria for storage, transportation, and disposal of the immobilized ILW. Test results of immobilization of $CaSO_4$ residue from acid digestion of combustible TRU wastes in cement are as follows: $CaSO_4$ content of mixtures ranged from 0 to 61 wt%; compressive strength = less than 1 to 168 kg/sq cm, abrasion loss (Los Angeles Abrasion Test) = 0.4-32.7 g/rev; maximum compressive strength and minimum abrasion loss was at a ratio of 5.4% $CaSO_4$, 26.3% H_2O, and 68.3% cement. Results of immobilization of anion exchange resin in cement are: resin content of mixtures = 0-52 wt%; compressive strength = less than 2 to 120 kg/sq cm; abrasion loss = 0.6-30 g/rev; maximum compressive strength and minimum abrasion loss in the resin/cement mixtures tested were 101 g/sq cm and 0.6 g/rev at a ratio of 25 wt% resin, 21 wt% H_2O, and 54 wt% cement. Immobilization in cement of cation exchange resin (mixtures of 0-57 wt% resin) yielded compressive strengths of less than 4 to 121 kg/sq cm and abrasion losses of 0.7-75 g/rev; maximum compressive strength with resin was 106 kg/sq cm at 6 wt% resin and at 25 wt% resin. Anion exchange resin was immobilized in urea-formaldehyde, bitumen, and cement and the resulting products were tested for mechanical strength. The results suggest that good strength urea-formaldehyde can be prepared containing as much as 68 wt% moist resin whereas a sample prepared with 75 wt% moist resin had a relatively low compression strength. All urea-formaldehyde products had free liquid present. A bitumen product containing 60 wt% resin was also prepared but, as expected, tended to flow at pressures above 5 kg/sq cm. It did exhibit excellent abrasion resistance. The cement sample had excellent product strength, but had the lowest packing efficiency (i.e., volume ratio of product to initial volume of resin) of all the waste products formed. Higher packing efficiencies have been obtained for cement-resin products, but at some sacrifice in compressive strength. (Auth) (LKM)

Compressive Strength; Abrasion Resistance

IMMOBILIZATION; WASTE TREATMENT; WASTE PROCESSING; WASTES, INTERMEDIATE-LEVEL; CEMENTS; PHYSICAL PROPERTIES; RESINS; FIXATION; RESIDUES; UREA FORMALDEHYDE; BITUMENS; BITUMINIZATION; CALCIUM COMPOUNDS; SULFATES; STRENGTH, COMPRESSIVE; STRENGTH, MECHANICAL; PROGRAMS, INDUSTRIAL; WASTE MANAGEMENT; WASTES, LOW-LEVEL; LABORATORY STUDIES

<#13>
Levi, H.W., and M. Melzer, Hahn-Meitner-Institut für Kernforschung, Berlin, German Federal Republic.

Some Recent Improvements in the Low-Level Liquid Effluent Treatment Process. (3)

CONF-651202; IAEA-SR-7/7; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 355-370), 948 pp. (CONF-651202,

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<813> CONT.
IAEA-SM-71/7).(1966)

The low-level liquid effluent treatment process at the Hahn-Meitner-Institute is designed for discontinuous operation. The normal treatment is iron phosphate precipitation sledge filtration and base exchange with "Filtrolit" for cesium removal. Ion exchange with resins is only used if it is not possible to achieve sufficient decontamination. Base exchange with "Filtrolit" was recently adopted at the Hahn-Meitner-Institute. "Filtrolit" is an inexpensive natural base exchanger containing several minerals. It shows a distinct selectivity for cesium, has reasonable volume capacity and can be used in columns with a high flow-rate. It was found to be an excellent material for low-level cesium removal from tap water. As mentioned above ion exchange resins are used only occasionally. Therefore, experiments were made to see if resins can be stored ready for use over a longer period of time. Strongly acid cation exchangers in the H^+ and Na^+ form and strongly basic anion exchangers in the Cl^- form show only a slight loss of capacity after a one-year period. With anion exchanges in the OH^--form and consequently with mixed beds a considerable decrease of capacity was observed. Usually the application of ion exchange resins can be restricted to cation exchanges. In some respects it is more convenient to use it in the Na^+ rather than in the H^+ form. No disadvantages have been observed. Some effort was made to optimize the regeneration of cation exchange resins. With a view to the corrosion risk in a subsequent concentration of spent regenerant by evaporation, $NaNO_3$ was chosen as regenerant instead of NaCl. Reasonable reduction of spent regenerant volume could be achieved by increasing the regenerant concentration with virtually no influence on the capacity and decontamination efficiency. The volume of rinsing water that needs to be treated as radioactive roughly equals the regenerant volume. Sludge filtration flocculation is carried out with a pressurized filter containing ceramic filter elements. The limiting factor of the volume reduction is the addition of a filter aid which is unavoidable with this filtration technique. Its application was carefully optimized with respect to the sort of filter aid, the amount and the mode of application. Celite has proved to be the most suitable material. (Auth)

Concerned mostly with analyzing ion exchange materials. Not relevant to shallow land burial. (DH/GB)

WASTES, LIQUID; WASTE TREATMENT; PRECIPITATION, CHEMICAL; SLUDGES; FILTRATION; ION EXCHANGE; ADSORPTION; RESINS; FLOCCULATION; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; VOLUME REDUCTION; EVAPORATION; DECONTAMINATION; PLANTS, WASTE TREATMENT; LABORATORY STUDIES

<814>
Lindar, F., AB Atomenergi, Studsvik, Sweden.

Final Disposal of Low-Level Wastes: When, Where, How? (3)

Health Physics 28(5):682.(1975, May)

By the year 1990 between 10,000 and 40,000 cu m of low-level wastes will be produced in the Nordic countries. When can the wastes be finally disposed, where shall it be disposed, and how should the waste be conditioned are questions that must be addressed. Possibilities for getting rid of wastes are on a city dump, controlled ground disposal, and sea disposal. Various methods can be combined in different ways depending on the activity content of the wastes at a station, location and size of the station, and the costs. Hence, clarification of the radiological and economical conditions for each process are required. Also some safety problems are considered. (NDV)

DISPOSAL SITE; WASTE MANAGEMENT; WASTE DISPOSAL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; WASTE VOLUME; THEORETICAL STUDIES

<815>
Lopez-Menchero, E., Eurochemic Company, Mol, Belgium.

Research and Development Work on the Treatment of Low- and Medium-Level Wastes in the European Nuclear Energy Agency Countries. (E)

CONF-651202; IAEA-SM-71/62; Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, Austria, (pp. 869-900), 988 pp. (CONF-651202, IAEA-SM-71/62).(1966)

The paper reviews research and development work that is (a) directed towards the treatment of low- and medium-level radioactive waste, but has not yet reached a stage suitable for coverage in paper describing treatment practices; and (b) related in a general way to the problems of waste treatment but is not being applied to their routine solution. The research work reported is described under the following headings. The separation of certain fission product cations by ion exchange: Work in this field deals with the relevant properties of naturally occurring ion exchange materials such as some Italian tuffs, and inorganic and organic substances in Netherland soils, and also with the improvement of natural materials, such as the treatment of inert silica sand with dilute hydrofluoric acid and a particle coating agent to increase the strontium uptake capacity. Synthetic inorganic ion exchangers like ferrocyanide, molybdate and polyantimonic acid are also covered. The separation of fission product cations by extraction or foaming techniques: The separation of Sr^{2+} by solvent extraction using DEHPA is included under this heading. A description is given of foam separation using the surfactant sodium dodecyl-benzene sulphonate as a technique for removing Cs^+, Sr^{2+}, and Ce^{3+} from very dilute solutions. The application of electrodialysis to demineralization: This work includes laboratory-scale investigations of the mass transfer mechanism in packed electro-deionization cells of ion exchangers (Deacidite FF and Zeo Karb 225) and also data from pilot plant experiments. The radiolytic stability of ion exchange resins: The review studies the degradation caused by alpha or gamma irradiation of commercial polystyrene-based resins with sulphonic or quaternary ammonium functional groups. (Auth)

Reviews research and development in waste

<a15> CONT.
treatment technology. Not directly applicable to shallow land burial. (DB/GE)

WASTES, RADIOACTIVE; ION EXCHANGE; SOLVENTS; RESINS; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; TUFFS; SOILS; SEPARATION PROCESSES; DEMINERALIZATION; VOLUME REDUCTION; REVIEWS

<a16>
Lathy, D.P., and W.H. Bond, Pound Laboratory, Plainsburg, ON.

Volume Reduction System for Solid and Liquid Transuranic Waste from the Nuclear Fuel Cycle: January-March 1977. (2)

NLR-2436; 9 pp.(1977, July)

During the first quarter of 1977 commercial facilities generating radioactive wastes were surveyed as to the types, volumes, contaminants, and general composition of their wastes; from this data the type and size of containers that should be used for solid wastes will be determined and waste acceptability for incineration and fixation evaluated. Burial ground regulations will be reviewed to identify methods of waste preparation required for each site. A system for burning a simulated waste extraction solvent (30% tributyl phosphate in kerosene) at a rate of about 5 gal/hr has been designed; fabrication and installation is expected by June, 1977. This system will provide design criteria for inclusion of a liquid feed option into the integrated incinerator system. Samples of sintered incinerator ash were analyzed for elemental content and for carbon before and after sintering. The relatively high Si, Al, and Ca oxide contents of the ash makes the glass the main candidate for immobilization studies. The results of leaching and heat exposure tests on glasses containing various amounts of borax and ash are given. Weight losses from leaching were 0.19-9.10% after 72 hrs for 18 samples containing 30-100% ash. Exposure to 900 degrees C for 1 hr produced no change or only slight softening in most samples. Ash/cement mixtures were studied as an alternative means of immobilization. Samples with 20-70 wt% ash content and variable water content were crush-tested and leached. A sample containing 5.3 uCi Pu 238 with a water/cement ratio of 1.7%, showed little or no Pu removed after 1 week of leaching. Pressed pellets were found to have greater crush strength than simple concrete cylinders; the process is slower and more expensive, however. A survey of compaction technology for empty waste drums found that only one company met the requirements necessary; results of a demonstration of the equipment indicate that DOT-17C drums can be compressed to a height of 8 in. and a diameter of 24 in. - a volume reduction of 80%. Designs for incorporation of drum compacting equipment into the cyclone incinerator system will be completed in 1977. (LKH)

Leaching Rate; Total Ion Concentration

Pu 238

INCINERATION; FIXATION; SOLVENTS; WASTES, ORGANIC; WASTES, LIQUID; ASHES; GLASS; IMMOBILIZATION; LEACHING; BORON COMPOUNDS; CEMENTS; COMPACTION; DRUMS; CONTAINERS; WASTES, SOLID; WASTES, LOW-LEVEL; EQUIPMENT; LABORATORY STUDIES

<a17>
Machida, C., A. Ito, A. Matsumoto, S. Sakata, T. Nagakura, and M. Abe, Japan Atomic Energy Research Institute, Tokai Research Establishment, Ibaraki-ken, Japan; Japan Atomic Energy Research Institute, Oarai Research Establishment, Ibaraki-ken, Japan; Japan Atomic Energy Research Institute, Tokyo, Japan.

Developments and Studies for Marine Disposal of Radioactive Wastes. (3)

CONF-760310; STI/PUB/433; IAEA-SM-207/16; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (pp. 339-367), 624 pp. (IAEA-SM-207/16, CONF-760310, STI/PUB/433). (1976)

The Japanese approach to sea disposal of low-level wastes is to emphasize treatments that reduce the volume of material to be dumped and to prove the integrity of the waste packages. Bitumenization and incineration are the preferred volume reduction processes, and new developments in these areas are being studied. Solidification of wastes is currently by incorporation in cement, and these packages have been tested for performance under high hydrostatic pressure and in free fall. Multistage packages are also being investigated. Leachability tests for Cs and Co under normal and high pressures with small specimens and full-scale packages showed the diffusion coefficient for Cs 137 to be 10(E-8)-10(E-6) sq cm/d for a slag-cement composite and 10(E-3)-10(E-6) sq cm/d for a Portland cement composite, under normal pressure. Also under normal pressure, Co 60 had a diffusion coefficient of approximately 10(E-9)-10(E-11) cm (E+2)/d. Addition of natural zeolite (mordenite and clinoptilolite) reduced the diffusion coefficient by a factor of 10(E+2)-10(E+3). Tests for Cs 137 on sealed drums under 500 kgf/sq cm pressure gave a leaching ratio of 0.03%. (LKH)

Diffusion Coefficient

Cs 137; Co 60

SEA DISPOSAL; CESIUM; LEACHING; FIELD STUDIES; WASTE DISPOSAL; WASTES, LOW-LEVEL; BITUMINIZATION; CEMENTS; INCINERATION; COBALT; CLINOPTILOLITE; MORDENITE; ZEOLITES; VOLUME REDUCTION; SOLIDIFICATION; PACKAGING; STRESS

<a18>
Mandahl, B., B. Persson, and C.E. Wikdahl, Oskarshamnsverkets Kraftgrupp AB, Oskarshamn, Sweden.

Handling of Waste at Swedish Nuclear Power Plants. (3)

IAEA-CN-36/282; Nuclear Power and Its Fuel Cycle, Proceedings of a Conference, Salzburg, Austria, May 2-13, 1977. International Atomic Energy Agency, Vienna, Austria, (pp. 1-12) (IAEA-CN-36/282). (1977)

The methods used and to be employed in

<a18>

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<a18> CONT.
handling radwastes at Swedish nuclear power plants are reviewed. Since 1972 ion exchange resins and evaporator concentrates have been solidified by incorporation in concrete or bitumen. Five commercial plants are in operation and by 1995 the total is expected to be 13 units. The low- and medium-level radwastes will be stored in the bedrock in accordance with Swedish law. Approximately 100,000 cu m of waste will be produced by these 13 units in 1990, and the BWR's will produce more than the PWR's. At present, core components are stored in the spent fuel pool at each reactor. A central storage station may be available as early as 1982. The system components are cut into suitable sizes and stored with the low- and medium-level wastes. Oil-water mixtures are stored in conventional oil barrels at the stations. Ion exchange resins, filter materials, and evaporator concentrators are incorporated in bitumen or concrete. Normal trash is compacted into 200 liter barrels or 600 liter metal boxes. The methods will be improved so the end products will be more resistant, volumes will be reduced, and the total collection dose received during treatment, transportation and storing of the waste will be reduced. Planned storage facilites will have an average capacity of 12,000 cu m, and one will be underground. Development of procedures to separate and to hold short-lived activity (less than 50 years decay time) before terminal disposal as conventional waste is desirable. Practical limits must be set giving the activity levels at which waste can be regarded as inactive. (NDT)

Waste Volume

BITUMENS; BOXES; CLASSIFICATION; COMPACTION; CONCRETES; CONTAINERS; DRUMS; EVAPORATOR CONCENTRATE; FUEL ELEMENTS; ION EXCHANGE; METHODS; NUCLEAR POWER; REACTORS, PRESSURIZED WATER; REACTORS, BOILING WATER; RESINS; WASTE DISPOSAL; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTES, SOLID; REVIEWS

<a19>
May, J.R., T.K. Thompson, and J.W. McConnell, Jr., Newport News Industrial Corp., Newport News, VA; Energy Incorporated, Idaho Falls, ID.

Fluidized Bed Radioactive Waste Volume Reduction System. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 8, (pp. 287-298), 1218 pp. (CONF-770512). (1979)

A new fluidized bed radioactive waste treatment system has been developed which can substantially reduce the volume of low-level radwaste presently transported from nuclear power plants to disposal sites. The system, designated RWR-1, can reduce the volume of concentrated liquids, ion exchange resin beads, filter sludges, and various combustible solids such as protective clothing, rags, paper, wood, and plastics. Tests using simulated radwastes in a pilot plant resulted in nominal reduction of 9 for concentrated liquids, 18 for spent resins, 5 for filter sludges, and 80 for compacted combustibles. Data suggest that the total present costs for radwaste disposal can be reduced by more than 50% using this system. The system consists of (1) waste feed systems for the various waste types, (2) a calciner/incinerator, (3) a particulate removal system, (4) an off-gas wet scrubbing system, and (5) an off-gas HEPA filtration system. The waste feed systems are primarily positive acting mechanical transfer devices. Pneumatic and/or gravity feed devices have been avoided in order to reduce the probability of the plugging of process piping and components by resins and sludges. The calciner/incinerator, or process vessel, is a single chamber vessel which contains the fluidized bed. The vessel is outfitted with refractory liner and an assortment of nozzles for the injection of waste materials, fuel, and process air. Particulate removal is accomplished primarily with a dry cyclone. Removal efficiencies of over 85% have been achieved with the pilot plant system. The off-gas wet scrubbing system consists of a quench tank, venturi scrubber, wet cyclone, condenser, demister, and scrub liquor cooler and storage tank. The wet scrubbing system is designed to remove the residual process heat from the off-gas, remove entrained particulate matter from the off-gas, and to provide for iodine removal from the off-gas. Laboratory tests are continuing to determine an optimum scrub liquor solution. Scrub liquor solution tests have demonstrated decontamination factors for iodine removal of between 10 and 100. The off-gas filtration system consists of an off-gas heater, roughing filter, HEPA filter, and iodine adsorber. A silver impregnated zeolite has been selected as an iodine adsorber. Test data indicate that decontamination factors for iodine removal of approximately 1000 can be expected. Construction of a full-scale pilot plant of the design described is near completion. The first commercial installation is planned for Unit 1 of the Nine Mile Point Nuclear Station, Scriba, New York. The system is expected to be operational in 1979. (Auth) (LKH)

WASTE TREATMENT; VOLUME REDUCTION; WASTES, LOW-LEVEL; WASTES, LIQUID; RESINS; SLUDGES; PLASTICS; WASTES, SOLID; DESIGN; INCINERATION; CALCINATION; FILTRATION; LABORATORY STUDIES; WASTE PROCESSING; EQUIPMENT; DECONTAMINATION FACTORS; IODINE; ADSORPTION; SORPTION

<a20>
McKenzie, D.E., L.P. Grantham, and W.R. Paulson, Rockwell International, Atomics International Division, Canoga Park, CA.

Volume Reduction of Waste Contaminated by Fission Product Elements and Plutonium Using Molten Salt Combustion. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 333-349), 1218 pp. (1979)

This paper describes the molten salt combustion system designed by Atomics International for Idaho National Engineering Laboratory to reduce the volume of low-level radioactive wastes. In the molten salt combustion process, transuranic or beta-gamma organic waste and air are continuously introduced beneath the surface of a sodium carbonate-sulfate-chloride melt at a temperature of about 800 C. The molten salt

<#20> CONT.
acts as a heat transfer agent to stabilize the temperature throughout the bed, a catalyst to assure complete combustion at moderate temperatures, a scrubbing agent to remove all noxious acidic gases and ash components from the off-gas, and a solidification agent to fix all radionuclides in the solid disposal product. The gases formed by combustion of the chloride, sulfur, or phosphorus content of the waste instantly react with the melt to form the corresponding sodium compounds, which are retained along with the ash in the salt. The molten salt has a retention efficiency for radionuclides which is equivalent to that of a high-efficiency aqueous scrubber. In benchscale tests, retentions for the elements Cs, Sr, Ru, Eu, I, Cr, Fe, Ni, and Co were all greater than or equal to 99 wt%. Molten salt combustion reduces the waste to about 2% of its original volume. Many reactor or reprocessing wastes which cannot be incinerated without difficulty are readily combusted in the molten salt. The spent salt can be either cast directly into metal canisters for disposal or processed to separate ash for disposal, to recover salt for recycle, and to recover fissile materials (plutonium). The design for a 50 kg/hr molten salt combustion system at the INEL Radioactive Waste Management Complex is nearing completion, and long lead time items have been ordered. Site preparation was done and installation of combustion components was started in 1977. System startup is scheduled for about April, 1978. (Auth) (LSS)

VOLUME REDUCTION; COMBUSTION; SALTS; WASTES, LOW-LEVEL; DESIGN; EQUIPMENT; WASTES, TRANSURANIC; WASTES, ORGANIC; WASTE TREATMENT; WASTE PROCESSING; FIELD STUDIES

<#21>
Moffett, D., CANMET, Elliot Lake Laboratory.

Uranium Waste Researchers Consider Alternate Means of Tailing Disposal. (J)

Canadian Mining Journal, 48-50. (1977, January)

The uranium processing industry produces as an interim product a concentrate containing about 80 percent U3O8 (yellowcake). This results in about 99.9 percent by weight of the incoming ore being discharged as tailings. In Canada, the amount of tailings to be disposed of amounts to about 11,000 tons per day. Other effluents, mainly liquid, are also discharged and must be treated or recycled. This paper briefly reviews the current methodology of treatment. (Auth) (LS)

A brief review of Canadian tailings disposal procedures. A table of reagents used in the mills and a table of typical discharges is included. (SM/LS)

pH

TAILINGS; RADIUM; THORIUM; MILLS; MINES; URANIUM; ORES; WASTE TREATMENT; WASTES, LIQUID; METHODS; WASTES, SOLID; REVIEWS

<#22>
Nakayama, T., T. Shirai, N. Hashimoto, Y. Kamiya, S. Sasaki, S. Kadoya, S. Hori, H. Kawara, S. Sugimoto, and T. Sakaki, Nippon Atomic Industry Group, Nuclear Research Laboratory, Kawasaki-shi, Japan; Tokyo Shibaura Electric Power Company, Tokyo, Japan; Tokyo Electric Power Company, Ltd., Tokyo, Japan; Ebara Manufacturing Company, Ltd., Tokyo, Japan.

New Techniques for the Treatment of Laundry and Other Low-Level Liquid Wastes. (J)

CONF-760310; STI/PUB/433; IAEA-SM-207/15; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 1, (pp. 161-176), 397 pp. (IAEA-SM-207/15, CONF-760310, STI/PUB/433). (1976)

Part I: At present liquid waste from cleaning of laundry contaminated by low-level radioactivity is discharged after filtration and dilution. Volume reduction by evaporation treatment has not been feasible because of foaming caused by surfactants, such as ABS; for this reason, a foamless detergent has been developed to make possible a closed liquid waste system. Testing of the new detergent showed it to be more effective in decontamination and as effective in cleaning power as commercial detergents. Volume reduction of wastes by evaporation was 1/2000, or 400 cm/m of liquid waste concentrated to one standard drum. No foaming was produced in concentration test runs from 500-200,000 ppm. Application of this treatment system is expected in Japan within a few years. Part II: Radioactive ruthenium and tritium pose serious problems in the treatment of spent nuclear fuel. Ruthenium in particular, because of its high radiotoxicity and chemical complexing, is difficult to remove. In this study, iron or iron compounds were demonstrated to be the most effective adsorbents. Batch and column adsorption experiments using steel wool with surfaces activated by treatment with saturated steam and at pH 6-7 produced the best decontamination factors. In an attempt to develop an industrially practical method, continuous tests were conducted; these tests showed that at space velocities of 40-50 cm/hr, decontamination factors averaging around 100 were obtained with Ru 106-spiked laboratory demineralized water, even with liquid passing through the column at more than 10,000 times the bed volume. (LSS)

pH

Ru 106; I 131; Cs 137; Eu 151; Co 60

DETERGENTS; EVAPORATION; VOLUME REDUCTION; IRON; IRON COMPOUNDS; RUTHENIUM; FILTRATION; WASTES, LOW-LEVEL; POLLUTION, WATER; METHODS; INCINERATION; CALCINE; COMPLEXES; ACTIVATED CARBON; ADSORPTION; WASTES, LIQUID; WASTE TREATMENT; LABORATORY STUDIES

<#23>
Morell, K.-T., AB Bofors, Bofors, Sweden.

Process for the Separation of Solid, Radioactive Particles from Liquid Waste and Conversion into Units for Long-Term Storage. (J)

German Patent No. 27 18 672; OLS-76-311; 7 pp. (1977, November 10; 1978)

A process is described whereby liquid low- and medium-level radwastes are converted into solid waste for long-term storage. The

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<423> CONT.

wastes would be fed into a tank for evaporation. During evaporation an organic compound would be added forming an azeotropic mixture which would eventually vaporize some of the waste. Distillation would continue until the water had been withdrawn at least partially from the waste. A substance is then added that would thicken or react with another substance so a solid would be formed. The rest of the organic compound would be distilled and the mixture decanted from the tank into transportable units. The solid constituents will either be partially or totally of ion exchanger masses. Not until 80% of the volume of the tank is dry substance, will the organic compound be added. Azeotropic distillation will be carried out at no less than 150 degree C. Phosphorous compound will be added as a fire-retarding material. Schematic flow diagrams are presented and a description of the process with the diagrams is included. (NDV)

PATENTS; DISTILLATION; EVAPORATION; ION EXCHANGE; ORGANIC COMPOUNDS; PLANTS, WASTE TREATMENT; SOLIDIFICATION; TEMPERATURE; VOLUME REDUCTION; WASTE TREATMENT; WASTES, LIQUID; WASTES, INTERMEDIATE-LEVEL; WASTES, LOW-LEVEL; WASTES, RADIOACTIVE; LABORATORY STUDIES

<424>

Paoletti, R., G. Bartoli, and A. Parrella, University of Naples, Science Department, Hygiene Section, Naples, Italy; ENEL-CPTN, Environmental Research Laboratory, Cellole, Garigliano, Italy.

Biofiltration Canals for Removing Cobalt 60, Cobalt 58 and Other Radionuclides: 4. Optimization. (3)

OLS-78-101; 18 pp.; Igiene Moderna 70(1):50-74.(1977)

Algae were used to concentrate low-level radioactive waste from nuclear power stations. With the biofiltration technique it is possible to remove a large part of cobalt (Co 58 and Co 60) from the radwaste which is not distinguished from stable Co. Other trace metals are removed by the algae. The canal system can be fed with highly diluted sewage so fecal microbes can also be eliminated. The system is capable, with proper conditioning, of removing 90% of the cobalt. The volume of the algal sludge is 300-600 g/10 cu m of water and can be decreased by a factor of 5 by drying and by a factor of 20 by incineration. The residue is then processed as solid radwaste. For protection the system can be completely automated and may occupy a relatively small space. Algae growth was found to vary with organic load, recycling of water, amount of cobalt added, frequency of removal of sludge, temperature, and nocturnal illumination. (NDV)

CONCENTRATION FACTORS; DECONTAMINATION; FIELD STUDIES; FIXATION; FILTRATION; DRYING; INCINERATION; MICROORGANISMS; SORPTION; ORGANIC COMPOUNDS; RADIOECOLOGY; SLUDGES; VOLUME REDUCTION; WASTE TREATMENT; WASTES, RADIOACTIVE; WASTES, LOW-LEVEL; WASTES, LIQUID; ALGAE

<425>

Pradel, J., P.J. Parsons, and E. Halasek, International Atomic Energy Agency, Vienna, Austria.

The Volume Reduction of Low-Activity Solid Wastes. (1)

STI/DOC/10/106; Technical Reports Series No. 106; 48 pp.(1970)

Techniques for volume reduction of low-level radwastes are presented. Two categories of reduction are considered: fragmentation and compaction (mechanical) and incineration. The mechanical techniques reduce the volume whereas, incineration yields a reduction in both volume and weight. It is estimated that 70% of the wastes produced are compressible or combustible, while 20% are hard materials, and 10% debris from plant conversions. Low-level solid wastes are produced at a rate between 0.25 and 0.5 cu m/employee annually. Waste sorting is essential to this kind of waste management because it will improve the efficiency of the chosen method. Decontamination of weakly contaminated scrap may be highly desirable in the overall efforts to reduce wastes from a plant. Compaction reduces waste volume by reducing the voids while fragmentation by reducing the size of large pieces, makes them easier to handle by other processes. Material easily compacted are paper, fragments of plastic or rubber, rags, glassware, and small metallic items. The compacting techniques, and experience are discussed in detail. Fragmentable wastes are a result of dismantling and elimination of large items of equipment such as waste tanks, heat exchangers, ventilation hoods, glove boxes and fluid supply lines. Such wastes are cut apart in cutting rooms. Several different techniques are discused along with practical experience. Packaging of the wastes depends on the final method of storage. A large portion of low-level radwastes is combustible and the quantity of ash is such that the reduction factor is on the order of 100 by volume and 13 to 25 by weight. Combustible wastes are divided into three types: cellulose materials; plastics and rubber; and animal carcasses. Important characteristics such as physical state, chemical state, and calorific value also must be taken into account. The physical state affects the combustion rate with material compacted too tightly or powdered. The chemical state governs the degree of corrosion. The calorific value determines the temperature in the furnace. Waste sorting is very important in combustion because it increases the homogeneity. Techniques and practical experience are included in the discussion. While the principal of incineration is simple, difficulties with gas clean-up pose a problem. Hence the method may not be as economical as for conventional wastes. Other techniques briefly considered are lead melting, ferrous materials and special steels melting, acid reduction, and mummification of animal carcasses. The disadvantages and advantages, choice of process, economic aspects, utilization of reduction facilities, influence of the storage possibilities, and importance of the choice of storage method are also covered. (NDV)

COMPACTION; COST BENEFIT ANALYSIS; INCINERATION; PACKAGING; VOLUME REDUCTION; WASTE MANAGEMENT; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, RADIOACTIVE; REVIEWS

<#26>
Rautenbach, R., and T. Welss, Federal Republic of Germany.

Equipment for Decontamination of Radioactive Waste Waters. (3)

German Patent No. 25 51 390; OLS-76-223; 8 pp. (1977; 1978)

Presented is a method for decontaminating low-level liquid radwastes, such as those used in hospitals. The plant would consist of a feed tank, decay tank, and a collecting tank which would then discharge the effluent into the waste water system. Within the plant the feed tank would be placed above the decay tank so the potential energy of the fluid would be sufficient to push the fluid through the decay tank and into the collection tank. The decay tank would be cylindrical in configuration with varying diameters and valves. The varying diameters would prevent laminar flow, and the valves would prevent back mixing. The feed tank is filled either continuously or cyclically while the decay tank is feed is pulses. This allows for long resting periods to permit decay to take place. This invention provides decontamination by a continuous operation which has a low investment and operating cost and a high safety factor. (NDV)

DECONTAMINATION; DESIGN; RADIOACTIVE DECAY; TANKS; FLUID MECHANICS; PATENTS; PLANTS, WASTE TREATMENT; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, LIQUID; LABORATORY STUDIES

<#27>
Reezen, P.V., S.S. Dubnik, and E.I. Gutin.

Low-Level Waste Waters Desalted and Purified by Ionic Membrane Electrodialysis. (2)

Atomnaya Energiya 22(5):393-396; Soviet Atomic Energy 22(5):491-495. (1967, May)

The application of electrodialysis to processing of low-level waste effluents is demonstrated. Electrodialysis is applicable to purification of process slurries to a maximum permissible concentration where the solutions contain less than 700 mg/liter salts, and to desalting of more concentrated solutions. If the waste effluents contain more than 5 g/liter salts, a desalting process concurrent with isolation of alkali and acid present is recommended with the alkali and acid recycled. (Auth) (PAF)

WASTES, LOW-LEVEL; WASTES, LIQUID; ELECTRODIALYSIS; SALTS; SEPARATION PROCESSES; MAXIMUM PERMISSIBLE CONCENTRATION; BETA PARTICLES; ION EXCHANGE; SLURRY; LABORATORY STUDIES; EFFLUENTS

<#28>
Roberts, R.C., and J.W. Koenst, Mound Laboratory, Miamisburg, OH.

Removal of Plutonium and Uranium from Process Streams Using Ultrafiltration Membranes. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 383-398), 1218 pp. (1979)

Experiments with hollow fiber ultrafiltration modules were performed on Mound Laboratory waste streams contaminated with Pu 238, Pu 239, and U 233. These modules had molecular weight cut-offs ranging from 2000 to 90,000. Waste water from the "hot" laundry, decontamination wash water from the Plutonium Processing (PP) Building, and influent to the Waste Disposal (WD) Building were studied. Rejection of radioactive contamination by all modules was 90-97.7%. Rejection of activity from alpha-contaminated laundry waste was 98.6-99.8%. For the AM-2 module (flux rate 6.03 ml/min-sq m, cutoff mol. wt 2000), the activity of the product was less than 0.1 dis/min-ml. Rejection of radioactivity from decontamination water generated in PP Building was only 77.8% to 86.5%. The much lower percentages can be accounted for by a higher percentage of ionic material. None of the additives had any noticeable effect on the rejection of radioactivity or conductivity in any of the solutions tested. When the pH of the WD influent was raised in stages from 8 to 11, there was an increase in rejection of radioactivity as pH increased. However, membrane fouling due to formation of a precipitate [probably Ca(OH)2] caused such a problem that this method of treatment would seem impractical, at least when hollow fiber membranes are being used. In the final test, using alum as an additive, the same fouling problem that was encountered by raising the pH occurred. This method of treatment will be tested again at a later date with a tubular membrane system rather than a hollow fiber one. These experiments showed that the ability to remove radioactivity was a function of the contents of the waste stream because the radioactivity in the waste water was variously ionic, polymeric, colloidal, and adsorbed onto suspended solids. Removal of suspended or colloidal material was very high, while removal of ionic material was very low. (Auth) (LKH)

FILTRATION; ULTRAFILTRATION; WASTES, LIQUID; PLUTONIUM 238; PLUTONIUM 239; URANIUM 233; pH; MEMBRANES; IONS; COLLOIDS; PARTICLES; WASTE TREATMENT; LABORATORY STUDIES; WASTE PROCESSING; EQUIPMENT; POLYMERS; PRECIPITATION, CHEMICAL

<#29>
Robinson, R.A., and L.C. Lasher, Oak Ridge National Laboratory, Oak Ridge, TN.

Low-Level Radioactive Liquid Waste Treatment at Oak Ridge National Laboratory. (1)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 353-369), 1218 pp. (1979)

A new Process Waste Treatment Plant has been constructed at Oak Ridge National Laboratory, in which wastes are processed through a precipitation-clarification step and then through an ion exchange step to remove low-level activity in the waste before its discharge into White Oak Creek. The facility went into operation in April, 1976. During the first few months of operation, periodic sampling of both the inlet and outlet streams was carried out to determine the Cs 137 and Sr 90 decontamination factor (DF). The average Sr 90 DF over a series of 10 runs was 2000 with a high of 6000 and a low of 220. A

WASTE TREATMENT

<829> CONT.
total of 2.3 X 10(E+7) liters of waste was processed during the 10 runs and an average of 1770 resin bed volumes was passed through the columns between regenerations. The corresponding Cs 137 DF was about 100. During the pilot plant testing of this process, the results indicated that this plant should get a DF of about 500 for Cs 137 and 900 for Sr 90 when the resin bed is regenerated after every 2000 column volumes. The reason why the Cs 137 performance has not lived up to expectations is not known. It appears to be unrelated to flow conditions through the ion exchange columns such as channeling since this would affect the Sr 90 DF as well. It may be related to some non-radioactive contaminants such as phosphates in the waste stream. However, since Sr 90 is the radionuclide of principal interest in the ORNL process waste because of its very low maximum permissible concentration in drinking water [3 X 10(E-7) uCi/ml] to Cs 137 [2 X 10(E-5) uCi/ml] and because the Cs 137 concentration in the incoming waste is usually much less than the Sr 90 concentration, the plant is routinely operated with resin regenerations after approximately every 2000 bed volumes even though some improvement in Cs 137 DF could be achieved through more frequent regenerations. Sr 90 releases to the Clinch River from the process waste system expressed in terms of percent of Radiation Concentration Guide (RCG) limits for unrestricted use of water, show that the contribution from process waste treatment in the Clinch River has dropped from 0.27% of RCG limits in 1975 to 1.9 X 10(E-3)% thus far in 1977 while the average monthly volume of waste treated has dropped only 25%. The values for Cs 137 are lower even though the plant is not as effective for Cs 137. (Auth) (LKM)

Cs 137; Sr 90

WASTE TREATMENT; PLANTS, WASTE TREATMENT; PRECIPITATION, CHEMICAL; ION EXCHANGE; CESIUM 137; STRONTIUM 90; DECONTAMINATION FACTORS; WASTES, LIQUID; EFFLUENTS; EFFLUENTS, LIQUID; WASTE VOLUME; PHOSPHATES; CONTAMINANTS; ADSORPTION; SORPTION; WASTES, LOW-LEVEL; RESINS; WASTE PROCESSING; FIELD STUDIES

<830>
Buchhoft, C.C., A.E. Gorman, and C.H. Christenson, U.S. Public Health Service, Cincinnati, OH; U.S. Atomic Energy Commission, Washington, DC; U.S. Atomic Energy Commission, Los Alamos, NM.

Wastes Containing Radioactive Isotopes. (2)

Industrial and Engineering Chemistry 44(3):585-589.(1952, March)

Coagulation and carrier precipitation procedures commonly used in treating municipal and industrial wastes are applied to the treatment of liquid radwastes. These procedures are ideal for wastes containing relatively long-lived isotopes too low in activity to justify prolonged storage but too high for innocuous discharge into ground or surface waters. Experiments with this type of treatment on wastes containing plutonium have been done at Los Alamos. The wastes varied considerably over an 8 hr period with total solids ranging from 230 to over 8000 ppm and the plutonium activity ranging from 200 to 25,000 counts per minute per liter. The experiments showed that although the complexing agents contained in the wastes interferred with coagulation procedures, effluent meeting the plutonium tolerance could be produced with iron and lime at a pH of about 12. The treatment design of the plant is described in detail and is to provide prolonged flocculation and sedimentation, aerial flocculation, and sedimentation and filtration through sand at low flow rates. Removal by the plant was considered excellent at 1.8 X 10(E-5) to 2.7 X 10(E-5) uCi/liter and was greatest when the coagulation tanks and sedimentation tanks are operated in series. The plant produced sludge cake at the rate of 2 gal/100 gal of waste. It was found that lime and ferric chloride gave the best results for coagulation. The decontamination factors obtained in this treatment may vary between slightly less than 10 to as much as 10(E+3). Over-all cost of this treatment is about 0.8 cents/gal which compares favorably with evaporation costs of 13 cents/gal. Wastes with citrate were found to be best treated by zoogleal organisms of the activated sludge process which oxidize the citrate. After such treatment, the wastes can be put through the coagulation process. (MSW)

ACIDS; DECONTAMINATION; EVAPORATION; FILTERS; FLOCCULATION; LABORATORY STUDIES; PLUTONIUM; PLUTONYL CITRATES; PRECIPITATION, CHEMICAL; SEDIMENTS; SEPARATION PROCESSES; VOLUME REDUCTION; WASTE TREATMENT; WASTES, LIQUID; WASTES, RADIOACTIVE; COAGULATION; COST BENEFIT ANALYSIS

<831>
Ryan, A.D., F.J. Hurst, and F.G. Seeley, Oak Ridge National Laboratory, Oak Ridge, TN.

Nitric Acid Leaching of Radium and Other Significant Radionuclides from Uranium Ores and Tailings. (2)

ORNL-TM-5988; 27 pp.(1977, August)

Samples of representative uranium ore and mill tailings from New Mexico, the Colorado Plateau, and Wyoming were collected and prepared for analysis and leaching tests. Results of leaching with nitric acid show that up to 98% of the Ra 226 is leached in two stages with hot 3 M HNO_3. The fraction of Th 230 leached was generally greater than that of Ra 226, while the fractions of Po 210 and Pb 210 were less. Concentration of Ra remaining in the residue after leaching ranged from 17 to 60 pCi/g for various ore and tailings samples. Virtually no difference was observed between ore and tailings from either sulfuric acid or carbonate leach mill processes. The lowest value is about an order of magnitude above that of soils in the western U.S. mining districts, but about the same as the level proposed as a standard for building materials in the United Kingdom. The sand fraction (+140 mesh) of the residues after nitric acid leaching ranged from 33 to 89 wt % and contained 80 to 70% of the Ra at approximately one-half of the concentration of that in the slime fraction. Tests indicate that the residual Ra is probably in the form of some refractory mineral and not present as sulfate or carbonate. Solubility of $BaSO_4$ in nitric acid was measured to aid in interpretation of the leaching data. Ra was leached from sulfate tailings by distilled water to produce solutions

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<831> CONT.
containing Ra at concentrations greater than an order of magnitude above the EPC for drinking water. Radon 222 emanation coefficients of samples of ore, tailings, and nitric acid-leached residues were measured. Although these coefficients varied from 8 to 65%, no consistent trend was observed. The rate of Ra emanation from nitric acid residues was only 2 to 10% of that for all tailings. This was a result of the lower Ra content rather than any significant change in Rn emanation coefficient. (Auth) (LKH)

Grain Size Distribution; Emanation Rate

Ra 226; Th 230; Rn 222; Po 210; Pb 210; U

URANIUM; ORES; TAILINGS; LEACHING; RADIUM; THORIUM; POLONIUM; LEAD; URANIUM COMPOUNDS; TAILINGS; THORIUM COMPOUNDS; MINES; SULFUR COMPOUNDS; ACIDS; BARIUM COMPOUNDS; CALCIUM COMPOUNDS; LABORATORY STUDIES; ORE PROCESSING; CONCENTRATIONS; RADON; EMANATION; STANDARDS, INTERNATIONAL

<832>
Spitsyn, E.Ya.

Treatment of Radioactive Wastes. (3)

Treatment and Disposal of Radioactive Wastes. Israel Program for Scientific Translations, Ltd., Jerusalem. (1965)

Liquid wastes are collected by sewerage pipe systems and forwarded to reservoirs. If the volume of waste generated is less than 200 liters a day, the liquid may be collected in containers and forwarded to the burial grounds without preliminary treatment. Wastes (liquid) with activities less than 10 times M.P.C. may be disposed of in the fecal sewerage system if the dilution factor is at least 10. High-activity liquid wastes [specific activity greater than 10(E-4)Ci/l] are shipped in transport containers directly to the burial grounds. Wastes containing radioisotopes with half-lives shorter than 15 days are stored to permit significant decay to occur prior to disposal. Equations are presented which calculate the relative decrease in activity in a volume that is continuously filled at a uniform rate in the storage system. Coagulation treatment of effluents high in Po 210, Pu 239, Y 90, Zr 95, and Ce 144 is routinely practiced. Common coagulants used are aluminum sulfate, ferric sulfate and ferric chloride. Ion-exchange is frequently used in conjunction with flocculation. Solid wastes are packaged at their site of origin. Principle type of packing for the wastes are plastic, rubberized fabric, or disposable paper bags. These are placed in reusable transport containers. Solid waste volumes, are reduced by crushing, compaction, and incineration whenever possible. (JT)

Reviews the treatment methods used on low-level liquid and solid radioactive waste. General discussion with no significant data. (DH/JT)

WASTES, RADIOACTIVE; WASTE MANAGEMENT; WASTE DISPOSAL; WASTE TREATMENT; FILTRATION; COAGULATION; EVAPORATION; ION EXCHANGE; COMPACTION; INCINERATION; DECONTAMINATION; WASTES, LOW-LEVEL; WASTES, HIGH-LEVEL; REVIEWS

<833>
Spitsyn, E.Ya.

Radioactive Wastes. (4)

Treatment and Disposal of Radioactive Wastes. Israel Program for Scientific Translations, Ltd., Jerusalem. (1965)

Radioactive wastes, liquids and solids, are classified according to their physical characteristics and their chemical properties. Liquid and solid radioactive waste with specific activities greater than 10(E-4)Ci/l or kg are routinely classified as high-activity wastes. Methods of handling solid radioactive wastes include packaging in drums and burial in trenches, packing in containers and filling containers with concrete prior to disposal into the sea, and crushing and compaction of waste prior to burial. Special centralized burial grounds (graveyards) are constructed in industrial regions in the USSR. These industrial regions are classified according to consumption: Type 1-consumption of less than 200 Ci/yr of exposed radioactive substances; Type 2-consumption up to 1000 Ci/yr; Type 3-consumption exceeding 1000 Ci/yr. (JT)

This chapter outlines the basic fundamentals of radioactivity, biological effects, and disposal techniques. Minimal data are presented on the burial of low-level radioactive wastes in the USSR. (DH/JT)

WASTES, RADIOACTIVE; WASTE DISPOSAL; WASTES, LIQUID; WASTE TREATMENT; PRECIPITATION, CHEMICAL; COAGULATION; FILTRATION; PACKAGING; INCINERATION; WASTE MANAGEMENT; REVIEWS

<834>
Spitsyn, E.Ya.

Treatment and Disposal of Radioactive Wastes. (4)

Treatment and Disposal of Radioactive Wastes. Israel Program for Scientific Translations, Ltd., Jerusalem. (1965)

A review of radioactive waste treatment and disposal practices in the USSR. Descriptions of the techniques for collection, processing, transportation, and burial of solid and liquid radioactive wastes are provided. Treatment practices reviewed include coagulation, ion exchange, evaporation, incineration, and compaction. General recommendations are provided for the selection of potential radioactive waste burial grounds. An appendix on basic concepts, definitions and terminology is also provided. (JT)

A general review of radioactive waste treatment, transport, and disposal practices in the USSR. No significant data are presented. (DH/JT)

WASTES, RADIOACTIVE; WASTE TREATMENT; TRANSPORTATION; WASTE DISPOSAL; WASTES, LIQUID; WASTES, SOLID; ION EXCHANGE; ELECTRODIALYSIS; EVAPORATION; PRECIPITATION, CHEMICAL; INCINERATION; COMPACTION; GEOLOGY; HYDROLOGY; DECONTAMINATION; ENCAPSULATION; SAFETY; CEMENTS; REVIEWS

<a35>

WASTE TREATMENT

<a35>
Storton, J.R., Babcock and Wilcox Company, Lynchburg, VA.

Ion Exchange As a Technique to Remove Technetium. (2)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 811-818), 1214 pp. (1979)

The radioisotope technetium 99, a weak beta emitter, has been detected in the effluent from a low-enriched uranium fuel fabrication facility. Technetium 99, a fission product, is introduced into the system by recycled enriched UF6 used in the conversion process. Other radionuclides present, such as Th 231, Th 234, and Pa 234, add to the overall beta activity; but in a reasonable time, these decay to acceptable levels. Because of its long half life, Tc 99 must be removed to stay in compliance with NRC regulations. Ion exchange resins have been previously used to reduce Tc 99 concentrations in relatively salt free solutions; but usually in these cases, the initial technetium concentration is high. In the present situation, low-level Tc 99 activity (about 2000 pCi/ml) is to be removed from a concentrated fluoride solution. Removal of Tc was measured via liquid scintillation spectrometry of synthetic liquid process waste solutions. Work to date has shown that Tc 99 beta activity can be reduced in the presence of high fluoride salt concentration. The reduction has been accomplished by using a strong-base anion resin. Dowex SBR resin consistently gave the best results. Decontamination factors determined for Dowex SBR in either the Cl- or SO4(-2) form were essentially the same. The Tc 99 concentration in the effluent was kept below 200 pCi/ml in all of the experiments. In the extended run, even after 3,200 bed volumes of solution had passed through the resin, the Tc 99 concentration was still in the 160 pCi/ml range. A beta activity of 160 pCi/ml results in a decontamination factor of 12.5 for the bed. Technetium 99 removal Dowex SBR resin has been shown to be dependent on typical ion exchange parameters. By increasing the resin bed height by a factor of 2 and decreasing the flowrate by 10 ml/min, the effluent Tc 99 activity was greatly reduced. After being contacted by 1,200 bed volumes of solution, the Tc 99 activity in the effluent was 10 pCi/ml. This level of activity converts to a decontamination factor of 200. Laboratory-scale experimental results indicate that the Dowex-SBR resin has a high affinity for the Tc 99, and its operating removal capacity is also high. (Auth) (LKH)

Tc 99

TECHNETIUM 99; WASTES, LIQUID; WASTES, LOW-LEVEL; RECYCLING; ION EXCHANGE; RESINS; FLUORIDE; SALTS; DECONTAMINATION FACTORS; WASTE TREATMENT; EFFLUENTS, LIQUID; LABORATORY STUDIES; URANIUM HEXAFLUORIDE; WASTE PROCESSING

<a36>
Stors, L.P., Wisconsin Electric Power Company, Point Beach Nuclear Plant, Two Rivers, WI.

Radioactive Waste Liquid Process System Design and Operation. (3)

CONF-770512; Management of Low-Level Radioactive Waste, M.W. Carter, A.A. Moghissi, and B. Kahn (Eds.), Proceedings of a Symposium, Atlanta, GA, May 23-27, 1977. Pergamon Press, New York, NY, Ch. 5, (pp. 461-470), 1214 pp. (1979)

This paper reviews the series of events which led to the development of the present Point Beach Nuclear Plant waste liquid process system. Events reviewed are: (1) a steam generator tube failure which contaminated the entire inventory of secondary plant condensate, generating about 75,000 gal of contaminated water; (2) steam generator sludge lancing, which generates about 15,000 gal of contaminated water per 8-hr shift; (3) spent fuel shipping cask flushing and decontamination, which produces about 3000 gal of contaminated water per cask; (4) refueling canal leakage in excess of 2 gal/min; and (5) groundwater seepage into contaminated sumps in excess of 2 gal/min. All of these events would have exceeded the capacity of the original evaporative equipment (a single 2 gpm waste evaporator). By the summer of 1974, four years after beginning commercial operation, new equipment had been added, including a gas decay duct on the condenser air ejector exhaust, full-flow primary let-down gas strippers, a noble gas removal and charcoal delay bed hydrogen gas recycle system, and a 35 gpm (132 L/min) steam generator blowdown evaporator. A number of problems have arisen since installation of the new equipment, but all have been dealt with, and, during approximately 7 years of operation, Point Beach has never had to ship liquid waste off-site for processing or hire a mobile waste liquid processor to come in for a "bail out". (Auth) (LKH)

WASTE PROCESSING; WASTE TREATMENT; WASTES, LIQUID; EVAPORATION; EVAPORATORS; NUCLEAR FACILITIES; VOLUME REDUCTION; DESIGN; METHODS; EQUIPMENT; FIELD STUDIES

<a37>
Sugimoto, S-I., and T. Ishihara, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai-Mura, Ibaraki-Ken, Japan.

Treatment Practices of Low- and Intermediate-Level Radioactive Wastes at the Japan Atomic Energy Research Institute. (4)

CONF-651202; IAEA-SR-71/9; Practices in the Treatment of Low- and Intermediate-Level Radioactive Waste, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965, (pp. 207-222), 988 pp. (CONF-651202, IAEA-SR-71/9). (1966)

The radioactive waste treatment plant, JAERI Tokai Research Establishment, has operated since 1958, and various contaminated wastes that have been discharged by research laboratories, radioisotope processing facilities, and the five reactors in Tokai site, have been processed and removed. Most liquid wastes are intermediate-, low- and extremely low-level. Extremely low-level (less than 10(E-6) uCi/ml) liquid is discharged after dilution with ordinary effluent. Low-level liquid is processed by flocculators, ion-exchange columns with a membrane dialyzer and evaporators, with capacities of 1 cu m/h. Intermediate-level liquid is processed by small evaporators installed in a shielded cell. The resulting sludges are solidified with Portland cement

<a37> CONT.
into drums, and stored in concrete pits. In 1968, 3700 cu m of low- and very low-level liquid were produced, the average volume per capita being 18 cu m/yr. The average removal percent of activity is 99.7%, and from 1959-1968 about 2.1 mCi were discharged into the sea after decontamination. Most solid wastes are low-level and sent to the treatment plant in 20-litre cartons. Combustible wastes are incinerated at the rate of 3 cartons/h, and non-combustible ones are compressed into drums with a volume reduction of one-fifth. In 1968, 11,000 cartons were processed by an incinerator or by a baling press, the average quantity per capita being 17 cartons a year. They were packaged into 200-litre drums and stored in a semi-underground concrete pit. (Auth)

Gives brief description of processing of solid wastes, which are at present only stored. Requires interpretation. (DEG/GH)

WASTES, RADIOACTIVE; WASTE TREATMENT; FLOCCULATION; ION EXCHANGE; EVAPORATION; INCINERATION; COMPACTION; WASTES, SOLID; WASTE STORAGE; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; WASTE VOLUME; DECONTAMINATION; SOLIDIFICATION; ENCAPSULATION; REVIEWS

<a38>
Tamura, T., U.S. Atomic Energy Commission.

Mineral Exchange Work at Oak Ridge National Laboratory. (2)

TID-7684; Use of Inorganic Exchange Materials for Radioactive Waste Treatment, D.K. Jamison, et al (Eds.), Proceedings of a Working Meeting, Washington, DC, August 12-14, 1962. U.S. Atomic Energy Commission, Division of Technical Information, Washington, DC, (pp. 29-45), 239 pp. (1963, January)

Mineral exchange using minerals with a layer silicate structure is discussed. While treating vermiculite and bentonite to get the illite structure which is favorable to Cs sorption, biotite showed that it could sorb Cs provided the sodium-cesium ratios were not so high as to be important. It is concluded that the high exchange capacity in very dilute regions for vermiculite is due to the biotite impurity, and the effect drops to zero at 10(E-3) meq. It was found that after treating biotite to increase its capacity to 100 meq/100 g that Cs was more selectively removed in spite of the decreased number of collapsed lattices. It appears that the newly generated exchange sites have much higher charge densities around them and hence greater selectivity. Two types of ion exchange exist, one where ion exchange capacity is important and one where it is not. The latter is absorption and the former is adsorption. Experiments were run investigating adsorption on gibbsite. A variety of sorbing materials is tabulated as to exchange capacity and ability to remove strontium. The material used in making materials more selective was alumina. However alumina has an exchange capacity of less than 1 meq and the removal rate was 40% at pH 8.5. The only good explanation for this was aluminum hydroxide which has a gibbsite structure. One use of the alumina is as a scrubber in a sorption column. Clinoptilolite is the best material to use at the head. Considering distribution coefficients, a 1000 value could be achieved for high strontium concentrations and 40,000 to 50,000 in trace concentration. The material works well, especially at pH's of 7, 8 or higher. Further work was done on the aluminum hydrates. An application using the aluminum hydroxides was made for the Conasauga shale. (MDV)

Ion Exchange Capacity; Distribution Coefficient; pH

ADSORPTION; BENTONITE; BREAKTHROUGH DISTRIBUTION; CATION EXCHANGE CAPACITY; CLINOPTILOLITE; DECONTAMINATION FACTORS; DISTRIBUTION COEFFICIENT; ILLITE; ALUMINUS COMPOUNDS; ION EXCHANGE; LABORATORY STUDIES; pH; SOILS; VERMICULITE; LATTICE; WASTE DISPOSAL; WASTE TREATMENT; WASTES, LIQUID; WASTES, LOW-LEVEL; CESIUM; STRONTIUM; SOLIDIFICATION; ENCAPSULATION

<a39>
Thomas, K.T., A.K. Khan, and M.V. Amalraj, Atomic Energy Establishment, Trombay, Bombay, India.

Incineration of Low-Level Radioactive Solid Wastes and Gas Cleaning: Some Operational Experiences. (3)

CONF-651202. Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes, Proceedings of a Symposium, Vienna, Austria, December 6-10, 1965. International Atomic Energy Agency, Vienna, (pp. 601-614), 848 pp. (CONF-651202). (1966)

The Waste Treatment Division of the Atomic Energy Establishment, Trombay, faced the problem of disposing of solid wastes which had accumulated from various production and research facilities. A 25-kg/h single-chamber refractory furnace of monolithic construction with an entirely dry-gas cleaning system was designed, installed and successfully operated for several months. Here the performance data is given on operations carried out in this plant during the incineration of a typical alpha-contaminated waste containing highly corrosive chemicals. Volume reduction of the single-chamber refractory furnace is 90 to 1. The decontamination factor of the furnace for gross alpha is 798, gross beta-gamma is 103, Ra 226 is 224, Ra 228 is 333, and ThO2 is very high. The performance characteristics of several filter fabrics were evaluated and the results obtained in cooling and cleaning the fl gases revealed that a completely dry-gas cleaning system is technically and economically feasible. Decontamination factors of the fabric filters are: gross alpha 100, and gross beta-gamma 70. Based on the above experience, a more advanced type of multi-chamber incinerator was set up to attain higher combustion efficiency and details of the equipment and its performance are presented. The operational health physics aspects of the plants are also discussed. Capital cost of the plant is Rs. 13,300 with a depreciation cost of Rs. 3100/yr. Operational cost is Rs. 0.13/16 of waste. (Auth) (MDV)

VOLUME REDUCTION; ASHES; COMBUSTION; WASTES, SOLID; DECONTAMINATION FACTORS; ECONOMICS; SAFETY; INCINERATION; PLANTS, WASTE TREATMENT; LABORATORY STUDIES; GASES

<440>

WASTE TREATMENT

<441>
U.S. Atomic Energy Commission, Division of Reactor Development, Washington, DC.

1953 Operating Report - WD-2 Plant, Los Alamos Industrial Waste Section, Atomic Energy Commission, LAFO. (3)

WASH-275; Sanitary Engineering, Proceedings of a Conference, Baltimore, MD, April 15-16, 1958, (pp. 198-214) (WASH-275). (1958)

An examination of the waste treatment program at Los Alamos Laboratories is presented. The paper runs through the treatment design and process, problems, and economics of the station. Data are given for operating costs and operating results. A chemical analysis of the wastes treated is included. Attention is given to the unique nature and requirements of the plant. (DLD)

A complete analysis of the process at Los Alamos from several aspects. (DH/DLD)

pH

AQUIFERS; BENTONITE; CONTAMINATION; COST BENEFIT ANALYSIS; EFFLUENTS; FILTRATION; FLOCCULATION; MONTMORILLONITE; PLUTONIUM; SEDIMENTS; SLUDGES; WASTE TREATMENT; VOLUME REDUCTION; REVIEWS

<442>
U.S. Atomic Energy Commission, Division of Waste Management and Transportation, Washington, DC.

Plan for the Management of AEC-Generated Radioactive Wastes. (3)

WASH-1202(73); 48 pp.(1973, July)

This report is a summary of the AEC's plans for handling high-level and other than high-level radioactive wastes. Management of high-level radioactive waste requires that the liquid be converted into a suitable physico-chemical form that will be confined in a manner to insure isolation from man's environment with minimal reliance on perpetual maintenance and surveillance. Initial storage may be in engineered systems equipped with adequate leak detection and control systems. Other than high-level liquids or solids are disposed of through the use of natural soil columns. Investigations into the use of compaction and incineration techniques for reduction of waste volume are planned. Interim and long-term storage plans at Hanford, Savannah River, and the National Reactor Testing Station are reviewed. The management techniques used for the handling and treatment of other than high-level radioactive wastes varies as a function of the type of processing, nature and concentration of the activity in the waste, and local conditions, i.e., climatic, soil geologic, and hydrologic conditions. Disposal of radioactive solid wastes in near-surface burial grounds will continue. However, solids containing significant plutonium activity will be segregated and stored under retrievable conditions. A glossary of terms is included as an appendix. (JT)

A review of the policies, criteria and planned programs for the management of high, intermediate, and low-level radioactive wastes. (DH/JT)

WASTES, RADIOACTIVE; WASTES, HIGH-LEVEL; WASTE STORAGE; WASTE DISPOSAL; SOLIDIFICATION; WASTE MANAGEMENT; PLUTONIUM; RETRIEVABILITY; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; GEOLOGY; HYDROLOGY; REVIEWS

<443>
Van de Voorde, N., G. Dumont, J. Claes, A. Taeymans, J. Vangeel, and P. Dejonghe, Nuclear Energy Research Establishment (SCK/CEN), Mol-Donk, Belgium.

An Integrated System for the Conditioning of Radioactive Solid Wastes and Liquid Waste Concentrates. (3)

CONF-760310; STI/PUB/433; IAEA-SM-207/7; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 1, (pp. 131-152), 397 pp. (IAEA-SM-207/7, CONF-760310, STI/PUB/433). (1976)

Concrete and bitumen used as matrices for conditioning of low-level radioactive wastes are not entirely satisfactory. The former is subject to elution, while the latter is combustible, characteristics which become of greater importance when dealing with Pu-contaminated materials. Also, present methods of incinerating waste create serious problems with off-gas purification and equipment corrosion. The system described in this paper is based on the combustion of contaminated materials and off-gases at high

<883> CONT.
temperatures (1500-1600 degrees C) and transformation of the resulting residues into an inert, insoluble basalt-like slag. Off-gas cleaning in such a system is greatly simplified by the high temperatures and production of slag instead of ashes. A major design problem was the effect such temperatures have on the incinerator. This was overcome by use of the FLK (Flammen Kammer) technique, in which a centrally-mounted burner is surrounded by "walls" of waste which is continually replaced as combustion proceeds. The necessary internal temperatures were achieved, while the outer walls remained below 80 degrees C. Experimental leach rates for selected elements in the product ranged from 1.6 x 10(E-5) g/sq cm/d for Ce to 4 x 10(E-10) g/sq cm/d for Cs and Ni. Materials for which this process is applicable include most common radioactive wastes, combustibles as well as some incombustibles such as glass, light metals, sludges, saturated ion-exchangers, and absolute filters. A pilot plant operation using non-contaminated materials was conducted for approximately one year; future plans include testing with Pu-contaminated waste. (LKH)

Leaching Rate

INCINERATION; WASTES, LOW-LEVEL; WASTES, SOLID; WASTES, LIQUID; WASTES, GASEOUS; SALTS; SLUDGES; FILTRATION; LEACHING; CERAMICS; METHODS; EQUIPMENT; LABORATORY STUDIES; WASTE MANAGEMENT; WASTE TREATMENT; VOLUME REDUCTION

<884>
Walter, P.D. (Chairman), U.S. Atomic Energy Commission, Washington, DC.

Compaction of Radioactive Solid Waste. (2)

WASH-1167; 38 pp (1970, June)

As of 1969, the annual volume of solid, low-level, radioactive waste that was disposed of by shallow land burial was estimated at 1,700,000 cu ft, of which 95% was disposed of at the federal sites at Idaho, Richland, Oak Ridge, Savannah River and Los Alamos. An additional 800,000 cu ft per year was buried at private facilities. In order to assess the means of reducing stored radioactive volumes and lengthening facility life, investigations were conducted into the applicability of sorting, incineration, and compaction operations to the radwaste problem. This report summarizes the results of the investigation of the applicability of compaction to low-level radioactive waste volume reduction. The report concludes that (1) 50% or more of the solid radwaste generated at AEC facilities could be compacted and volume reduction factors achieved would range between 2 and 10, (2) compaction in Department of Transportation approved containers would result in cost savings, (3) airborne radioactivity is the primary health hazard, and (4) commercially available compaction units can be modified, cheaply. Compaction equipment should be contained in a chamber that has suitable off-gas treatment equipment and be remotely operable. Commercially available equipment is divided into four types; balers, compactors, baggers, and packers. (JT)

Directly applicable to shallow land burial.

(DH/JT)

WASTES, RADIOACTIVE; WASTES, SOLID; COMPACTION; WASTE DISPOSAL; BURIAL; WASTES, TRANSURANIC; ECONOMICS; EQUIPMENT; GASES; DENSITY; VOLUME REDUCTION; WASTES, LOW-LEVEL; THEORETICAL STUDIES

<885>
Watson, L.C., U.S. Atomic Energy Commission.

Mineral Exchange in Canada's Waste Treatment Program. (2)

TID-7644; Use of Inorganic Exchange Materials for Radioactive Waste Treatment, D.K. Jamison, et al (Eds.), Proceedings of a Working Meeting, Washington, DC, August 13-14, 1962. U.S. Atomic Energy Commission, Division of Technical Information, Washington, DC, (pp. 75-82), 238 pp. (TID-7644).(1963, January)

Contaminated wastes have been disposed directly to pits at Chalk River for ten years. The soil is such that it provides retardation of movement of Cs, rare earths, and transuranics by ion-exchange and adsorption, but not for Sr 90. Due to the uncertainty of the underground travel of Sr 90 it is necessary to limit if not avoid additions of Sr 90. A plant for treating the wastes needs to have a basic capacity of 25 to 50 gal (UK)/min and additional capacity to treat, within a reasonable length of time, 1 to 2 million gallons (UK) that would accumulate from a reactor accident. Waste treatment with the clinoptilolite is done in the following steps: mixing all relevant waste streams; adjusting them to pH 3; clarifying them; flowing the mixed waste through two beds of clinoptilolite in series and disposing of the effluent. The clinoptilolite beds are 3 ft deep by 10 sq ft with the mineral being granular. The initial head loss for a bed operated at 0.7 gal (UK)/min-sq ft is 6 to 12 in. of water. Problems with the fines created by crushing the clinoptilolite, plugging of the bed as a result of using Ottawa River water, and whether neutralization of the effluent before disposal is necessary still need to be solved. This work will ultimately include other Canadian sites. (WDW)

Sr 90

ACIDS; ADSORPTION; CLINOPTILOLITE; DECONTAMINATION; ION EXCHANGE; LABORATORY STUDIES; PLANTS, WASTE TREATMENT; PITS; pH; SOILS; WASTE TREATMENT; WASTE VOLUME; WASTES, LIQUID; WASTES, LOW-LEVEL; SOLIDIFICATION; ENCAPSULATION; WASTE DISPOSAL; DISPOSAL SITE

<886>
Zeger, J., and K. Knotik, Institut fur Chemie, Forschungszentrum Seibersdorf der Osterreichischen Studiengesellschaft fur Atomenergie, Wien, German Federal Republic.

Studies on the Thermal Stability of Bitumen-Salt Mixtures. (3)

Kerntechnik, 19(4):188-195.(1977)

The results of a study of the thermal performance of various bitumen/salt mixtures are presented. When $NaNO_3$ is added to the bitumen, the salt is not affected in air but

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WASTE TREATMENT

<8866> CONT.
at low temperature some decrease in weight was due to evaporation of volatile components. In nitrogen no visible effect was noted. No observable effect on the bitumen in the mixture was caused by K2HPO4.3H2O nor 4:1 KH2PO4+Na2B4O7.10H2O cause detectable changes in the bitumen/salt mixture with the exception of bitumen B 85. In this bitumen the stability was reduced in a temperature range of 180 to 200 degrees C. No reaction between KCl+NaNO3+Na2SO4+K2HPO4.3H2O and the bitumens occurred in either air or nitrogen. While no measurable effect of CaSO4+PbCl2+KH2PO4+Na2B4O7.10H2O on the bitumen was noted the stability was markedly poorer than that of pure bitumen paticularly for bitumen B 80. Sudden combustion was observed when the mixture was heated at 370 to 374 degrees C. A molten salt fraction coalesces and forms a salt block after cooling which is no longer enveloped in bitumen. A similiar combustion reaction occurs at 180 degree C for NaH2PO4+NaNO3/bitumen mixture, burning the bitumen and forming a used salt block. NaH2PO4+NaNO3+KH2PO4+Na2B4O7.10H2O remains in the bitumen after heat treatment up to 500 degree C. Fe(NO3)3.9H2 and Fe(NO3)3.9H2O+NaNO2 had an extremely violent reaction completely burning the bitumen. A full study was done on the iron nitrates and chromium nitrates. The results showed salts which release oxygen at relatively low temperatures have the greatest effect on the thermal stability with the important factors being kind and rate of oxygen release. However, thermal y unstable hydrous salts had hardly any effect on the surrounding bitumen. Nitrite and nitrates release strongly oxidizing gases which attack the bitumen. Hence, low to medium level liquid wastes generated in the course of operation of nuclear power plants are suitable for embedment in bitumen after concentration and drying. The liquid wastes from nuclear fuel reprocessing plants will have to be specially dried and embedded due to nitrate and heavy metal ions. (NDV)

ACIDS; BITUMENS; CHROMIUM; DRYING; IMMOBILIZATION; IRON COMPOUNDS; OXIDES; SALTS; NITROGEN COMPOUNDS; SODIUM COMPOUNDS; WASTES, RADIOACTIVE; WASTES, LIQUID; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-LEVEL; LABORATORY STUDIES

<8867>
Zeger, J., K. Knorik, and H. Jakusch, Institut fur Chemie, Osterreichische Studiengesellschaft fur Atomenergie GmbH, Seibersdorf, Austria; Vereinigte Elektrizitaetswerke AG, Zeltweg, Austria.

Sedimentation Technique of Waste Bitumenization and Thermogravimetric Characteristics of the Final Products. (3)

CONF-760310; STI/PUB/433; IAEA-SM-207/55; Management of Radioactive Wastes from the Nuclear Fuel Cycle, Proceedings of an IAEA Symposium, Vienna, Austria, March 22-26, 1976, Vol. 2, (p. 113-122), 624 pp. (IAEA-SM-207/55, CONF-760310, STI/PUB/433). (1976)

This paper reports on a new bitumenization process for low- and intermediate-level wastes that has been tested inactively at the Osterreichische Studiengesellschaft for Atomenergie GmbH since 1973. Its main features are: 1) dewatering of the waste solution by distillation, leaving only dry salts, 2) mixture of the salts with liquid bitumen via sedimentation, and 3) no use of mechanical mixers, making decontamination simpler. The final product is 50-70 wt% salts, and has a leach rate of 3 x 10(E-4) g/sq cm per day after 120 days, using 52 wt% NaCl as the salt and distilled water as leachant. Thermogravimetric analyses of simulated products were made in a Mettler-thermoanalyzer at temperatures up to 500 degrees C. and under both normal atmosphere and nitrogen. Results showed that the thermostability of bitumen is impared by nitrate and nitrite, especially in the presence of Fe(III) as catalyst; there is a sudden weight loss between 370 and 410 degrees C., reflecting the oxidative decomposition of bitumen. Normally, this should pose no serious problem, as the maximum temperature encountered during processing is 200 degrees C.; however, in the interest of long-term storage, the salts may be denitrified with formaldehyde or other reducing agents, or Fe (III) inhibited by hydrolysis. A method has also been developed for measuring the dose rate of an unknown radioactive salt mixture at any point in the mixture. The procedure is to make two measurements with glass dosimeters, first with a beta-absorbing layer of rubber to determine the gamma-dose, then without the absorber for the combined dose. (LKH)

Leaching Rate

BITUMINIZATION; NITRATES; NITRITES; IRON; DOSIMETERS; DOSE RATE; SALTS; NITROGEN COMPOUNDS; WASTE TREATMENT; WASTES, LOW-LEVEL; WASTES, INTERMEDIATE-[illegible], LIQUID; BITUMENS; LABORATORY [illegible]

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Geologic Survey Research 1961, (pp. D-376 - D-379) 167

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